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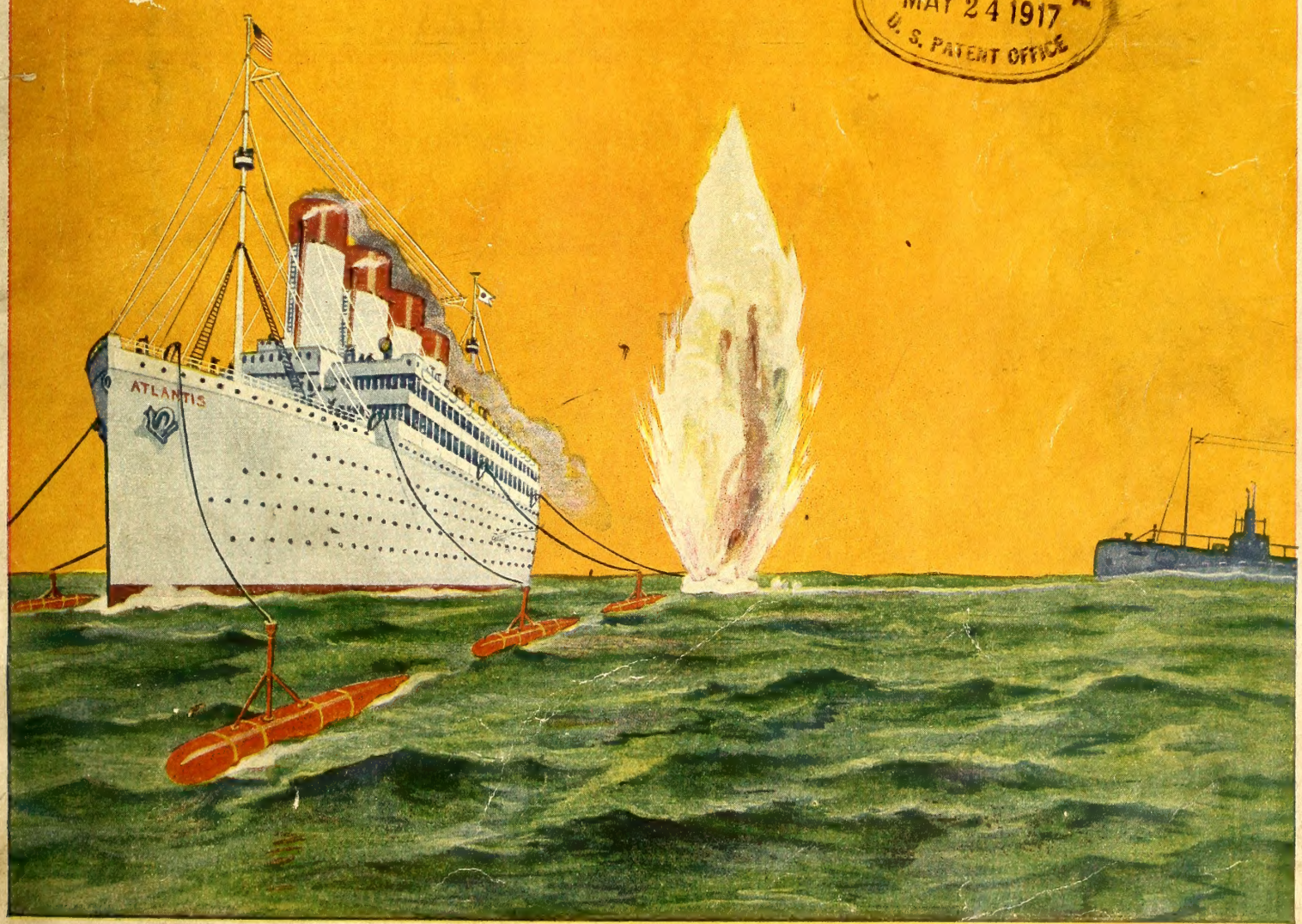
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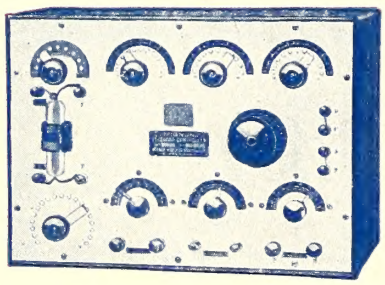
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War and the Radio Amateur

THE Radio Act of 1912, under section 2 states:

Every such license shall provide that the President of the United States in time of war or public peril may cause the closing of any station for radio communication and the removal therefrom of all radio apparatus, or may authorize the use or control of any such station or apparatus by any department of the Government, upon just compensation to the owner.

We now stand on the threshold of war; indeed, before this issue is in the hands of our readers war will have been declared, or what is equivalent, this country will be in a state of war.

Let us then be perfectly frank with each other, and let us face the situation as it behooves upright, patriotic, law-abiding citizens. The European war has taught us that messages sent from secret radio plants by spies have been of priceless value to the enemy. Small wonder then that hysteric officials of all the warring nations have exterminated every possible as well as impossible private wireless plant in their respective countries. But to what good? True, every stationary outfit has been dismantled or confiscated by the warring Governments, but as always: where there's a will there's a way. When the German spies in England and in France found that it was not very healthy to operate their outfits in attics or in house chimneys—for a sending outfit is soon located—they simply put their radios in touring cars, cleverly concealing the aerial wires inside of the car bodies. The apparatus too were easily concealed, and the English and French were outwitted simply because you cannot locate a moving radio outfit except by pure chance.

Which brings us face to face with the question: Did it pay the warring nations to kill the few private Radio stations they had before the war? We are honestly inclined to believe that far from being an advantage, it proved an actual disadvantage. No one at all familiar with the technique of the radio art, doubts for one minute that if a spy has the courage as well as the funds—and spies always have both—he cannot be stopt from sending wireless messages if he elects to do so. Working under cover and by moving from one place to another, nothing will stop him.

If we recognize this truth we realize how absurd it is to close all privately owned radio stations during the war. It will do no earthly good and can do only actual harm. Now we do not wish to appear selfish, nor do we wish to be classed as unpatriotic. Very much the contrary. If the administration, after carefully considering all the facts, decides to close all privately owned radio stations in this country, we will not as much as raise a single word of protest. The administration knows what is best for the welfare of the country and in time of national peril we would be the last ones to annoy our officials.

But is it not true that our splendid body of over 300,000 patriotic American Radio Amateurs, scattered thickly all over the country, can be of inestimable value to the Government? Can not our red-blooded boys be trusted to assist our officials in running down spies, who probably would not be readily located otherwise? In our big cities thousands of ears listen every minute of the day to what is going on in the vast ether-ocean. Trust our very capable American youths to ferret out the senders of questionable signals or strangely worded messages. The very multitude of these amateurs is a priceless protection. Then again both our Army and Navy badly need Radio operators. What other country can furnish such a vast army of well trained and intelligent operators as ours, thanks to the amateurs?

When in 1916 the writer organized the *Radio League of America,* he incorporated in its statutes that every member should pledge in writing his station to the Government. Up to this moment the League has forwarded to Washington thousands of such pledges, among them every important amateur station in the country. These stations can be used by the administration at a moment's notice. At least our amateurs are fully prepared.

Would it not be questionable wisdom to shut down all these stations that can and will do enormously more good than possible harm?

Let our officials ponder and let them consider fairly the facts in the case. That is all that we desire.

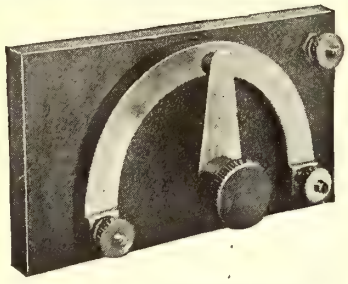
H. GERNSBACK.

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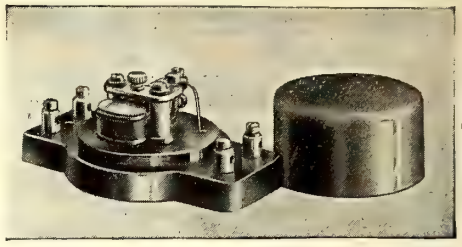


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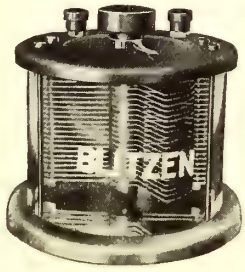
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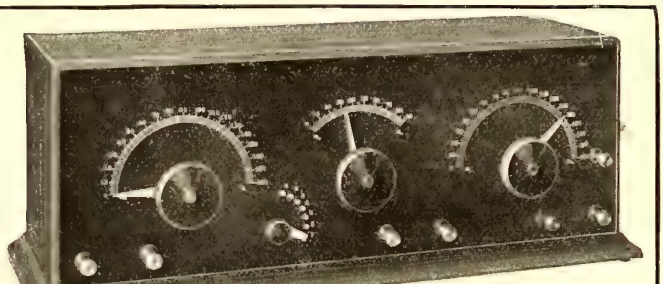
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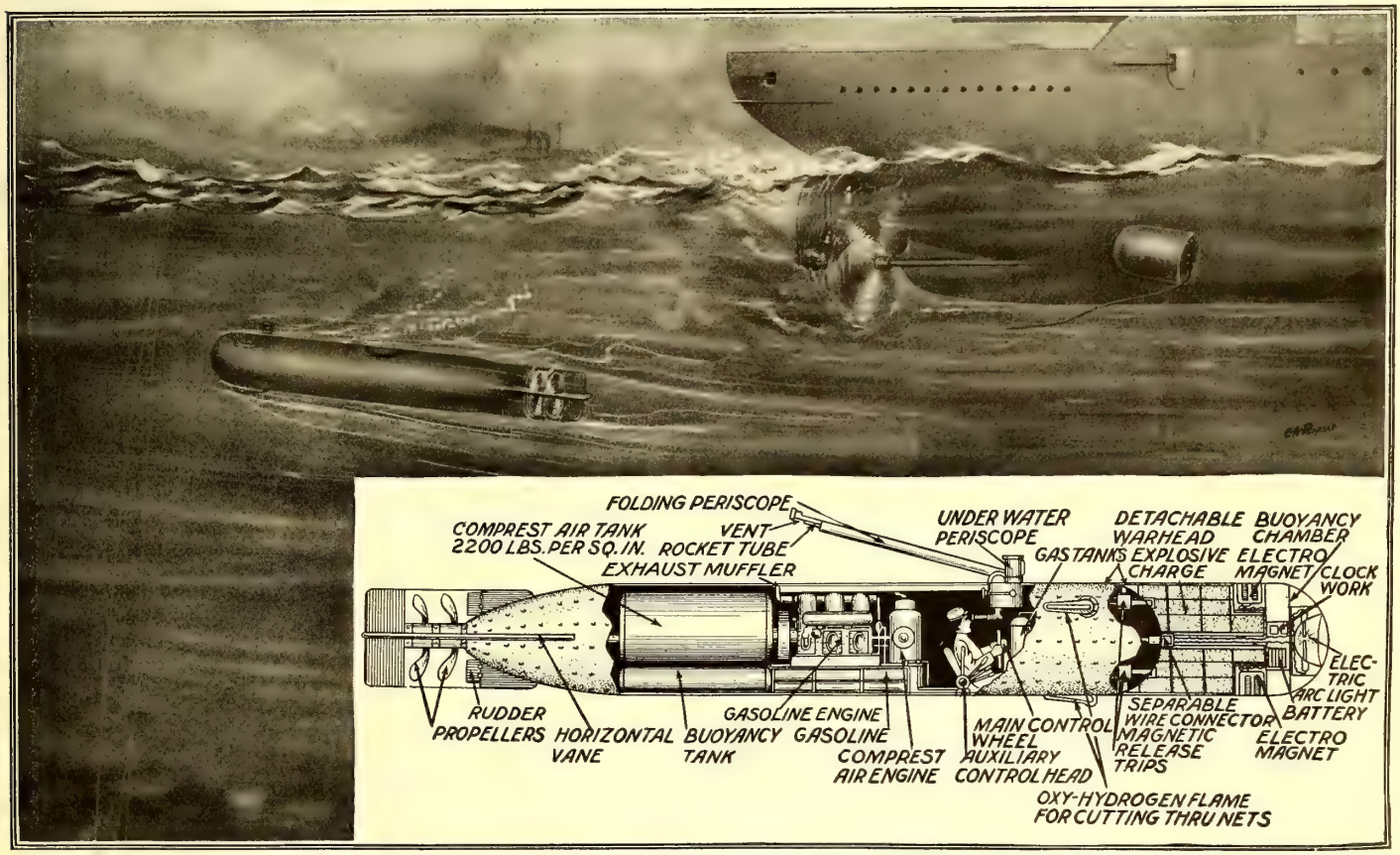
A One-Man Electric Submarine

By H. WINFIELD SECOR

WHILE Henry Ford has been urgently advocating the use of a one-man submarine of more or less efficacy, and comprising among other things a long collapsible pole extending from the miniature submarine, on the end of which there is supposed to be placed a torpedo or bomb which is to be exploded by the operator within the submersible, a number of other enterprising inventors have been engaged on a similar yet somewhat different problem. One of the most promising of these designs for a one-man submarine is that of Mr. Eric R. Lyon, the engineer who was responsible for the mastodonic two-hundred-foot high electric gyro-cruiser featured in our February, 1916, issue.

The accompanying illustration shows a detailed view of a one-man electro-mechanical submersible along the lines laid down by Mr. Lyon, and also an artist's conception of one of these demons of war making its attack on the hull of a mighty Dreadnought, with a magnetic bomb properly timed to explode a few minutes after its attachment, in order to give the operator of the one-man submersible sufficient time in which to get far enough away from his victim to protect himself.

In the first place, it is the inventor's idea to make up these miniature submersibles of about the same size as the modern automobile torpedo, or measuring say 25 feet long by 3 feet in diameter. This compares approximately with the dimensions of the latest type U. S. torpedo with a range of ten thousand yards or 5.7 miles. When comprest air is utilized for propulsion, the air being stored in the tank at two thousand pounds pressure to the square inch, the comprest air engine used in the modern torpedo (and which could be adapted to the one-man submersible) is rated at two hundred horse-power for the above range, if the craft is to make a speed of 42 knots or approximately 50 miles per hour. In the event that the navigator of such a submersible should have to make a detour in order to get back to the mothership or to his shore base, it would be advisable to equip the boat with an auxiliary gasoline engine as shown in the accompanying illustration. Most probably under ordinary conditions, the operator of this new war engine would have no trouble in getting back to his base of operation by means of the comprest air equipment. It has been claimed by Mr. Ford and other investigators that it is now possible to operate a gasoline engine under water by means of special absorption apparatus attached to the exhaust manifold of the gasoline or other engine, and that this means of propulsion can be attached to submarine war vessels. If such is the case, then it



The One-man Electric Submarine Here Shown in Detail and Also in Action Has Considerable Promise. It Can Dart Thru the Water at Torpedo Speed (50 miles per hour) When, Having Attached Its Magnetic "War-head" Containing the Gun-cotton and a Time Fuse to the Hull of an Enemy Vessel, It Can Easily and Quickly Make Its Escape at Mile-a-minute Speed. It Should Prove Ideal for Coast and Harbor Defense.

"ELEVATING" CENTRAL.

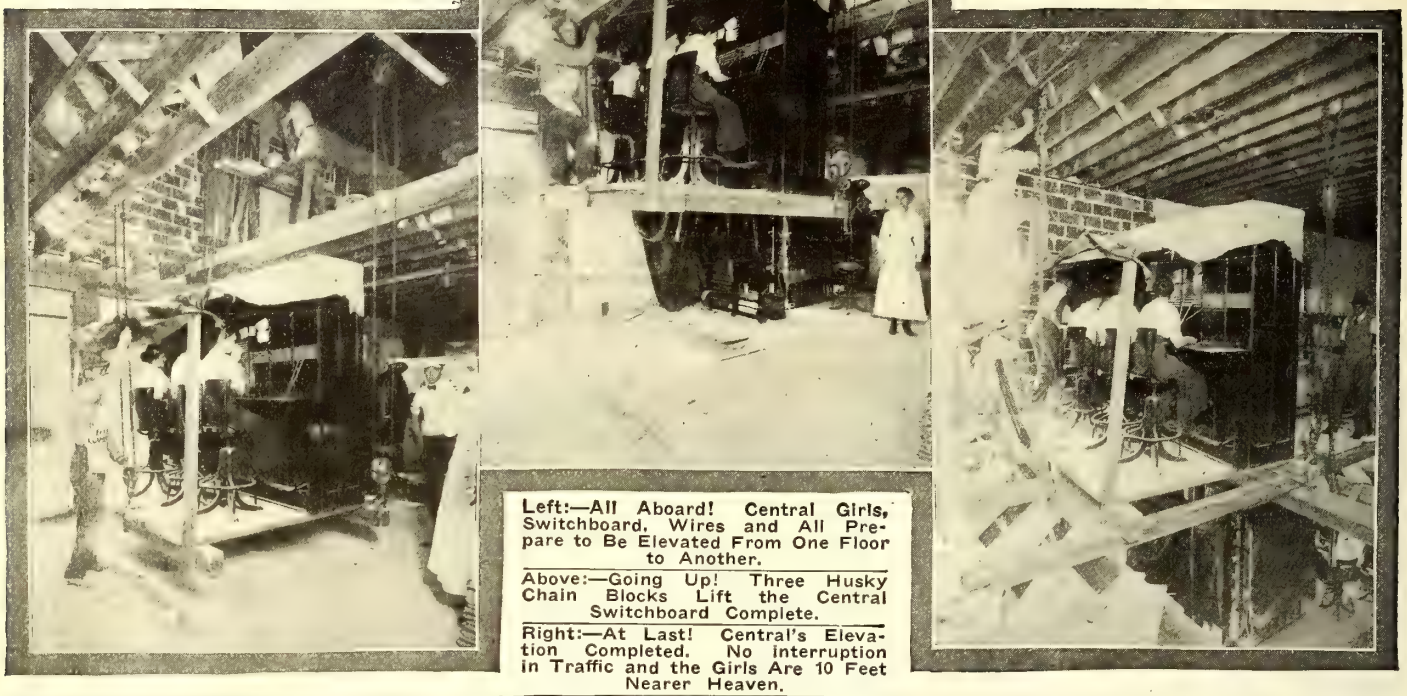
The upper stories of the West Palm Beach Telephone Company's office in Florida, which has just had two floors added to it, was the scene of a remarkable engineering feat recently.

Under the new arrangement it became necessary to remove the big switchboard, at which the operators sit and make the connections that enable people to communicate with each other on an infinite variety of subjects, important or affectionate or merely frivolous, from the third to the fourth story. The move was made in the following simple but effective manner.

A platform composed of two pieces of 4x6 timber, on which was laid a floor of 2x12 planks, was built under the heavy switchboard—wide enough to accommodate the operators' chairs around the edge of the board. Slings were then placed about the whole business, to which a tackle and three heavy differential blocks, each capable of handling a weight of four tons, attached to a sling of log chains fastened to a heavy beam at the top of the fifth story.

The switchboard, with the girls seated at it, and still carrying on their work, was hoisted thru a hole in the floor of the fourth story.

The work was carried on without a hitch, and the girls remained suspended until the floor had been rebuilt under the switchboard. There was not the slightest interruption to business from first to last during the ascent. Nor did the subscribers, talking over the switchboard, suspect in their wildest utterings, that "Central" Switchboard Girls—chewing gum and all—were moving skyward, angel-like, all the while.



Left:—All Aboard! Central Girls, Switchboard, Wires and All Prepare to Be Elevated From One Floor to Another.

Above:—Going Up! Three Husky Chain Blocks Lift the Central Switchboard Complete.

Right:—At Last! Central's Elevation Completed. No Interruption in Traffic and the Girls Are 10 Feet Nearer Heaven.

will mean that the one-man submarine will become all the more practicable.

Coming down to the means whereby this novel engine of war is to be used in carrying out offensive operations, we see upon looking over the detail drawing that in front of the submarine there is a detachable *war-head* in the form of a steel cap which fits against the parabolic nose of the submarine very tightly. This war-head contains the usual quantity of gun-cotton or other high explosive. Suitable quick-acting magnetic clutches enable the operator to instantly release the entire war-head at any desired moment.

This submersible not only carries two distinct forms of prime mover, but also carries the necessary gas tanks to supply a set of ultra-powerful oxy-acetylene flame nozzles, suitably disposed about the forward part of the vessel on the exterior, and by means of which the operator can *burn his way thru any ordinary submarine net entanglement.*

This feature is one of the latest scientific discoveries and involves the operation of an oxy-acetylene flame *under water,* which is made possible by blowing a stream of comprest air around the gas nozzle, and in this way forming a flame pocket in the water so to speak.

Mr. Lyon is very enthusiastic on this particular innovation, and has drawn plans for a one-man submarine which utilizes an extra powerful and especially contrived set of these high power oxy-acetylene nozzles with which to burn a hole thru the bottom of a Dreadnought, causing it to founder sooner or later.

Among the other interesting features of the idea here pictured we find a collapsible periscope which may be folded down into a suitable pocket provided in the top of the hull, and attached to which there is an air tube and also a (distress) rocket shute. When running submerged, a special air machine is used to supply the necessary oxygen to the navigator. A powerful electric searchlight is fitted to the front of the detachable war-head and by means of the small periscope shown the operator can see ahead at a considerable distance under the water. A compact but powerful battery is contained in the war-head which can supply sufficient energy to energize the electromagnets which hold the explosive chamber to the hull of the enemy war vessel once the operator has managed to approach close enough to accomplish this result.

The war-head also carries a special electric time switch, which functions a few minutes after the war-head has been attached magnetically to the hull of the enemy vessel, and which causes an electric spark to detonate the gun-cotton charge.

It has been argued by a number of naval experts that the *One-man Submarine* is doomed to failure for several different reasons. This, however, does not seem to be the case so far as we can see, and providing the submersible is properly designed in its details.

Let us take a concrete case for example to show how the Lyon one-man ship destroyer would go about its task.

Assuming that these engines of destruction, of which there would be most probably several in each attack to make doubly sure that the enemy would not escape, have been despatched either from a fort or other point on the coast, or from a mother-ship several miles distant from the enemy, the intrepid navigator of the 50-mile-an-hour submarine starts forth on his perilous journey. With only his periscope exposed and at a distance of several miles, it is well known that a periscope projecting a foot or so above the water presents an almost impossible target for ordinary gun-fire, and moreover, as the vessel darts forth on its way and as the range decreases between himself and the enemy, the buoyancy and submerging tank motor-pumps are manipulated so that only occasional sightings are made with the periscope. It thus becomes very problematical whether the enemy could hit the submarine. Also at a distance of say one mile, and in accordance with standard submarine maneuvering the submarine officer then proceeds to take accurate sightings of the enemy both with regard to the range and the direction geographically, after which he submerges and may proceed at high speed at a depth of fifteen to twenty feet below the surface of the water (the same as modern torpedoes) and in a little over a minute or so, and providing he has gaged the enemy's position accurately, he will find himself in the vicinity of the bottom of the hull. Owing to the high speed possible with this miniature submarine, built like a torpedo, it should be possible for the navigator (in the event that he does not strike his mark, when he has gone the range calculated up-

(*Continued on page* 47)

Electrifying the Aeroplane

ELECTRICITY is being rapidly introduced in the new art of Aeronautics as the illustrations herewith tend to testify. The greatest development in the art of flying is the aerial limousine or so-called *Autoplane* illustrated in Fig. 1, which was exhibited at the recent aeroplane show held in New York City. This aeroplane is built in the form of an automobile limousine and equipt with three planes for the sustaining surface. Aside from its perfect mechanical features its electrical equipment is exceedingly interesting, as the engine is automatically started by means of an electric motor installed exactly the same as the modern automobile engine electric starter. The engine develops 100 horsepower and drives a four-bladed propeller placed at the rear. The interior lighting is accomplisht entirely by electric lamps and its ignition is of the very latest electrical design. Altho it may seem that the machine was not made for speed, yet it has a speed range of sixty-five miles per hour and can sustain a weight of 710 pounds. It can carry two passengers and a pilot.



Fig. 1. The latest in flying machines—the "Autoplane." It is an aerial limousine.

The *stallemometer* illustrated in Fig. 2 is an electric instrument devised to warn the aviator when his machine is approaching a *stalling* condition by indicating that the minimum air speed has been reached. It is mounted in any convenient position where the air flow is unobstructed.

The stallemometer is adjustable for any desired air speed, depending on the aeroplane on which it is installed. When the predetermined speed is reached, an electric contact is closed in the stallemometer, closing the circuit thru an indicating lamp mounted on the instrument board stationed in front of the pilot.

An *incidence indicator* increases the efficiency of an aeroplane by warning the aviator before he stalls and by enabling him to get the best climbing and gliding angles out of his machine.

The transmitter of the *Incidence Indicator* in Fig. 3, is mounted on a forward strut so as not to interfere with any part of the plane. The lamp bank or indicator is on the instrument cowl, always visible to the pilot observing other essential instruments. The red light warns the aviator before he stalls as well as when he begins climbing at a dangerous angle. The white lamp signals whenever the pilot dives at too steep an angle. The green light indicates the best climbing angle. Being of low voltage as well as low current consumption, the lights can be operated on a dry battery, encased in metal and installed wherever most convenient. The signals are regulated by a vane operated by the air stream.

The lamp bank container is seen in the background. Each lamp is equipt with the proper colored screen and each connected to the required contacts enclosed in the incidence indicator chamber. The lead wires are led thru one of the supporting tubes.

Aviators wishing to know at any time the correct 'fore and 'aft position of the machine, with reference to the horizontal, can read it on the scale of the dead-beat *clinometer* illustrated at Fig. 4.

The operation of this instrument is simple. Whenever the clinometer is tipt forward or backward by the motion of the plane, this movement is registered on a scale mounted on a wheel which is damped by floating in a liquid.

If the aeroplane tips forward, the scale moves upward, indicating in degrees below the zero line the exact angle. If the machine tips backward, the scale moves down-

(*Continued on page 54*)

Fig. 3. Electrically operated "Incidence Indicator" for showing best gliding and climbing angles.

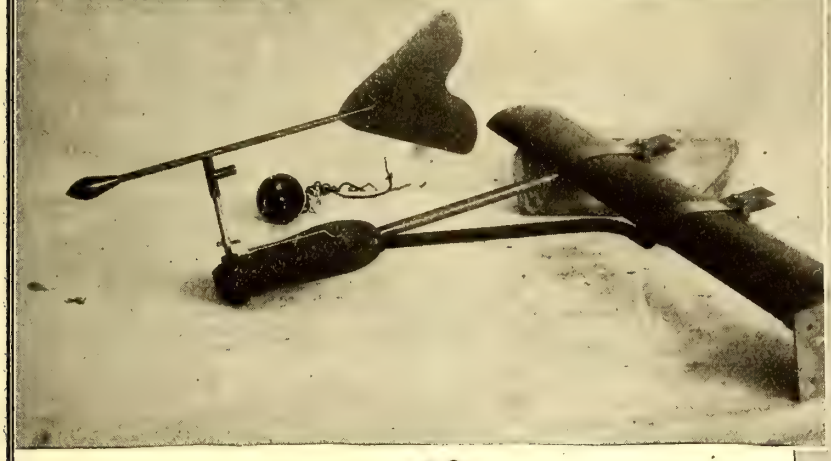


Fig. 4. Dead-beat "Clinometer" which shows angle of aeroplane with the earth.

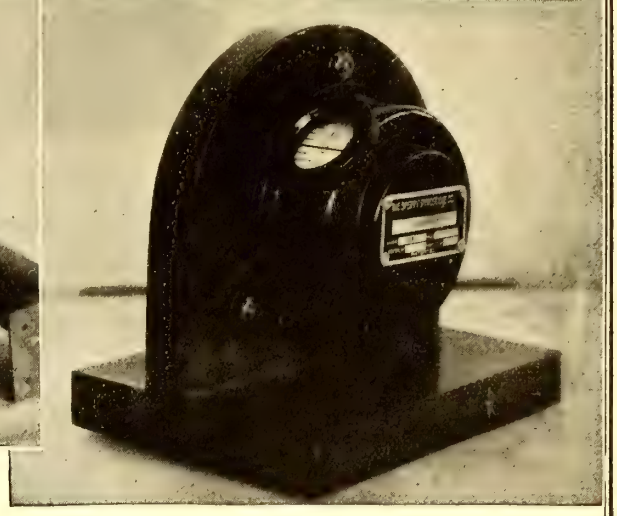
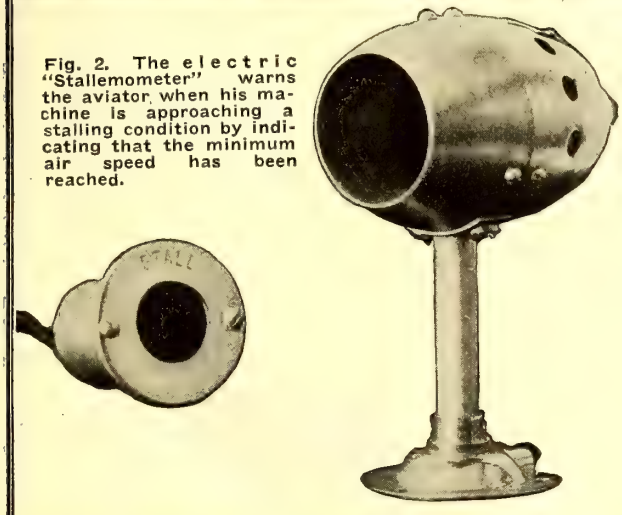


Fig. 2. The electric "Stallemometer" warns the aviator when his machine is approaching a stalling condition by indicating that the minimum air speed has been reached.



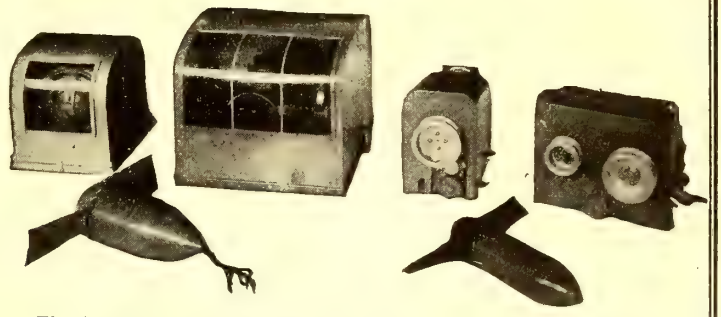
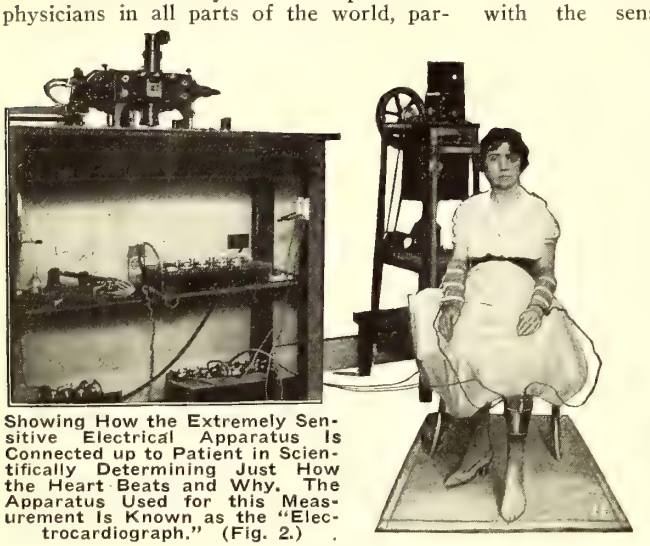


Fig. 5. The "Sperry Automatic Pilot" which, by means of electric driven gyroscopes, serves to control and maintain an aeroplane in any desired position; the pilot may drop bombs, etc.

The Autograph of Your Heart

By SAMUEL COHEN

ONE of the most important mechanisms of the human body is the Heart. Its action in health and disease has been the subject of attention by numerous prominent physicians in all parts of the world, particularly those interested in fighting *heart disease,* the most unrelenting malady with which one can be stricken. Yet it has been said that 15,000 to 20,000 school children in New York alone are suffering from it.



Showing How the Extremely Sensitive Electrical Apparatus Is Connected up to Patient in Scientifically Determining Just How the Heart Beats and Why. The Apparatus Used for this Measurement Is Known as the "Electrocardiograph." (Fig. 2.)

In view of its most important function and delicate structure, cure, by way of operation, is usually impossible. Therefore, the only thing left is to carefully study the heart, locate the trouble and determine the reasons for this trouble. A *first aid* in this direction is a biographical history of the patient.

The rapid growth of this disease, and the rapid advancement of science has led to the development of a new instrument called the *Electrocardiograph.* This instrument is really a modified Einthoven galvanometer, consisting of a very powerful magnetic field produced by an electromagnet and excited by a constant direct current, such as the current given by a storage battery. A very short air gap is made between the poles of the magnet and in this powerful field a fine quartz filament or fiber is stretched. Delicate adjusting means are provided for controlling the tension of this wire. (See Fig. 1.)

A small diafram is placed on the center of this which closes two small holes that extend thru in each pole piece. These holes are the condensing microscopes and the projecting microscope to focus a fine beam of light to strike a moving photographic film. If the wire is slightly displaced by the passage of an electric current thru it, it will naturally displace the small diafram and in turn permit the fine beam of light to pass thru the openings and strike the film placed opposite to the projecting lamp throwing out the fine beam of light. It will, therefore, be seen that by displacing the quartz wire in certain movements that a record will be made on the film accordingly. This quartz filament is connected to a Wheatstone bridge of proper dimensions and also to special terminals which are connected to the patient whose heart is to be examined. These terminals are three in number and are made of German silver plates, each of them being fitted with binding posts connected to the leads, connecting the plates with the sensitive galvanometer and Wheatstone bridge circuit. Two of the plates are secured to the arms of the patient, while the third terminal is strapt around the left ankle. Proper care is taken to see that the electrical connection between the body and the terminal is of low resistance and for this purpose a wet cloth which is saturated with a 20 per cent salt solution is placed between the foot and plate and again the cloth is wrapt about the plate. The Wheatstone bridge circuit is balanced so that the resistance of the electrical path between terminals is constant, and this is obtained when the quartz string or filament of the galvanometer is in a zero position.

It is evident that a slight addition of current to the galvanometer circuit will cause a displacement of the filament, which is recorded on the film. Since the *contraction of the heart creates an electric current* as found by various scientists, and as the intensity of this current depends upon the intensity of the heart contraction, it is therefore obvious that the fine quartz wire will be displaced a certain amount by the generation of current by the heart. With the contraction wave, the electric potential spreads over the heart and thus the galvanometer records the heart beat and also indicates the origin and path by which the current spreads.

An exact replica of the apparatus used in recording the pulsation of the heart is illustrated in Fig. 2. This shows the apparatus in actual use and also how the various electrodes are secured to the patient. This photograph was taken at the time a record was actually being made of the condition of the patient's heart. The sensitive galvanometer is seen at the left, while the beam of light is derived from a powerful arc projector stationed at the extreme left, but not shown. The instrument at the extreme right is the photographic film apparatus. The film is driven at a definite and uniform speed by an electric motor mounted at the bottom of the machine. This instrument is placed in exact line with that of the telescope of the galvanometer pole-piece. The resistance box is shown on the shelf of the galvanometer table.

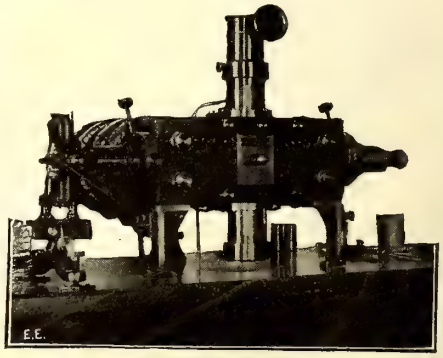
The instrument traces its indication of conditions in the heart by curves on the photographic film. These heart pictures are as characteristic as finger prints or photographs. No two individuals' hearts beat alike, and the electrocardiograph, by its extremely delicate registration of the contraction of the muscle, readily shows the most minute difference.

A remarkable story of a *dying heart* is told by the accompanying curves registered by the electrocardiograph. The graphs illustrating this remarkable story are shown in the third figure, and these were taken by Dr. R. H. Halsey, of New York City.

The records here reproduced form an almost complete electrocardiographic record of the heart beat during the last moments of the patient's life. Tho death was expected, yet its actual advent was much earlier than had been anticipated; the transition from life to death was abrupt. The warning of change is to be found in the lengthened conduction interval and in the changed ventricular complex of Fig. 5. That fibrillation of the ventricles was not the immediate cause of death is clear from Fig. 6, taken when the usual signs of life were in abeyance; the heart was profoundly affected, and the patient past all possible hope of recovery before fibrillation ensued.

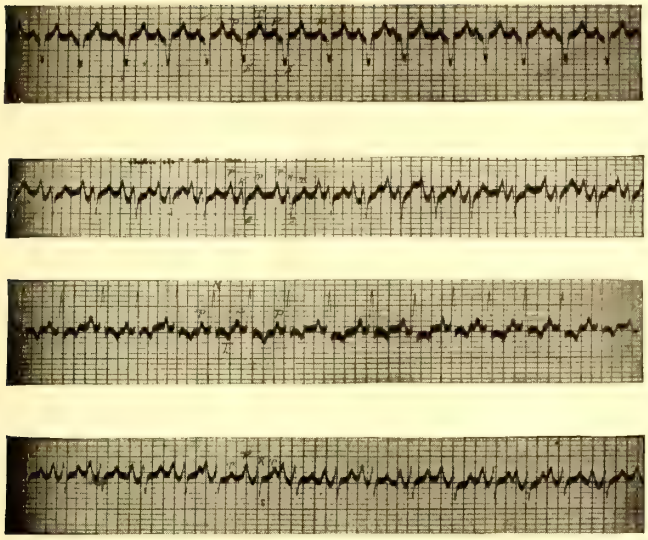
The record was obtained from a female patient thirty years of age, suffering from broncho-pneumonia of both lower lobes. The curves were taken one after the other in quick succession and are described in this order. In Fig. 1 the frequency of the heart is 75. The duration of the diastole* varies from 0.2 sec., to less than 0.1 sec., and is non-rhythmic. The up-stroke of P is quicker than the downstroke. The conduction time is within the normal limits of 0.2 sec. T is upward in its direction and of considerable excursion. In the second figure, the frequency of the heart is 80. There are the same vibrations in the duration of the diastole. The *electrocardiograph* Figures 3, 4 and 5 show the different frequencies of the heart at different periods. In curve 5, the frequency of contraction of the heart appears to have dropt to 45, while association of auricle and ventricle is still present. The conduction time is 0.4 sec.; double the time in the earlier record. During the very brief interval between the taking of Figs. 5 and 6, convulsive gasps and a slow contraction of the skeletal muscles occurred. In Fig. 6, the change is re-

IN the present article we have one of the most interesting and startling revelations of what medical science, plus electricity, is doing to bring about a clearer understanding of our bodily actions. Herewith is presented a true electrical record of a patient's heart, which shows the fluctuations occurring just before and at the critical moment when life ceased to exist. In other words, the patient died.



Close View of the Einthoven String Galvanometer Used in Actually Measuring and Analyzing the Infinitesimal Electrical Currents Produced by the Human Heart at Every Beat. Did You Know that Your Heart Was a Dynamo? (Fig. 1.)

* Diastole is the period of rest between contractions of the heart.



(Above)—Figures 1 to 4.

markable, and the frequency of the ventricle has increased to 63 per minute. The remaining complexes vary in their detailed form, but are similar in general outline. In Fig. 7, there are no evidences of coordinate ventricular contraction. The remaining records are similar; in Fig. 13, *all movement ceased permanently, the patient having died.*

When the heart takes a sudden jump to the fast rate, stops suddenly and returns to the normal rate, a typical curve is made as indicated above. This condition is called a "flutter." The auricles of the heart sometimes contracting three hundred times a minute and the ventricles only one hundred and fifty times a minute!

By the use of the electrocardiograph and a stethoscope connected with a microphone, the sounds made by the contractions of the heart are recorded with curves indicating the rhythm so that the exact point in the heart cycle of various normal and abnormal sounds may be recorded.

Electrocardiograph records showing the action of the heart under certain treatment may be made and sent to physicians in various parts of the world, who by interpreting the curves can obtain information of great value in the treatment of their own patients.

In order to standardize such records, the tension of the galvanometer quartz wire is adjusted so that a current of one-thousandth of a volt will deflect the filament to such an extent that its shadow projected on the recording film will move one centimeter in both directions! Since the wire is set to move a definite amount for a known voltage of current, the deflection shows the amount of current that caused it. The heart of the average individual causes a deflection which indicates the passage of a current of approximately one to two one-thousandths of a volt. Thus it is known that it would require the heart beats of thousands of persons to generate enough current to light an incandescent lamp.

In conclusion it may be said that the conditions of the human heart can now be studied with far greater accuracy than was ever possible heretofore, thanks to the Electrocardiograph.

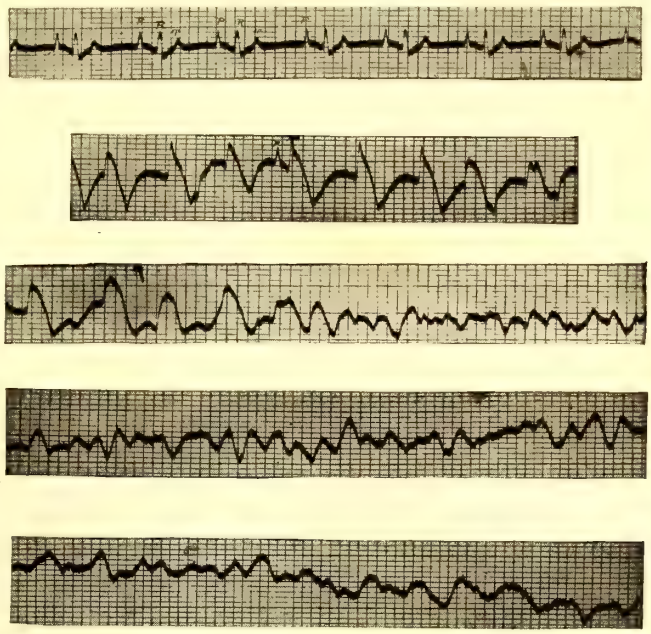
RADIUM AND CANCER.

"The Other Side of the Radium Cure" is the title of an article by Dr. J. H. Blaisdell, in the Boston *Herald.* This is of such great interest that we give it below, as many of our readers have undoubtedly read the recent report of the Director of the Crocker Cancer Research Commission printed in these columns.

"Newspaper interpretation of medical subjects, vital to the interests of the health of the community," says Dr. Blaisdell, "should be peculiarly conservative and well advised. To me your editorial comments on radium in cancer on Wednesday morning of this week seem especially open to criticism on this score.

"Briefly stated, your summing up of the findings of the Crocker cancer commission of Columbia University unqualifiedly placed radium in the discard as a 'cure,' damned it with faint praise as a palliative, and noted with the cheerful abandon of 'life opportunity given the medical profession to make 'the patient's condition worse than if he had been left alone.' Such is the pessimistic side of the picture based on truth but, unfortunately for your readers, only half the truth. Simply because radium cannot act as a 'cure' in inoperable or hopeless cases of systemic cancer is no reason why readers should be instructed to regard it as a discarded fad to the utter disregard of countless cases of early malignant disease that this remedy has saved.

"Point out rather to your readers (referring to the editor of the Boston *Herald*) the significance of the recent purchase of many thousand dollars' worth of radium by the Huntington Hospital of Boston, as an example of how useful it is in experienced hands. Tell them of its curative effects beyond that of any other remedy in epitheliomas or cancers of the skin. Lay your emphasis on how radium can absolutely prevent cancers of the skin if people could be taught to have the early pre-cancerous possibilities such as keratoses, warts, moles, etc., removed before degeneration starts. By such statements it seems to me you would be doing the greater services to the community and more rightly interpreting the findings of the Crocker Cancer Commission on Radium."

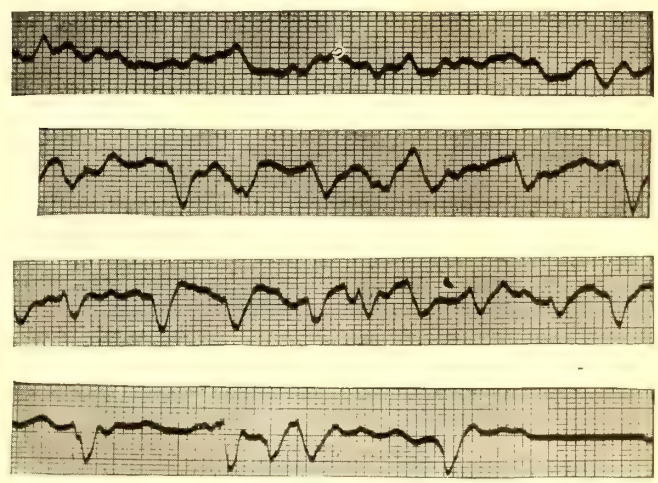


(Above)—Figures 5 to 9.

MAN SWALLOWED $20,400 WORTH OF RADIUM.

In an article treating on the use of "Radium in Surgery and Gynecology" in *Radium,* Dr. John M. Lee relates a peculiar accident which happened in applying a valuable tube of radium. Sarcomata and epitheliomata of the tonsils in several patients have yielded excellent results. In one of my first cases, a vigorous, powerful man, with more money than judgment, jerked his head backward thru the supporting hands of the nurse, and at the same time yanked the mucous-smeared and slippery braided silk thread out of my hand, just as I was about to seize the tubes in the pharynx with forceps, and swallowed 175 milligrams of radium in three well-screened tubes. He refused immediate gastrotomy, and the tubes were past thru the alimentary canal at the average rate of nine inches per hour. No injury followed and he said: "None of the crowned heads of Europe have anything over me in luxurious repasts, for I have had the only distinction of the consumption of a $20,400 meal."

(Below)—Figures 10 to 13.



The Above Electrocardiograph Records, Numbered 1 to 13 Consecutively, Represent the Most Remarkable Scientific Analysis of Just What Does Happen In a Person's Heart Shortly Before and at the Exact Period When Life Ceases to Exist, or Death. By Inspecting These Charts of the Heart's Variations During the Last Moments of the (Female) Patient, a Victim of Broncho-Pneumonia. One Can See How the Heart Started to Fluctuate Progressively, Finally Stopping Action at the Right End. (Fig. 13.)

Combating the Torpedo*

By H. GERNSBACK

WAR after all is but a game of chess. The greatest generals of modern civilization realized this so profoundly that every one of them had been at one time a good chess player. In war, as in chess, luck plays but an insignificant part. Given like equipment, the general who has the greatest strategical ability will win, whether it be in the field or on the chessboard. Also, if both opponents can sufficiently anticipate each other's moves, no one will win. In this case there will be a *stalemate*, as it has existed for over two years in France. But stalemates necessarily always denote equal strength of both opponents and a stalemate often turns out to be a negative victory, for it is certainly not defeat.

The present submarine warfare is no exception to the rule of comparing war to chess, for the simple reason that it is an uneven game—all the powerful pieces are on the U-Boat's side and no Queen, Rooks and Knights on the other side of the board to defend the King. At least there was no defense worthy of the name up to a few months ago.

But science, as always, is progressing steadily and soon the submarine will have found its master, or at least its equal, with which to stalemate it.

Let me first correct a popular illusion. Almost every one of us thinks or speaks of the "deadly submarine," when, as a matter of fact, the submarine itself is not only not deadly but a very weak contrivance at best. Point a 3-inch gun at it and it will vanish instantly. Send a 20-foot motor boat chaser against its periscope and the "deadly" submarine at once becomes deader than the proverbial doornail.

It is the submarine's deadly weapon—the torpedo—that has so far out-generaled the cleverest brains and has given the greatest statesmen untold sleepless nights. To fight the submarine itself is comparatively easy, given good guns and good gunners on board the attackt ship, providing of course that the enemy submarine commander is foolish enough to expose his craft too much above the waves.

Several methods have been adopted of late to combat the submarine, none of which have been great successes.

First, we have the smoke-screen—perhaps one of the most effective schemes developed lately. By means of dense volumes of chemical smoke, blown around the ship by powerful exhaust pumps, the ship is enveloped almost completely in a fog-like screen and it becomes a very difficult target for a torpedo. The ship's bow, however, is nearly always exposed. The other method is to protect the ship with strong torpedo netting suspended by means of booms from the ship. The torpedo upon striking the net is thus rendered harmless, as it never reaches the ship, unless the netting is made of rope and the torpedo is equipt with cutting blades. In that case the torpedo will strike the ship and blow it up.

But the one great drawback of the netting is that it is almost impossible to use it on a fast moving ship. It is too cumbersome and most important of all it greatly retards the speed of the ship, due to the excessive friction of the netting against the water.

The next—and poorest—means to combat the submarine is our widely advertised mounting-guns-on-a-ship scheme. No submarine commander in his right senses exposes more than one or two feet of his periscope when making a torpedo attack. And remember no torpedo attack is ever made at a closer range than 800 yards. Two thousand, and even four thousand, yards are very common nowadays. Imagine a gunner on even a slightly rolling ship trying to hit an object one foot high and less than six inches in diameter, at a distance of 3,000 yards! It simply can't be done. Scoring a hit under such circumstances is pure chance, and don't forget that the periscope itself does not stand still either. It, too, bobs up and down. In fact, at such a distance it is often almost invisible.

Mounting guns on merchant vessels nevertheless is of distinct use, in so far as the guns will keep a submarine at a respectful distance and prevent the U-Boat commander from attacking the ship by means of his own gun-fire. But mounting guns on ships will never prevent a torpedo from finding its deadly mark. You can't shoot at a torpedo—the bullet is too small and the modern torpedo making 43 knots, i.e., 50 miles an hour, moves far too fast.

After much thought on the subject, I came to the conclusion that in the torpedo itself we have an effective weapon to combat the torpedo, strange as it may sound at first. You can combat a gun with another gun, and you can combat one rifle with another, as well as you can fight one aeroplane with another.

Why not combat the torpedo with another torpedo? It is all very possible and simple if you know how; as a matter of fact the idea struck me so favorably that I decided to apply for patents in all civilized countries.

Several navy experts have reported favorably on the idea, and while up to this writing no ships have been equipt with the device, I would not be at all surprised to see the idea put into practise very shortly.

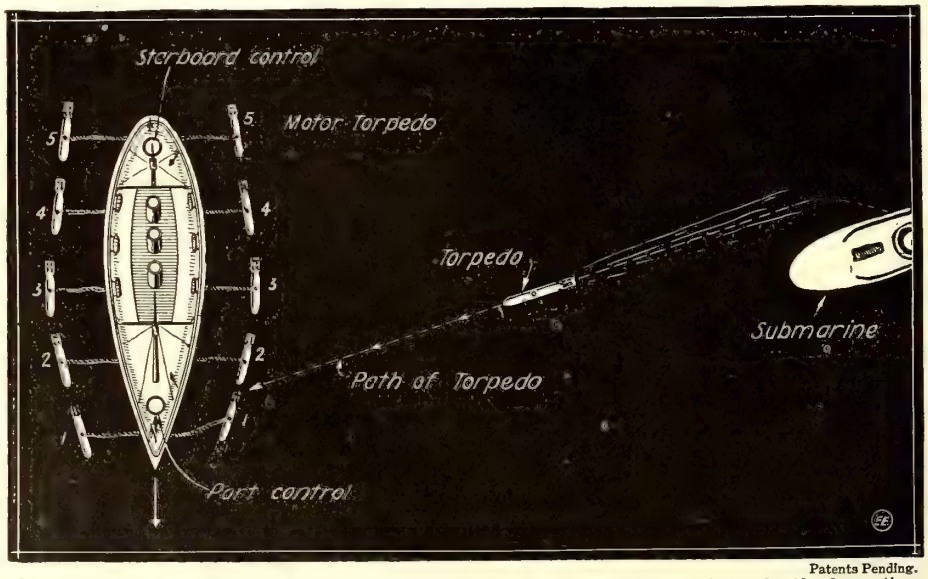
Our front cover and the two accompanying drawings illustrate the idea clearly.

The underlying idea of the whole scheme is that it takes the torpedo an appreciable length of time between the instant of being released from its submarine and the moment it strikes the attacked ship. Taking the closest range at which a torpedo can be fired as 800 yards—and it cannot be fired much closer successfully—this gives a time of 55/100th or over half a minute to cover that distance, short as it is. Taking the average range of 2,000 yards, it will take the torpedo 1⅔ minutes before it will strike. These figures are for the latest type Bliss-Leavitt torpedo making 43 knots, i.e., 50 miles an hour.

But a torpedo, whether it runs on the surface of the water or submerged below it, always leaves a very noticeable "wake" in its course. Remember a torpedo is propelled solely by comprest air, comprest up to *2,200 lbs. per square inch.* This air must of necessity come to the surface of the water, as the torpedo runs over its course. The disturbance created thus gives rise to the almost snow-white wake, which is very noticeable from a distance. Thus a man stationed on a ship readily sees the wake as it comes nearer and nearer and he can gage pretty accurately just where the torpedo will hit. Escape for the comparatively slow-moving ship is impossible, even if the engines were reversed instantly. The vessel's momentum would still be so great

OUR readers will find much food for thought in this interesting article. While the idea may not effectively stop enemy submarines from torpedoing every merchant vessel, we feel confident that we have shown a fairly practical way to obtain satisfactory results.

Mr. Gernsback is donating his invention to the Nation and he wishes it to be understood that he will not require to be paid royalties or any other considerations from Amercian ship owners. Foreign ship owners are not included in the above.



Patents Pending.

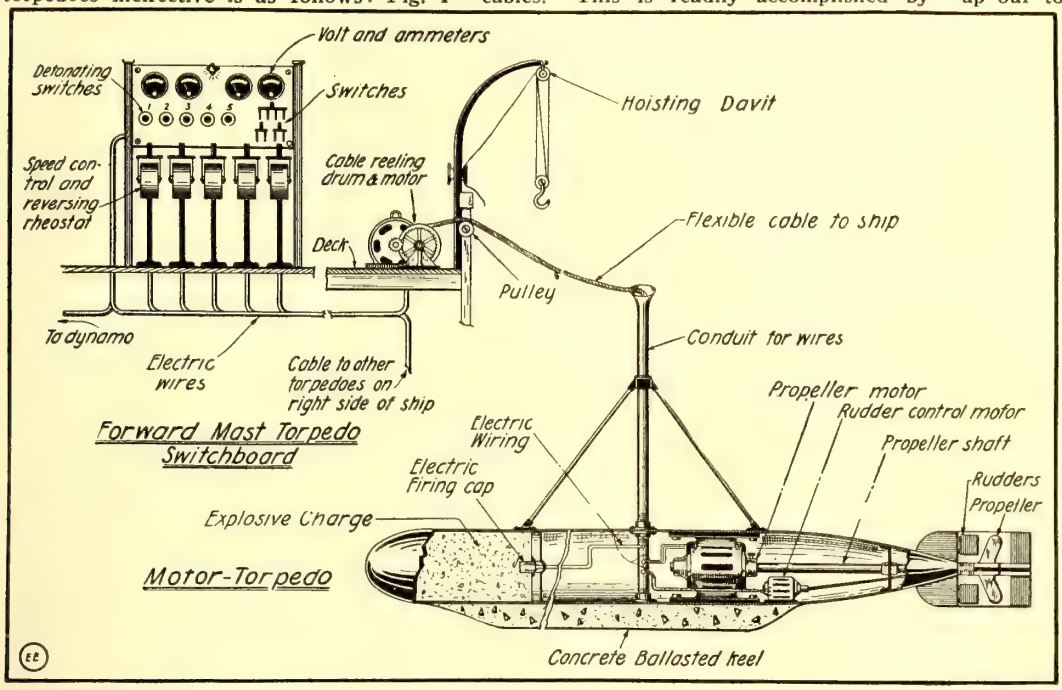
Top View of Ship with Its Ten "Motor-Torpedoes" Which Operate Independently from the Steamer. An Approaching Enemy Torpedo Is Blown Up or Thrown Off Its Course by Exploding One or More of the Little Motor-Torpedoes at the Critical Moment. Note that the Modern Torpedo Leaves the Submarine in a Curved Line After Which Its Gyroscope Rights It on the Final Straight Run. (Fig. 1.)

*This article appeared originally in the Sunday "New York American" of April 15th.

that the deadly torpedo would surely find its mark.

My proposed means of rendering enemy torpedoes ineffective is as follows: Fig. 1 shows the plan view of an average steamer, 600 feet long. On each side we observe five (or more) independent, electrically propelled torpedoes. Fig. 2 shows the construction of the torpedo itself. Briefly, it is built along the shape of the regulation torpedo and measures from 15 to 20 feet in length and from 3 to 5 feet in diameter. It has a 12 horse-power electric motor geared to the propellers and there is also a little ½ H.P. motor geared to the rudder with which to steer the torpedo. Most of the space between the *warhead* and the motors is taken up with the usual charge of gun-cotton. This torpedo, unlike its other brethren, has a heavily weighted keel to prevent it from rolling over, for reasons which will be apparent later. On the back of the torpedo is mounted a steel mast-like structure thru which the control cable passes. This cable then runs to the deck of the ship over pulley arrangements as shown in Fig. 2. There is also a drum to take up the slack of the cable, or to play out more cable should the occasion arise. The cable then runs up on the mast into a special turret located as high up as is feasible. Here we find one or more operators sitting in front of the electric *control-board*. All the cables from the star-board side torpedoes run into the forward mast-turret, while all the cables from the port side torpedoes run into the rear mast-turret. Thus each set of operators watches out for the safety of his side of the ship.

All of the torpedoes are painted in such a color that the operator can watch them readily and guide their individual course. Sitting at the control-board the operator sees to it that the speed of each torpedo keeps up exactly with the speed of the ship, for there should never be a drag on the cables. This is readily accomplished by means of rheostats, one for each torpedo. By cutting in more or less resistance the 12 H.P. motor can be made to run faster or slower and the torpedoes are thus easily controlled as to speed. By means of a double-pole, double-throw switch the little ½ H.P. motor is revolved in either direction, thus effectively steering the little craft so that it will always keep at a distance of some fifty feet from the mother ship. On the control board furthermore there is a switch connected to a storage battery from which wires are run thru the cable into the torpedo and thence into the *detonator* placed in the gun-cotton charge, Fig. 2. Throwing this switch will blow up our torpedo.



Patents Pending.

Fig. 2. The Electrically Propelled and Electrically Steered Gernsback "Motor-Torpedo." It Is from 15 to 20 Feet Long and Runs Independently from the Mother Ship. An Operator High Up on the Ship's Mast Blows Up the Motor-Torpedo by Electric Contact as Soon as the Enemy Torpedo Approaches Within 15 Feet. Both Torpedoes are Thus Destroyed.

The war action of the idea is as follows: Our ship has left New York with all of the motor torpedoes hoisted out of the water and lashed securely to the decks. The moment the need arises the torpedoes are lowered quickly into the water and the control operator starts the machinery of each torpedo, and in less than two minutes all of them should be running smoothly. fifty to seventy feet distant.

Suddenly the outlook scanning the waters with his binoculars sights the periscope of an enemy submarine and in less than a minute later our operator observes the rapidly lengthening wake of a death-carrying enemy torpedo. High up as he is located, he calculates that in less than two minutes the enemy torpedo will strike somewhere between his motor torpedoes Nos. 1 and 2 (see Fig. 1). By cutting in resistance into rheostat No. 1, he immediately slows up motor torpedo No. 1 thereby intercepting the path of the enemy torpedo. Or if, for certain reasons, he wishes to use his motor torpedo No. 2, he leaves No. 1 in its original course but by cutting out more resistance from rheostat No. 2, he speeds up the latter with the result that it advances faster than the ship and in this case as well it will intercept the course of the enemy torpedo.

Suppose he decides to use motor torpedo No. 1. He has nearly two minutes to jockey it for position and he will find little trouble to intercept the course of the hostile engine of death. His eyes glued to the enemy torpedo (or to its wake), his

(*Continued on page 68*)

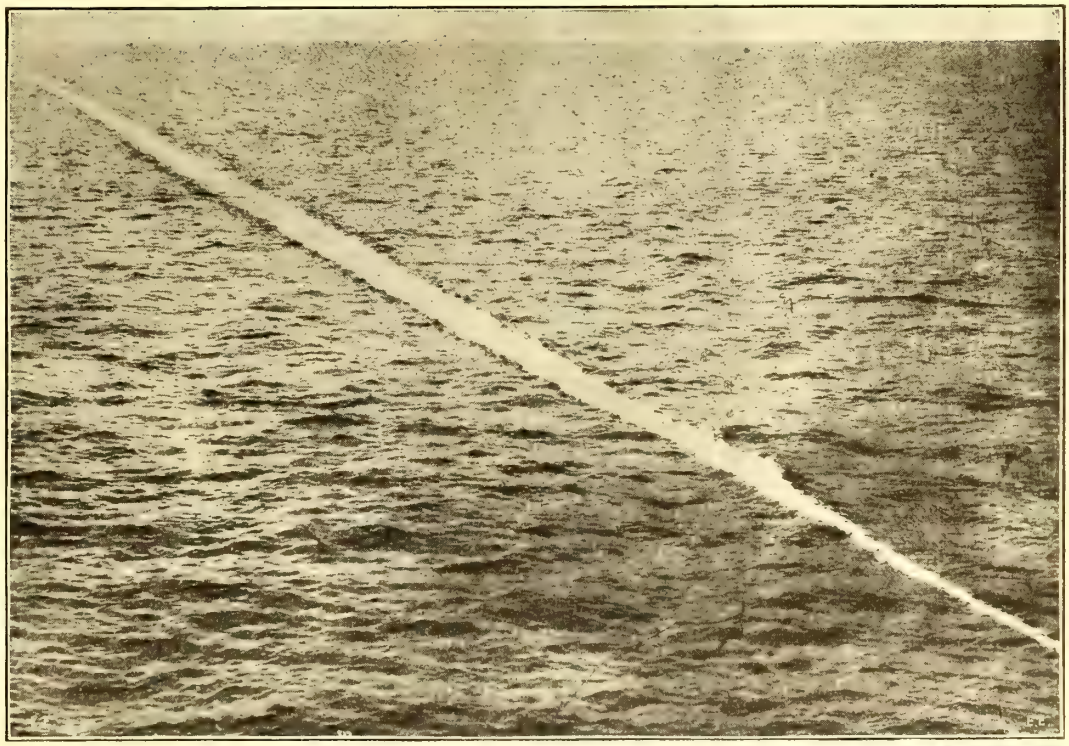


Photo by Paul Thompson.

An Actual Photograph of the "Wake" of a Modern Torpedo. Attention Is Called to the Fact That This Particular Torpedo Ran About 10 Feet Under Water, Having Been Fired by a Submerged Submarine.

Sources of Electricity

WHILE most of us are familiar possibly with several sources of electrical energy, we do not always stop to think of the many possible sources which are little known, especially to the layman. We have endeavored in the present article, and with the aid of the accompanying full page illustration, to describe the principal known sources of electricity.

Static Electricity: This form of electricity is that which we see when we stroke pussy's fur in a dark room and obtain a spark when the hand is withdrawn from contact with the fur; or again, we may obtain the same form of electric shock or discharge by rubbing together two dissimilar substances, such as a stick of sealing wax with a silk handkerchief, after which it will be found that the electrified stick of sealing wax will attract bits of paper or small pith balls. A rapidly moving belt often develops a considerable amount of static or frictional electricity, which will tend to discharge to earth whenever possible. One may often stand near such a belt, and by holding the knuckles or even the ends of the fingers near the belt, a heavy static discharge will take place between the belt and the fingers, the electric charge passing thru the body to earth.

One of the usual and practical sources of such electricity is the *static machine* (Fig. 1) and when the handle of such a machine is turned, one or more insulating discs are rapidly rotated, and by successive intensification of a very slight electric charge existing on the tin-foil sectors of these plates before the machine is started up, a surprisingly powerful static discharge is rapidly built up. This will manifest itself in the form of an electric spark, which crashes across the gap between two metal balls on the side of the machine. There are many other sources of static electricity but the whole phenomenon is practically the same.

Contact Electricity: It was Volta who showed that the contact of two dissimilar metals in the air produce opposite kinds of electrification, one becoming *positively*, and the other *negatively* electrified. There has been considerable discussion as to the exact action occuring in the production of electrical currents by the contact of two dissimiliar methods in air, and for a long time, says Silvanus P. Thompson, the existence of this *electrification by contact* was denied, or rather it was declared to be due (when occurring in voltaic combinations) to chemical actions going on; whereas, the real truth is that the electricity of contact and the chemical action are both due to transfers of electrons between the substances under the peculiar actions of forces, about which very little is known with certainty as yet.

Volta found that the difference of electric potential between the different pairs of metals was not all equal, as while zinc and lead were respectively positive and negative to a slight degree; zinc and silver proved to be positive and negative to a much greater degree. The voltage obtained by the contact between zinc and carbon is 1.09 volts.

The phenomena of electrical currents produced by the contact of dissimilar methods is illustrated by Fig. 2. A difference of potential or voltage is also produced by the contact of two dissimilar liquids. It has been found that a liquid and a metal in contact exhibit a difference of potential or voltage, and if the metal tends to dissolve into the liquid chemical, there will be an electro-motive force acting from the metal toward the liquid. A hot metal placed in contact with a cold piece of the *same* metal, also produces a difference of potential, and lastly Sir Joseph J. Thomson has demonstrated that the surface of contact between two non-conducting substances, such as sealing wax and glass, is the seat of a *permanent* difference of potential.

Galvanic Electricity: The primary battery is generally defined as one in which electrical energy is produced by chemical means, without having to charge the battery from dynamo or other source originally. The simplest form of such a battery comprises a glass or other vessel containing sulfuric acid and water, or any other oxidizing acid solution, and in which are immersed two clean metal strips, one of zinc and one of copper. Most of us are probably familiar with the common form of primary battery used in American practise for ringing bells and operating medical coils in the form of the well-known *dry cell*, or with the zinc-copper-salammoniac cell. In the zinc-copper-acid cell above mentioned, a continuous flow of electricity may take place thru a wire or apparatus which connects the two plates. When such a current passes, the zinc strip may be seen to waste away, or decompose by the electro-chemical action taking place, and its consumption, in fact, furnishes the energy required to drive the current thru the cell and the connecting wire or apparatus. In such a cell, the zinc strip forms the *positive electrode* or negative terminal, while the copper strip forms the *negative electrode* or positive terminal. Such a cell gives about one volt potential.

Fig. 3 shows a unique form of primary battery known as the Hauck *Circulation battery*. In this battery, composed of several cells, the electrolyte or solution is caused to pass from a tank above the battery cells, thence thru the first or higher cell, then thru the next lower container, etc This is a chromic acid battery with carbon and zinc electrodes. The zincs are located in the rectangular porous cups while the two carbon plates are outside of the porous cups, all the space between porous cup and carbon plates, as well as between the carbon plates and glass vessel being filled out with small carbon pieces. In the porous cup there is a sulfuric acid electrolyte, while the carbons stand in chromic acid. As the latter is caused to circulate continuously from one battery to the next, all polarisation is done away with and we obtain a very steady and powerful current. The battery illustrated gives 6 volts and 60 amperes and can be used to charge storage batteries, run fans, or electric lamps. It is one of the best chromic acid batteries ever designed.

Electricity from Gases: Fig. 4 shows the famous Grove Gas Battery invented in 1839. It shows how two gases are used to produce an electric current. The two glass tubes contain platinum strips coated with spongy platinum. The glass bottle contains acidulated water in which the two glass tubes plunge, as seen. One of the tubes contains oxygen, the other hydrogen, as will be noted the gases make contact with the acidulated water. If we connect the two terminals with a galvanometer we will observe an electric current, the oxygen furnishing the positive, the hydrogen the negative pole of the battery. Incidently we note that, as we consume current, the liquid rises in the two glass tubes, but twice as fast in the hydrogen tube as in the one containing the oxygen. As each tube is identical with the other, except for the gases, it follows that the current can be due only to the gases. Also different gases produce different voltages and currents.

Pyro-Electricity or Electricity from Crystals: In the accompanying Fig. 5, we have several methods by which minute quantities of electricity are produced from crystals, when these are manipulated in a specific manner. Certain crystals, when they are heated or cooled, exhibit electrical charges at certain regions or poles, and such crystals which become electrified by heating or cooling are said to be *pyro-electric*. One of the principal crystals which manifest this peculiar action is *tourmaline*. The tourmaline has been cited in history, and is mentioned by Theophrastus and Pliny under the name of *Lapis Lyncurius*. The tourmaline possesses the power of polarizing light, and is usually found in slightly irregular three-sided prisms which, when perfect, are pointed at both ends. It is interesting to note that in heating such a crystal as the tourmaline, it attracts light pith balls to its ends when electrified. If the temperature is kept steady, then no such electrical effects are observed either at high or low temperatures, and again the phenomenon ceases altogether if the crystal is warmed above 150° C. If a heated crystal of tourmaline is suspended by a silk fiber, it will be attracted and repelled by electrified bodies or by a second heated tourmaline. Among other crystals which belong in the pyro-electric family are silicate of zinc, boracite, cane sugar, quartz, tartrate of potash and sulfate of quinine.

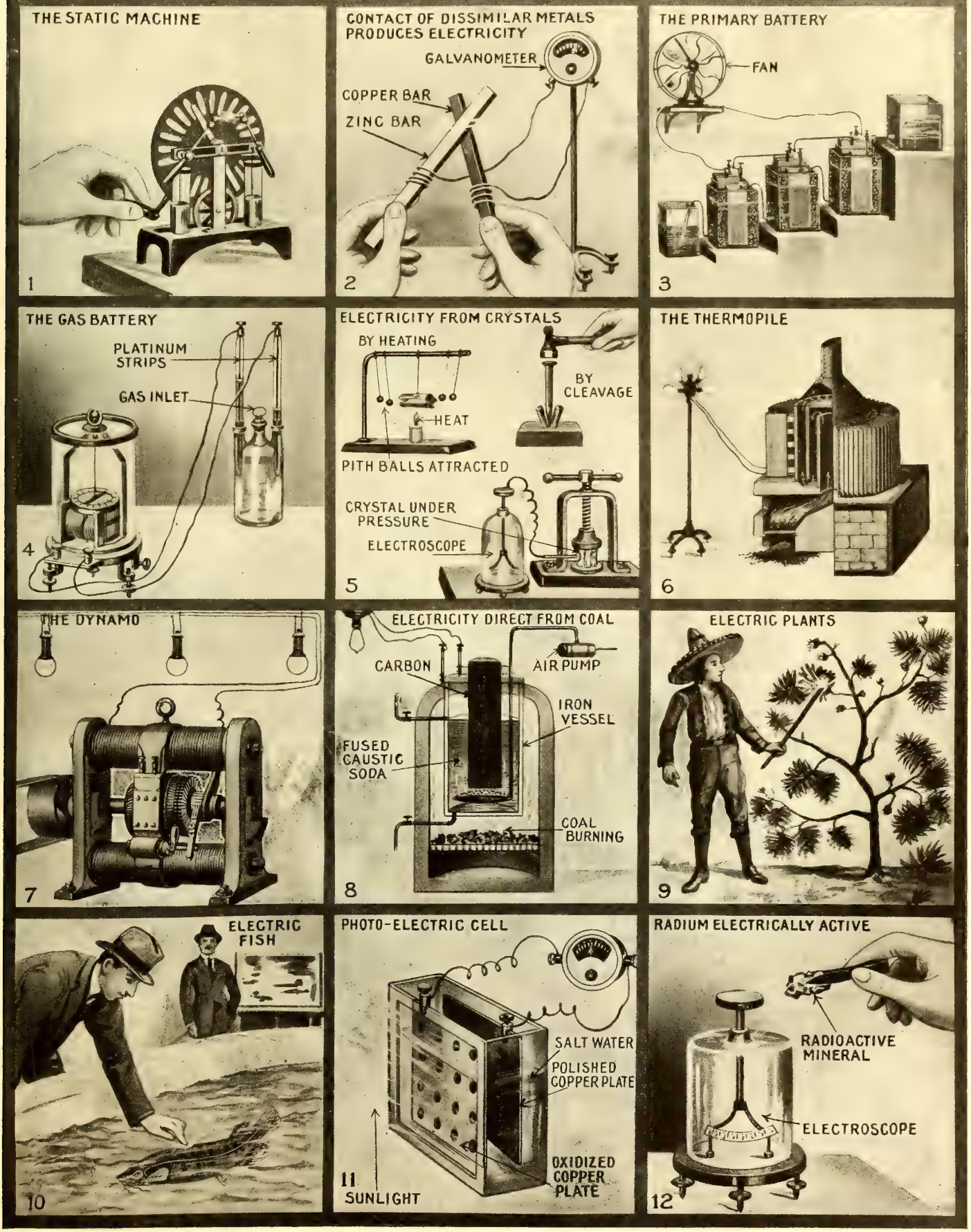
Electricity is produced by the disruption and cleavage of certain substances, as for instance, when a sheet of mica is split apart, which action is usually accompanied by the production of a number of sparks, and both laminae are found to be electrified. If sulfur is fused in a glass dish and allowed to cool, it becomes powerfully electrified, which action may be tested by lifting out the crystalline mass with a glass rod. Chocolate is another substance which manifests such an electrification while becoming solidified.

Piezo-Electricity is the term given to that form of electrical energy produced when certain crystals are placed under pressure in a certain direction. With respect to the make-up of the crystal, it was found that if a crystal of calspar was prest between the fingers so as to compress it along the blunt edges of the crystal, that it becomes electrified, and retains its electrical charge for some days. This phenomenon is believed to be due in certain crystals to what is known technically as *skew-symmetry* or hemihedry in their molecular structure.

Thermo-electricity: If we take two metal bars, one of bismuth and one of antimony, and join these together, it will be found that an electric current is produced of an appreciable magnitude when the juncture between the metals is heated in the flame of a candle or other source of heat. To demonstrate that there is an electric current produced in all such cases, it is but necessary to connect a sensitive electric current-detecting device, such as a galvanometer to the free ends of the bismuth-antimony couple, as it is called. If all parts of the circuit, including all sections of the bismuth-antimony couple, are at one temperature, there will be no current produced, since the electro-motive forces are in perfect equilibrium. However, when a junction between two such metals is heated, this equilibrium of the electrons and molecules no longer exists, and gives way to the production of an E.M.F. or difference of potential.

(*Continued on page 71*)

SOURCES OF ELECTRICITY



(For description see opposite page.)

Magnetism Produces Remarkable Photographs

BY F. F. MACE

Superintendent of Public Schools, Pecos, Texas

WHAT causes iron, a dense, heavy substance, to ignore or overcome the laws of gravity and to dart thru space to a magnet? What is this mysterious, so called, attraction? Can this swift and sure motion of a heavy body thru space be caused by *lines of force without motion,* by *lines of tension in ether* or by mere *lines of direction,* like lines of latitude or longitude? Can these lines of force tending or extending, moving without motion from one pole to the other, or lines of force or tension "emerging," without motion, from one pole and "entering," without motion, the other pole, produce the same result at both poles? Can any possible arrangement of the molecules of the magnet, supposing this arrangement to be brought about, possibly extend thru space and accomplish this result? Can any or all of these miracles, these things themselves contradictions of the known laws of nature, bring about another miracle—a result opposing, apparently, one of the laws of nature? Is there a cause for these things in keeping with the known laws of nature?

These questions presented themselves when I first studied physics. They asked themselves more insistently when I began to teach physics, and they have been reiterated again and again in varying form by every class of beginners whom I have appeared before. For more than fifteen years I sought to obtain an answer, a true answer, to these questions—an answer which would really account for the facts and which would be in accord with the other known laws of nature. For years only a faint glimmering of the truth appeared. Then gradually the light grew stronger until I had worked out a clear and logical answer. But to answer these questions by pure logic based on the known facts of nature was not sufficient. Modern science demands experiment; tho Newton and Galileo, and Leplace never performed an experiment but based their discoveries on the facts before them. Therefore, I worked patiently for years to demonstrate in a new way that which I knew to be true, until I had proven by experiment that which I had proven by logical deduction, that the attraction of the magnet and all of the phenomena of magnetism are produced by the motion of *ether currents* about and thru the magnet, and until I was able to demonstrate the cause, nature, and direction of these currents, and by the direction of these currents to account logically, consistent with the laws of nature, for all the facts of magnetism.

But even this was not sufficient. The facts of nature had been distorted for years. These experiments, conclusive as they were, might be distorted and thrown aside. It must be proven beyond a shadow of doubt in some striking manner that there are actually *currents* about the magnet—that there is *motion.* How could this be done? I had worked with photography for years and was familiar with the X-ray. While pondering this situation the thought occurred to me: will the photographic plate—a photographic plate in a vacuum—prove this? A photographic plate is only affected by motion; by light, which is *ether motion;* by chemical action, which is molecular motion; by heat, which is molecular motion; and by the X-ray, which is in motion. Even granting the ether currents about the magnet as I had proven them to exist, would their wave length, their rate of vibration, be such as to effect the photographic plate? I could only try it, as I had tried other things, and hope to obtain the result sought.

The result justified the hope. Taking every precaution known to a photographer to prevent the result being effected by light or other influences I exposed a plate on which were placed a number of objects under an exhausted receiver. At the end of three days I removed and developed the plate. *Images were there, faint but unmistakable.* The experiment was a success! I am sorry that I afterwards dropt and broke this first plate while attempting to handle it during a spell of illness.

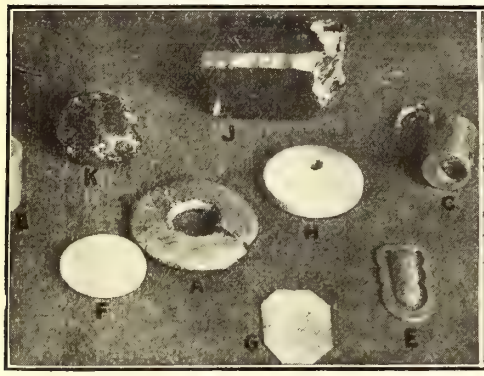


Fig. 2. Photograph Taken in Usual Manner, Showing the Various Objects "Magnetographed."

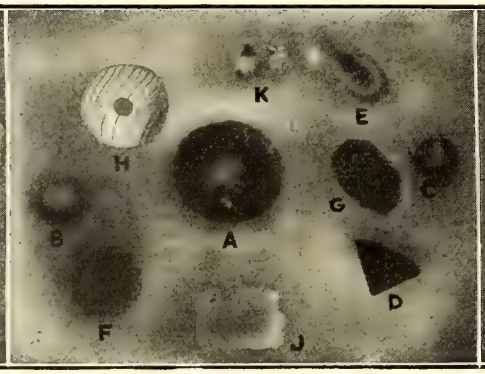


Fig. 3. Here We See the Best "Magnetograph" of the Objects in Fig. 2; It Was Made in a Vacuum.

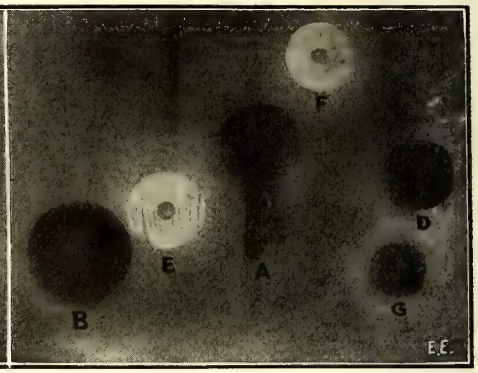


Fig. 4. Exposure of Photo Plate and Various Objects Placed Over a Magnet Under Atmospheric Pressure. Compare with Fig. 3.

With certain success before me I took every precaution to render the result beyond question. In a dark room from which every ray of light was excluded, using only a perfectly safe ruby light, I placed objects on a common photographic plate and placed them under the receiver of an air pump as shown in Fig. 1. These articles are shown in Fig. 2, as they appear when photographed with an ordinary camera. "A" is a lead ring or washer. "B" and "C" are metric weights. "D" is a piece of gasket rubber. "E" is a broken metal buckle. "F" is a bone button. "G" is a scrap of acid-eaten zinc. "H" is a wooden button. "J" is a piece of sealing wax. "K" is a lump of resin. The magnet used is an ordinary steel U-magnet, weighing one kilogram (or 2.2 lbs.). The sensitive side of the plate is above and the objects lie on the sensitive side.

After the objects were placed on the plate under the receiver, twelve thicknesses of black cloth were placed over the receiver and the air was exhausted. Then over all of this was placed a light-tight box and the whole was finally wrapt in ten thicknesses of black cloth. The ruby light was then removed from the room and the room was locked and not reopened for twenty days. I may add that the whole operation took place after nightfall.

At the end of twenty days the room was entered after dark and the plate was taken from the receiver and developed by ruby light as with an ordinary photograph. The result is shown in Fig. 3. The articles are lettered to correspond to Fig. 2. The one marked "D" was lost and is not included in Fig. 2.

Here is incontestable proof that there is *motion,* that there are *currents,* about a magnet. No mere line of force, no tension in ether, no mere line of direction

(*Continued on page 70*)

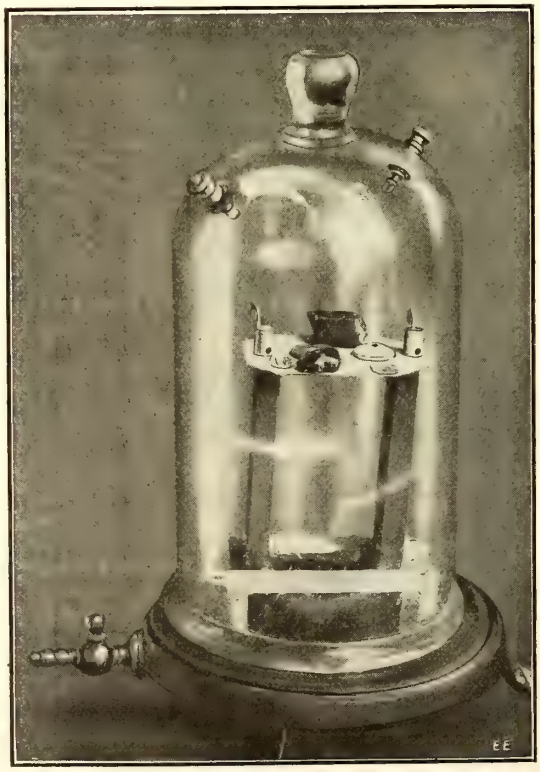


Fig. 1. How the Author Arranged the Objects to Be Photographed by a Magnet, Placing Them on a Photo Plate Under the Bell of a Vacuum Pump, Permitting the Air to Be Exhausted.

The Therapy of Light and the New "R-Ray"

By H. ROSENTHAL

THE therapeutic use of light has been known for ages; in fact, it belongs to a period so remote that we are unable to determine even approximately the time of its introduction as a healing agent.

In the far East the earliest writings mention the use of light in the cure of disease, and in the comparatively more recent records of Central American aborigines we find accounts of miraculous cures performed by the Sun God. Even at the time of our early pioneers on this continent there are authentic reports of a custom practised by many Indian tribes, who treated wounds and pulmonary afflictions, rheumatism, neuralgia, et cetera, by exposing the naked skin to the mid-day sun, allowing the rays to fall directly on the part afflicted. This custom was in vogue ages before the Spanish Conquest, and was common among the aborigines of America, from Yucatan to the Arctic Sea.

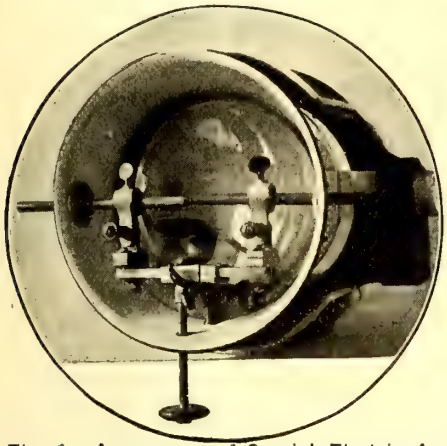


Fig. 1. Appearance of Special Electric Arc Devised for Producing the "R-Ray" Radiations, Which Have Proven Extremely Satisfactory in Light Therapy Treatment for Certain Diseases and Ailments.

We have, therefore, historic proof that light rays have been used from time immemorial in the treatment of disease, and while modern science and modern methods have attained the same ends, they have not changed the principles known to primitive man—but have merely developed the art.

As light rays are the oldest and most universally accepted therapeutic agent, we naturally ask—how are they translated into terms of therapy by the human body? To which the answer is, thru the medium of *vibration* and *penetrative force of quantity*.

Light and electrical radiations are both waves that are projected thru space at the same velocity. They are identical in nature, tho one wave length or radiation may differ from another, the same as one sound wave may vary in length from another, as found in the various tones or vibrations of music. Yet all wave lengths, whether light or sound, produce their own corresponding vibrations and we therefore recognize all such vibrations in terms of light or sound.

In further proof of this existing vibratory theory we have color, which in reality exists only in the mind, for color value is dependent solely upon the number of vibrations impinging upon the retina of the human eye. As for instance when the retina is stimulated by a vibratory force that approximates 400 trillions per second, the impression produced upon the brain is that of the color red; 750 trillion vibrations per second is interpreted by the brain as the color violet. And so on thru the scale of our visible spectrum. Yet, were the human retina sufficiently sensitive to receive and distinguish the many intermediate vibrations, it would perceive, thru the brain countless millions of tints and numerous values that lie between these two extremes.

When these countless millions of tints are all combined we see only *white*. And tho we perceive and interpret white light as being white, still we know that it is not white, but the combined primary colors and their countless intermediate tints. This fact is easily proved by simply passing a beam of white light thru a prism, which will show the primary colors making up the white beam.

Light vibration without penetration, force or quantity is in itself therapeutically negligible. To have force, it should be direct, and to have penetration the source and quantity should furnish vibrations of practically uninterrupted intensity.

One source of light which fulfills the above conditions is our own *sunlight*, which penetrates every portion of the human body and exerts a most powerful influence on its economy by oxygenating the blood, generating hemoglobin and producing red corpuscles. And when we become *Sun-Dodgers* we cannot expect any other physical condition than that which takes place in plants under like circumstances, and which entails on human beings the necessity of resorting to other means for making up the deficiency—generally drugs.

Summing up therefore the laws that govern the therapy of light, we find it has the same relation to chemical actions which are governed by the chemic response set up in the substance or tissue, and not by the inherent quality of the ray; while all physical conditions are secured in direct ratio to the penetrative power, quantity and vibrating quality of the light employed.

All light waves possess two main characteristics that differentiate the effect produced namely: first, the *number* of vibrations in a given interval of time, and second, the *length* of each oscillation or wave in a given interval. So that from a therapeutic standpoint it is always highly important to have at our command as great a number of these vibrations as possible; i.e., of the oscillatons. It has been averred by the medical profession that each and every corpuscle and cellular structure in the human body is composed of an infinite number of delicate receivers, each of which respond only when the right *tune* or *vibration* strikes them. Thus when given major, minor and chromatic scales to operate with, the skilled therapist can compel the brations of any cellular structure to respond to those which are produced artificially; and call into action complete therapeutic results, just as in music we call into play the various graduations of tone and produce perfect harmony.

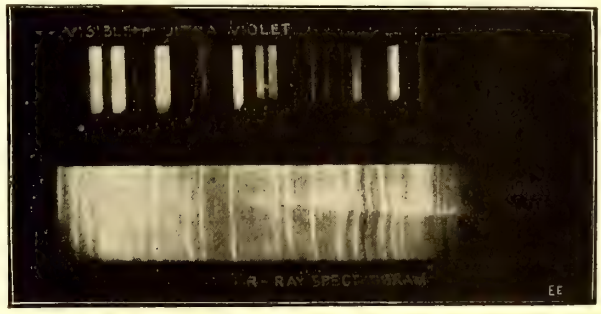


Fig. 3. Spectrogram of the New "R-Ray," Showing Clearly Its Great Range in the Field of Light Therapy, Extending as It Does Beyond the Visible Spectrum.

The period of vibration or oscillations which make up light waves and which the human eye will respond to, are those above the infra-red rays or heat rays and those below the ultra-violet or invisible light rays. The difference between the two is that the vibration of the infra-red is very small and the wave length very long, while those of the ultra-violet region have a tremendous period of vibration and a very short wave length.

The therapeutical work that has been conducted points to the fact that the *ultra-violet rays* are most advantageous and consequently of greatest use in light therapy.

We know that light rays from such sources as the Finsen, Minin, Ultra-violet and X-ray are each capable of exciting a normal, subnormal or abnormal human receiver.

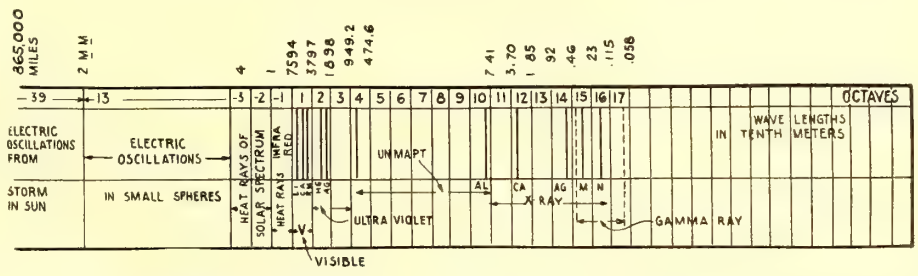


Fig. 2. Chart Showing the Position Occupied by the New "R-Ray" in the Spectrum, Including the Relative Position of the X-Ray Vibrations and Ultra-Violet Rays.

4,503,599,627,370,496 ..... = Ultra violet photog. in vacuo
789,000,000,000,000 ..... = Violet end of visible spectrum
562,949,953,421,312 ..... = Green light
451,600,000,000,600 ..... = Red end of spectrum
281,474,976,710,656 ..... = Infra-red
70,368,744,177,664 ..... = Heat rays of solar spectrum
47,000,000,000 ..... = Electric osciliations in small spheres
Once in 4.7 seconds ..... = Electric oscillations from storm in sun

However, our scientists not being satisfied with the belief of the existence of another source of vibration beyond the ultra-violet region, took another step in this direction which proved to be successful, inasmuch as they have found a region between the extremity of the ultra-violet and the beginning of the X-rays. The region is still unexplored, but there is little doubt that the greatest therapeutic secrets lie hidden there.

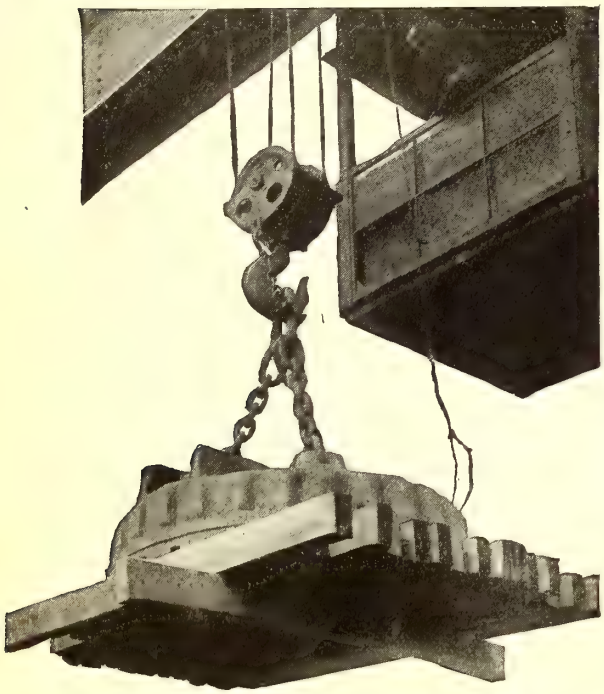
It is believed that we are only beginning to learn of the real benefits to be gained by the scientific application of light rays by skilled therapists.

The author, who has been engaged in this, as well as the electrical field of research for many years, discovered a new ray which he has christened the R-ray. The production of this new source of

(*Continued on page 47*)

Powerful Electro-Magnets Perform the Work of Many Men

The ordinary work of a man loading pig iron from the ground upon a railway car was from 12 to 13 tons per day. The lifting magnet, however, has rendered it unnecessary for this laborious work to be performed by human effort, and the results, as given in the unloading of the steamer, *Erwin L. Fisher,* at Indiana Harbor, Ind., are given in brief below:



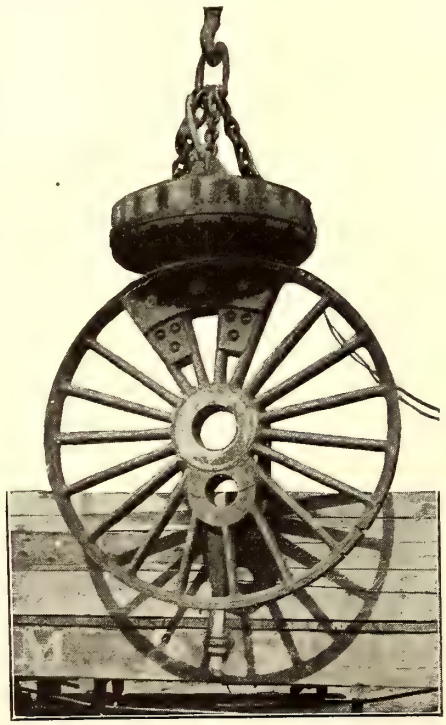
The Crucible Steel Company Have in Use at Their Pittsburgh Plant This Gigantic 62-inch Electro-magnet. It Can Lift 4½ Tons of Steel Bars and the Trip of a Switch Releases the Entire Load Instantly. This Class of Work Spells "Economy" in Big Letters and Foundries Everywhere Are Rapidly Awakening to the Fact.

With a cargo of 4,000,000 pounds of pig iron, the time required to unload this vessel with twenty-eight men was two days and two nights, which corresponds to about 3,000 pounds per man per hour, or about 15 tons per day of ten hours. When the lifting magnet was introduced, the total time required for unloading was reduced to eleven hours and was done by two men, whose labor consisted in manipulating the controllers in the cages of the cranes. Thus two men and two magnets duplicated the work of twenty-eight men in less than one-fourth the time. Under these conditions the handling capacity of a man and a magnet was nearly one thousand tons in eleven hours, or about 900 tons per day of 10 hours. This is fifty times as much as was accomplished by hand labor, or twenty times as much as is possible even under scientifically managed manual labor. Furthermore, the operation was chargeable with less than one-fourth the overhead charges, while the vessels were enabled to double their number of productive trips.

The lifting magnet has been adapted for the handling of materials in all branches of the iron and steel industry. It is used for handling pig iron, scrap, castings, billets, tubes, rails, plates, crop ends; for loading and unloading cars and vessels, and for handling skull-cracker balls and miscellaneous magnetic material. In fact it seems to be axiomatic that wherever magnetic material, and especially raw material, is to be handled in any considerable quantity, a lifting magnet can be used to advantage and will be a profitable investment.

The accompanying illustration shows in a marked manner the practical application and efficiency of large electro-magnets used industrially. The first illustration shows a gigantic electro-magnet measuring 62 inches in diameter and swung from a crane at the plant of the Crucible Steel Company at Pittsburgh. This mighty magnet has been photographed in the act of lifting 17 steel billets, each weighing 575 lbs., or a total of 8,925. It takes but a moment's reflection to readily conceive just how much man-power would be required to move this same weight of steel, not to mention the time occupied in moving it. A single operator, in this case the man operating the crane, lowers the magnet onto the steel bars and when in contact or nearly so, he closes the switch supplying the magnet with electric current. The magnet instantly becomes alive and exerts several tons of magnetic tractive power and holds the billets to its face securely, as pictured in the illustration. The crane may swing along for several hundred feet, carrying its suspended load, and as soon as it reaches the desired location the magnet is lowered; when the operator opens the switch the magnet instantly releases its 4½ tons of steel.

The second illustration shows a powerful electro-magnet at work in the yards of the Chicago, Milwaukee and St. Paul Railroad's West Milwaukee shop, the magnet measuring 43 inches in diameter and lifting in this case a locomotive drive wheel. The lifting magnet is an attractive proposition to-day and not only appeals in large sizes but in the very small sizes as well. The small hand type electro-magnet is particularly efficacious for picking up quantities of iron nails, screws, etc., in hardware stores and stock rooms and finds application in a thousand and one different ways daily.

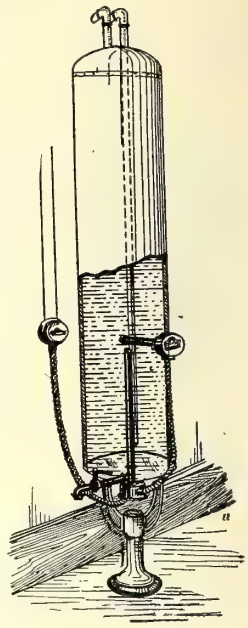


43-inch Magnet Lifting a Locomotive Drive Wheel at the West Milwaukee Shop of the C. M. & St. Paul Railway. Another Instance of What the Lifting Magnet Is Capable of Doing.

THE ELECTRIC HEATER FOR THE KITCHEN BOILER.

The accompanying semi-sectional view of an ordinary kitchen boiler shows how a recently perfected electric water heater is attached to it. This heater heats the water before you turn the faucet and not —some time afterward. The tank is always charged with scalding water at any temperature you wish up to 200° F. (212° F. boiling point), or enough heat for about five baths—always on tap.

The heater has six steps—and the regulator is a six-point current control. When no water is being drawn the heater will probably be cut entirely out so that no electricity is being used. Then as some water is drawn the regulator picks out that step of the heater which will pump back into the boiler the same amount of heat that is drawn from the faucet in the hot water. At the sixth step the regulator applies two full horsepower, storing heat at 100% efficiency. It is claimed that this particular electric water heater will operate on 15 to 20 per cent less energy than the circulation type heater, for the same monthly gallon production.



An Electric Heating Unit That Fits the Kitchen Boiler.

The present heater has been specially designed to make it self-cleaning. Under the intermittent operation of the thermal control there appears a slight but constant opening and closing of the split heating tube, which readily cracks off all scale and any precipitate forming on the tube. This deposit accumulating at the base of the heater is then easily flushed out of the full size 1¼-inch drain. This self-cleaning feature is, perhaps, next to efficiency in importance to the housewife to whom a burned-out heater means not only needless expense but several days' interruption in the hot water service and a recent engineering report gives the external circulation type water heater four months in which to become absolutely choked with scale.

CAN SINK SUBMARINES BY WIRELESS, SAYS INVENTOR.

Theodore Eichholz, a young engineer and architect of Pittsburgh, has invented a wireless device that may be used to destroy submarines by causing an explosion of gases that are always present in submersibles, he claims. For several years the inventor was connected with the United States Corps of Engineers.

Mr. Eichholz stated that just recently a small experimental apparatus in his home on Neville Island sunk a small "dummy" submarine in the Ohio River, five miles away. The destroyed model was of steel and submerged to a depth of ten feet.

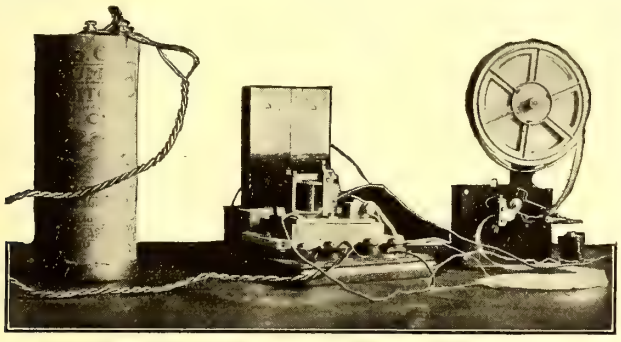
All submarines while under water are propelled by electric storage batteries which throw off a gas that pervades the hull. This gas, Eichholz says, he detonates by the wireless current and destruction follows. The apparatus will be submitted to the U.S. Government at once.

NOVEL TELEGRAPH INSTRUMENT THAT RESPONDS TO VOICE.

Strange as the title may seem, yet the successful operation of such a device has been accomplished thru the researches of Mr. Christian Berger of New York City.

The accompanying photograph shows the complete equipment of the electric voice-operated telegraph instrument. The operation of the device is not attained by the employment of a microphone of any kind, but by means of a sensitive sound-operated circuit-breaker, which controls a special relay and which in turn operates electrically either a sounder or recording instrument. The circuit-breaker is placed in a metal box which is seen in the center background of the photograph. This consists of a bent wire, properly balanced on an insulating block. The end of this wire presses lightly against the side of the box, which makes a permanent contact when it is not disturbed. The second connection is made thru the metal box and this is terminated with one binding post of a battery, while the bent wire is connected to one side of the relay electro-magnet, the opposite side being linked to the other binding post of the battery. The electro-magnet actuates an armature which controls a cog-wheel by means of a projecting strip on the armature. On the same shaft with the cog-wheel is a drum upon which a number of contacts are secured. These are alternately connected, so that one will complete the electrical circuit when desired and when moved to the next stud, the circuit will be opened. It is built on the lines of a step-by-step relay, which has been used some years ago for controlling moving vessels by radio waves. The drum circuit and the horizontal brushes which touch the drum studs, are connected in series with the recording instrument and battery.

The operation of the apparatus is exceedingly simple as one must only be familiar with the telegraph code, but not experienced in handling a telegraph key, as the transmitting is done by calling out the dot and dashes to the instrument. When a signal is made the sensitive sound actuated circuit-breaker opens the circuit which causes the armature of the relay to release it, thus giving a rotary motion to the cogwheel and in turn closing the recording instrument circuit. The complete equipment is very interesting when in action and possesses many diversified possibilities.



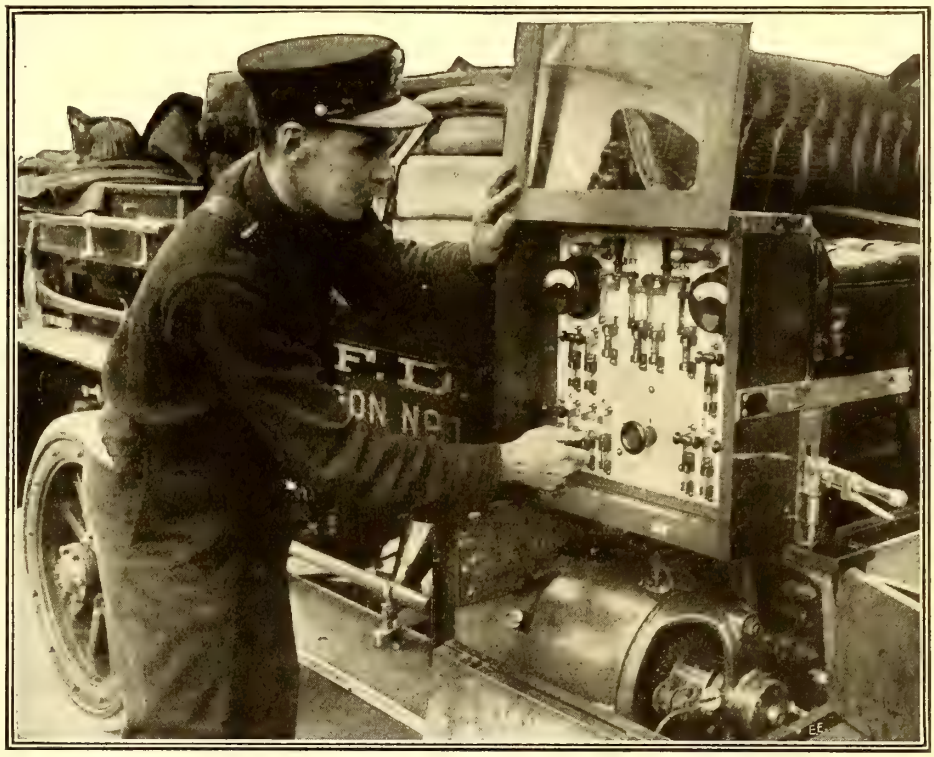
Speak to This Telegraphic Novelty and It Records the Equivalent Dots and Dashes on a Paper Tape.

ICELAND'S ELECTRICAL PAPER.

Elektron is the name of an electrical magazine publisht monthly at Reykjavik, Iceland. The leading article is on the Icelandic telegraphs and telephones, by Mr. Gisli J. Olafsen, who visited this country a year or more ago and studied American telegraph and telephone methods. This article is printed in the Danish and English languages.

LOS ANGELES HAS WONDERFUL ELECTRIC FIRE TRUCK.

THE electric equipment of a new fire-fighting apparatus recently built by the Los Angeles fire department has no equal in the country. This equipment is mounted on a ton and a half motor truck and was both designed and built by members of the fire department.



Los Angeles, Cal., Boasts of Having One of the Most Complete Electric Fire-fighting Trucks in the United States. The Equipment Comprises Five Powerful Searchlights Which Are Supplied with Power from Either a Large Storage Battery or the Dynamo Shown in the Picture.

The equipment consists of five powerful searchlights, each rated at 250 watts, capable of throwing a brilliant beam of light over 500 feet away. At this distance work at a fire can be carried on with great efficiency. Yet these lights are so arranged with diffusing lenses that it does not blind the firemen, even a few feet away.

The lights are 16 inches in diameter. Three are permanent and two are portable, each being attached to 320 feet of heavily insulated cable wound on a reel which can be unrolled, permitting the lights to be carried this distance into a burning building.

The handicap of a strange and smoky building is overcome by the use of these portable lights. They will penetrate smoke to almost an unbelievable distance, permitting the firemen to fight fires thru dense smoke with the greatest of ease.

Power is received from eight large storage batteries placed behind the seat. These batteries themselves are capable of furnishing current for the lights for seven hours. Also installed on the right foot-board is a generator of 50 amperes, 25 volts, 1.25 K.W. This is run by a silent chain drive off the main propeller shaft and is controlled by a separate clutch, shown in front of the switchboard seen in the photo. The generator may be cut in or out at will, by means of this clutch.

As a precaution against any one accidentally touching the foot throttle and speeding up the engine to too great a speed, when the wagon is standing at a fire, a special protective device has been provided, which consists of a hood which can be lowered and locked in a position, completely protecting the foot throttle from the curious.

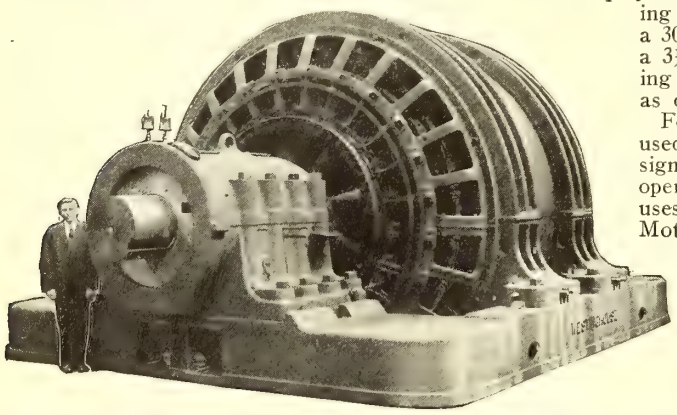
A perfectly equipt switchboard is mounted on the right side immediately above the generator, having a marble back in an enclosed case with a glass front. It is equipt with a master switch for both the batteries and generators. Also an individual switch for each light and gages to show amperes and volts, a resistance cut-out and small lights to illuminate the board. Fuses of proper capacity are installed for each switch. To prevent damage to generator or batteries an under-load and an over-load switch is installed. This acts as a governor, the purpose of which is to automatically disengage the charging line from the generator when the rate of charge reaches a dangerous value or when the rate of charge is so low that there would be danger of the batteries bleeding.

The portable lights are adapted to be used on a tripod. They are mounted on the wagon on a swivel connection with a one-inch diameter stem projecting, which fits into a socket fastened with a nut. A similar socket is provided on the tripod and when the light is set on the tripod, a large hand nut is provided which holds it securely. The light mounted on the tripod can be readily moved from place to place by one man. As he carries the light to he fire the reel automatically unwinds.

A wireless telegraph distance record of 11,500 miles was establisht by the steamer *Sonoma,* which pickt up messages from Eilvese, Germany, when two days off Australia, according to Royden Thomberg and Clio Bowers, operators on the *Sonoma.* Ellery Stone, assistant United States radio inspector at San Francisco, said it was the greatest distance achievement in wireless telegraphy.

MONSTER MOTOR GREATEST EVER BUILT.

We are told that at one time this old world of ours was inhabited by gigantic monsters. Well, we still have monsters—mechanical ones—that are far more powerful than any of which our ancestors knew. Take, for instance, the mastodonic Westinghouse reversing motor here shown, which was specially designed for driving 35-inch reversing blooming mills in large steel plants. When we realize that it has a capacity of 15,000 horsepower, the largest electric motor ever built, we need no further proof—we know it is monstrous. Some idea of its size may be gained when it is stated that the man standing alongside the motor is six feet tall.



The Egyptians Built the Pyramids—but See How Modern Man Builds an Electric Motor Developing the Combined Power of 15,000 Horses. This Is the Largest Motor Ever Built.

ELECTRIC LIGHTS CHEAPER THAN KEROSENE.

How much cheaper are gas mantles and electric bulbs than candles? The Society for Electrical Development, anxious to encourage a wider use of electricity for lighting, has prepared figures showing that both are much cheaper than candles or kerosene, and that electric light, while it is more expensive than light from a gas mantle, is much cheaper than light from an open gas flame.

A recent test of six candles showed that for one cent only 2.68 candle-power hours were obtained. If electricity for lighting costs nine cents for a kilowatt-hour a 20-watt lamp can be lighted for 50 hours for nine cents. The efficiency of a 20-watt incandescent is a candle-power for 1.17 watts. Thus a 20-watt lamp will provide about 17 candle-power. It will burn 50 hours for nine cents or 850 candle-power hours will cost nine cents. One cent will buy 94.4 candle-power hours, or 35 times as much light as can be obtained from a candle for one cent.

Ordinary kerosene lamps with kerosene at 15 cents will give 72 candlepower hours for one cent. Figuring electricity at nine cents a kilowatt hour as above, we find 72 candle-power hours for one cent balanced against 94 for electricity, or a margin of 22 candle-power hours in favor of electricity. With an open gas flame and gas costing 85 cents a thousand cubic feet, one cent will buy 51 candle-power hours. For this price electricity will provide 94 candle-power hours. Thus balancing gas against electricity, we find the margin to be 43 in favor of electricity. Gas mantles have become very popular and with best mantles one cent will buy 201 candle-power hours.

TRAVELING ELECTRIC SIGN FOR SHOW-WINDOWS.

The traveling electric sign here illustrated is a new moving feature sign for window attraction that can be operated where heretofore the ordinary signs have been used. It displays the same amount of reading that ordinarily requires a 30-ft. length of space into a 3½-ft. space. The wording can be changed as often as desired.

Four 10-watt lamps are used for illuminating the sign, and the motor which operates the moving band uses only about 20 watts. Motor and lamps together use about the same amount of current as a 32-c.p. lamp. During the daytime, when the motor only is working, it uses less than one-half as much and the sign is equally effective.

Any length of film from 6 ft. to 30 ft. can be used and changed in a few minutes.

This sign can be operated on either 100 to 120 volts direct current or 100 to 120 volts (60 cycle or less) alternating current by changing the connections at the terminal board.

The sign comes complete, ready for use, and can be operated from any convenient lamp socket. It can be set anywhere, or suspended with cords to hang at the top, middle or back of any show window.



The Traveling Electric Sign Provides 30 Ft. of Word Space in a 3½ Ft. Cabinet, the Moving Belt Presenting An Ever-changing Sign—Particularly Adapted to Show Windows.

MUNICIPAL TROLLEY OF SEATTLE LOSES MONEY.

The municipal street railways of Seattle, Wash., continue to lose money, as shown by the report of A. L. Valentine, superintendent of public utilities, in his report for October, the net loss being about $2,000 monthly. Since the city light department took over the street railway substations the power cost is being checked against the value of the substations, so that in October the street railways received $1,069 worth of power without cash outlay.

SAYS U.S. SHIPS HAVE GREATEST RADIO RANGE.

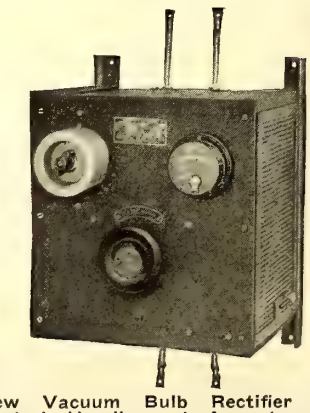
After he had inspected radio apparatus on a number of vessels recently, Secretary Redfield of the Department of Commerce said that American vessels have a wider range in sending and receiving messages than ships of other countries. He also asserted that, from a comparison which he made of apparatus on an American and a British steamer, the wireless regulations past by Congress give greater power to radio inspectors than do British regulations.

NEW VACUUM BULB RECTIFIER FOR BATTERY CHARGING.

The latest novelty in small rectifiers for charging storage batteries rated at 2 to 6 amperes charging rate and from 7.5 to 75 volts is here illustrated. It operates on a new principle for this class of apparatus. The discovery that made it possible is the perfection of the small bulb similar to that of an incandescent lamp, in which rectification of the current takes place. This bulb is filled with an inert gas and contains a tungsten filament and a grafite *anode*. It screws into a lamp socket in the outfit.

A black-japanned casing with perforated top furnishes the mounting and incloses all live parts. This casing carries the bulb, a fuse to protect against reversal and other overload and the compensator which reduces the alternating current without wasteful resistance and excites the tungsten filament. For charging, the rectifiers need only be connected to a convenient lamp socket and the pair of leads attached to the proper posts on the battery.

The smallest unit is of 2 amp. maximum capacity. From a 115 volt, 60 cycle alternating current circuit it will charge three lead battery cells at 2 amp., six cells at about 1 amp., and eight cells at 0.75 amp. Between these figures the charging rate is proportionate. At 10 cents the kilowatt hour for current, the cost is about 1 cent the hour, including tube renewal costs. The weight is about 15 lbs. Medium size rectifiers have a capacity of 6 amp., 7.5 to 15 volts, and are designed primarily for charging three or six-cell automobile starting or lighting batteries in home garages. This type is designed for 115 volts, 60-cycle current, but may be used on 105- to 125-volt circuits. The weight is about 15 lbs. The largest type is designed for use in public garages and service stations, and has a capacity of 6 amp., 7.5 to 75 volts. It will charge from one to ten three-cell storage batteries from a 115-volt, 60-cycle, alternating-current circuit. A compensator with fifteen taps is part of the device and a dial switch for instantly adjusting voltage according to the number of batteries to be charged. Amperage can be regulated between limits of 1 and 6 amp. A single three-cell battery may be charged by itself or any number up to and including thirty cells. The controlling devices, including ammeter, switch and regulating handle, are located on the front of the case as seen.



New Vacuum Bulb Rectifier with Control Handle and Ammeter, Designed for Charging Storage Batteries.

CIVIC FORUM MEDAL FOR DR. BELL.

Dr. Alexander Graham Bell, inventor of the telephone, before a gathering which filled Carnegie Hall, received the Civic Forum Medal of Honor for Distinguished Public Service on March twenty-first. This medal was presented in 1914 to Major-general George W. Goethals and in 1915 to Thomas Alva Edison. After many eloquent speeches in his praise, Dr. Bell responded modestly, endeavoring to share the tributes to him with those who have been associated with him in developing the telephone.

"I may perhaps claim the credit of blazing the trail," he said, "but I am embarrassed at all the honor which has been done me, because so much of it should go to the many men who have since improved upon and extended its use—to such men as Mr. Carty and his associates. Why, I am not even able to understand some of the mechanism which they have introduced into the use of the telephone. When they telephoned from Arlington and were heard at Eiffel Tower in Paris, I could not see how it was done, nor could I understand how an operator in Hawaii was able to pick up the message."

Dr. Bell told how, shortly after he got the idea of the telephone in 1874, he had called on Professor Henry at the Smithsonian Institution, who was then recognized as the greatest authority on electricity in America. Professor Henry listened kindly to his plan, and told him that he thought he had the germ of a great invention.

"I told him that the trouble was that I did not have enough knowledge of electricity," said Dr. Bell. "He said, 'Get it.' Now the fact is that, had I known much about electricity, I would never have invented the telephone. I would have thrown up the idea as wildly improbable. My study had been that of sound."

A NEW INSULATING MATERIAL.

"Galalith" is a bone-like substance similar in many respects to celluloid. It is manufactured from casein and formaldehyde. A solution of casein is obtained by treating skimmed milk with caustic alkali, after which the solution is clarified and the casein then precipitated by means of acids and filtered. The water is then extracted under pressure and the product slowly dried over a period extending several weeks. The product obtained is casein plate, which is treated by thoro saturation with formaldehyde and dried again. Galalith is said to be an excellent insulating material somewhat transparent, altho never completely so, and of a yellowish-white horn-like color. It is workable either in the hot or cold state, the cold galalith being softened by treatment in hot water. It is odorless, and much less inflammable than celluloid. It cannot be made into very thin sheets.

Senator Sheppard recently introduced an amendment to the naval appropriation bill calling for $50,000 to be expended in the erection of a radio station at Galveston.

HEINRICH HERTZ.

Born Feb. 22, 1857. Died Jan. 1, 1899.
Inventor of Wireless.

HEINRICH HERTZ was born on February 22, 1857, in Hamburg, Germany. He received his early training in the engineering schools but at the age of twenty-one he decided upon an academic career and entered the University of Berlin as a pupil of Von Helmholtz and Kirchoff.



Heinrich Rudolph Hertz—Father of the Wireless Telegraph. Upon His Scientific Researches and Practical Demonstration of Maxwell's Electromagnetic Theory, Marconi and Others Have Built Up the Commercial System We Know To-Day.

Of the many gifted students of physics who have come forth from the celebrated Berlin laboratory, there are probably none who have become so world-famous as Heinrich Hertz. His qualities as an investigator were speedily recognized by Von Helmholtz, who urged him while still a student, to undertake the solution of the prize problem proposed by the Berlin Academy of Sciences in 1879.

From 1880 to 1883 Dr. Hertz was an assistant in Von Helmholtz's laboratory; he then lectured for two years as instructor at Kiel. From 1885 to 1889, he was professor of physics in the Polytechnische of Karlsruhe. In the latter year Clausius, a professor of this institution, died, and Hertz was selected as his successor in the University of Bonn, where he spent the few remaining years of his life.

Hertz's career as a scientific investigator covered a period of scarcely more than ten years, during which time he publisht thirty-six papers. Of these, a series of thirteen which appeared in Wiedemann's Annalen, were upon the subject with which his name will forever be connected, *the laws of the propagation of electro-magnetic induction thru space.* Of this great work, which afforded a complete experimental verification of the Maxwellian theories concerning electro-magnetism and the relation of electricity to light, there is no need to speak of its great importance to the scientific world.

The importance of Hertz's contributions to this great subject received instant recognition. It would indeed be difficult to find any other instance in which researches bearing upon a most subtle and difficult question, and absolutely devoid of basic elements of a utilitarian or even of a popular character, having secured to their author such sudden fame. In addition to the recognition of those who were able to appreciate his work, Hertz received the acclamations of the entire world of thought. Fortunately, he possest a nature of such complete simple-mindedness that his sudden rise into a position akin to notoriety had no effect upon him. The unassuming bearing which had always characterized him remained with him to the end.

In delightful harmony with the genuine and simple nature of the man were his surroundings in the quiet university town of Bonn. His laboratory was situated in the apartments formerly occupied as a dwelling by Clausius in a wing of the old palace. Since electricity has become utilitarian, we find it associated everywhere with moving machinery and with the rush and bustle of modern industrial life, but in Hertz's laboratory, there was nothing to suggest the science of electro-technics. The place seemed to breathe that spirit of academic repose which to the inmates of the present day must have seemed to have vanished altogether from the world. What might such a man, in such an environment, have not been able to achieve, had he lived?

The promulgation of the theories of Dr. Heinrich Hertz in connection with *Wireless waves,* stimulated universal interest all over the world, which led to their use in the propagation of intelligence thru free space.

In 1892, Hertz's researches upon the electric waves were gathered together in a volume under the title "Untersuchungen ueber die Ausbreitung der Elektrischen Kraft." Almost on the day of his death, another excellent translation of Hertz's researches appeared.

TO ALL RADIO AMATEURS.

THE Department of Commerce of Washington, by its Secretary, the Hon. Wm. C. Redfield, has kindly sent us the following information of particular interest to all amateurs in the United States at the present time.

Secretary Redfield has issued orders that for the present no new licenses to radio amateurs will be issued and the renewal of outstanding amateur licenses will be granted only by the Department upon special favorable reports by the radio inspectors. (This refers to sending outfits only.)

The Department also informs our readers, reminding them of the fact that the operation of transmitting radio instruments without licenses is prohibited under severe penalties, which, under the conditions of the time, would be exacted in the case of those who showed no regard for the requirements of the law.

Up to the time that we go to press, the Department has not formulated final plans as to what steps will be taken in regard to radio amateurs as a whole, and whether they will be allowed to continue to operate the same as before. It is our personal impression, however, that no drastic steps are likely to be taken by the Government as long as the amateurs cooperate with the Department.

In view of this we most urgently and earnestly request all amateurs at the present time to refrain from using their transmitting stations except for regular work. In other words, all unnecessary gossip and fooling should be rigidly suspended for the present, particularly the "Q.R.M." nuisance which at best, only serves to irritate our officials, and makes their work harder. If amateurs do not voluntarily stop such annoyance the Government will certainly prohibit the use of all privately owned radio outfits.

These are no times to use the ether for a lot of nonsense; we all wish to help our country as much as we possibly can until normal conditions are restored again.

Always remember, that our Government has granted the radio amateurs more powers than any other country in the world, and in times of stress, it is up to the amateurs to show of what stuff they are made by cooperating with our officials to the fullest extent of their powers.

THE EDITOR.

"Eddy Currents"

By C. M. ADAMS

"LIEUTENANT Commander Parker, U.S. submarine 'F-609.' Our torpedoes useless. Proceed at once and see if you can do anything. Enemy's defense perfect.
Admiral Gregg, U.S.N.,
Commanding Flotilla."

I glanced up from reading this message, scrawled on a scrap of paper, to ask Parker what it meant, but he was not there. I heard him in the forward compartment issuing orders in his rapid-fire manner.

It puzzled me, this brief dispatch which Parker had translated from the muddle of code words that had come in over my wireless. Could it be that the great fleet of submarines now in mid-Atlantic, supposed to be torpedoing the enemy's fleet as it tried to approach our shores, had failed in its mission? Were the new powerful torpedoes, loaded with hundreds of pounds of high explosive, and the great mechanical fish which launched them, useless as far as defense was concerned? I wanted to ask Billy Parker these and many other questions but he was busy.

An hour after this message had come buzzing in we cast off our moorings and were slipping out thru the harbor dotted with hurrying navy craft. We did not attract any unusual attention, for submarines were quite common sights in these times. Soon we past Sandy Hook, thru the line of patrolling cruisers, then out into the open sea. Our turbines were purring smoothly and our driving motors were spinning like great smooth-running tops as we went out, thirty-two knots an hour, headed for the open sea.

As we went I picked up a message with my wireless which seemed to be related to the information in the code message Billy had received. It was a press dispatch and read:

"There is a report that the defensive submarine flotilla which was to meet the imperial fleet in mid-ocean, is helpless because of the excellent defense of the imperial fleet against torpedo attack. The report says that the submarines have discharged every torpedo aboard and have not damaged a single enemy ship.

"The imperial fleet was reported by aeroscouts to be of sixteen battleships, together with eight destroyers and followed by twenty transports carrying the invading army. There are also several enemy aeroplanes which accompany the enemy fleet."

Evidently something was wrong with the defense planned by the navy officials. The fifty great under-sea craft were not doing their duty, which had been to sink as many of the invader's ships as possible. I puzzled over this as I sat about waiting for my call and wondered what we would do now that our chief defense had gone.

What would happen when the army in those twenty transports landed on our shore, unprotected save by the scanty coast defense guns, made scantier by the appropriation for submarines, and met our volunteer army in a pitched battle? This truly was a surprise, an overwhelming, unexpected contingency which could not be met by our navy with its present equipment. How could we save our country from the invader? How could we stay off the defeat which seemed iminent when that wonderfully trained army got into action against our meager forces?

I voiced these sentiments when, about nine o'clock I found Billy standing beside the conning tower on the open deck, looking forward over the double wave that marked our bows.

I felt free to ask Billy Parker much, for we had been old classmates at the Tech. school before he went into his electrical engineering work and I drifted off into mine, not seeing each other until I dropt into this craft as its wireless operator when the call came to me from the navy. Wireless operator was all I was good for, owing to my lame leg.

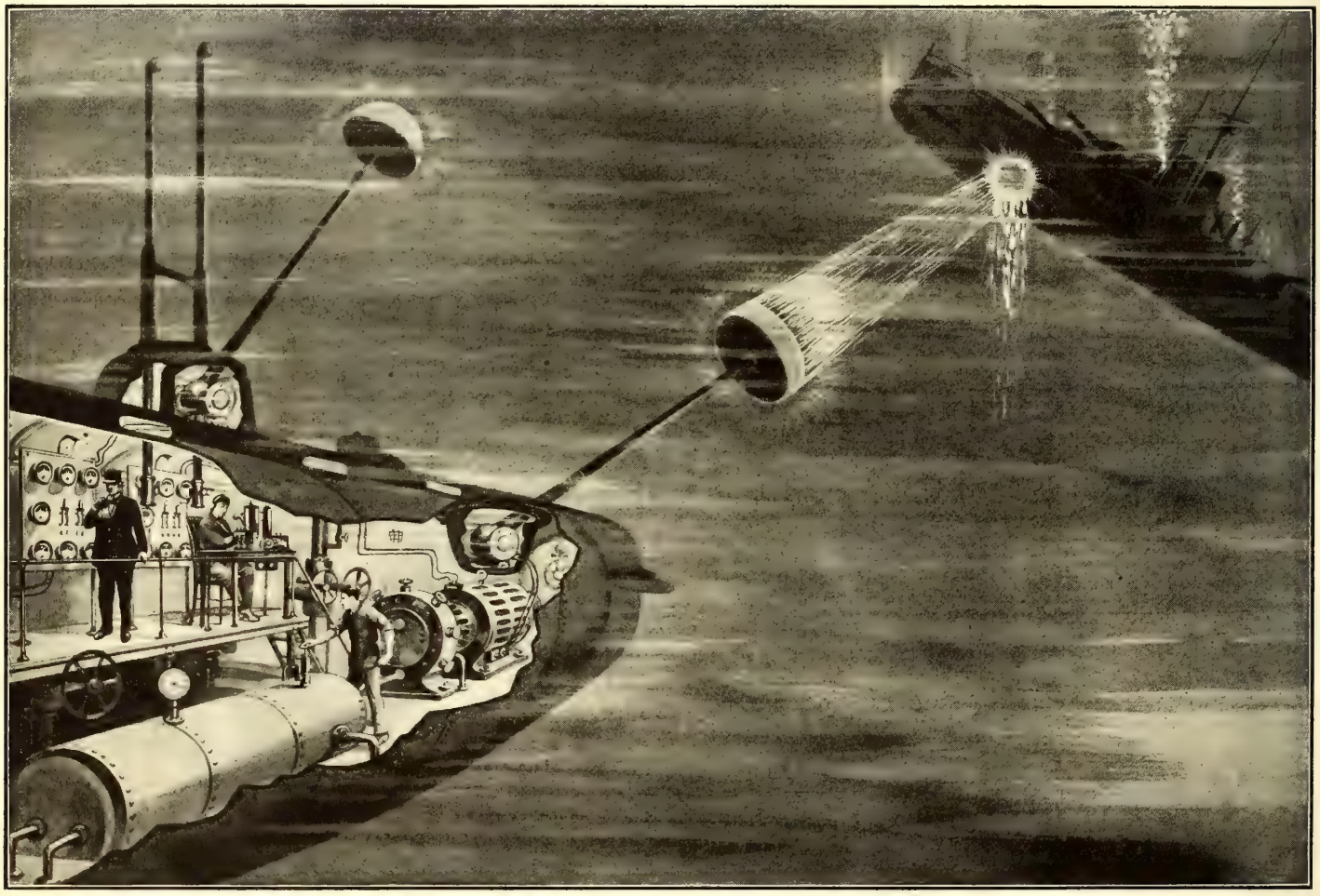
"What will happen now that our submarines are helpless?" I asked.

"It's up to the coast defense and the fleet if we can't stop them," he said, looking away ahead where the sea rolled under the faint stars.

Billy confided in me. His showing me the translated code message proved that. But this was a new turn.

"If *we* can't stop them?" I repeated blankly.

It had not occurred to me that we were going to try to stop them at all. I did not know why we were going, but it seemed obviously impossible for us to do anything in that direction when the rest of the submarines had failed.



Once Again He Called to Start the Alternator. The Hum of the Machine Sounded and as Before the Switch Was Deprest. I Timed It Now and Found That It Was Held Down Six and a Half Minutes.

14639

"Yes, if we can't stop them," he repeated after me.

"Why, we won't be any better than the rest of them. That torpedo defense is too good," I argued.

"Who said anything about torpedoes at all?" he demanded, wheeling and staring at me aggressively.

"Well, we're only a submarine," I retorted.

"Does that mean that we necessarily have to use torpedoes?" he countered.

"Why, don't we?" I asked.

"We haven't a thing that resembles a torpedo on this boat except the shells for that three-inch gun under the deck, and they will be about as effective against a battleship as birdshot against an elephant."

I stared at him a long time then. He was serious as I could see, even in the starlight, but he was not lucid.

"Well, how are we going to get them then?" I asked, thinking that this natural question was expected of me.

"I'll show you," he answered, and stept down the ladder leading below.

I made to follow.

"No, stay there," he commanded.

I did, leaning against the steel conning tower. A moment later I heard the sound of mechanism close to my head and glancing up I saw something appear above the conning tower. I climbed upon the low rail and looked up to see what it was.

The steel plates had opened in the center and from the opening had emerged a hemispherical object, made of what appeared to be very heavy glass and measuring about three feet in diameter. Inside it was what looked to be a small mechanical device which seemed to run on a small circular track.

I was busy examining the device when I heard Parker beside me.

"That," he said, "Is the *Feeler*."

"The feeler?" I repeated, this was new to me.

"Yes, the feeler, a device that will locate any ship within ten thousand yards, without any part of our boat being seen."

I looked at the device again with increased interest. I could not see anything distinctive about it.

"Don't you see how it works?" Parker asked.

"No, I can't say that I do," I admitted.

"Come on down in the control room and I'll show you."

He led the way down the ladder and we went into the little box of a room under the conning tower where one is afraid to lean against the wall for fear of starting or stopping something necessary to the life of the boat.

He picked out a glass case from among the litter of instruments on the walls and pointed it out to me. It was not a very big case. In it were three dials, an electric lamp and below it were three small control wheels. It looked very much like the other dials and wheels so thick about me, and was distinguished only by the word "Feeler" on the case.

"This device," he said, "works on the principle of electro-magnetic induction. You know what that is, the setting up of a current in something that cuts the field of force caused by a magnet. Well, up there in that glass case which will stand any pressure the boat hull will, is a magnetic coil mounted on a revolving and inclined carrier. This coil is shaped and wound so that its lines of force are kept within a very small area, in this case about one and three tenths square feet. Consequently when a metal object passes thru this relatively intense field, the induced current in the metal object will be sufficient to make a difference in the load on the coil. You see that don't you?"

I did. That was perfectly plain sailing, electrically.

"Well then, when this load comes on, the lamp lights up as a signal, and this dial here which is really a calibrated galvanometer, shows how far away the object is."

He pointed to one of the three dials which I had noticed was calibrated in yards.

WE have publisht a great many stories in the past, but we do not hesitate to state that "Eddy Currents" is one of the very cleverest we have ever printed. Not only is it a rattling good story, but the scheme is so plausible that we venture to prophesy that it will be actually tried in the not too distant future. And then, the submarine will earn its adjective "deadly" in the fullest sense of the term.

IN THE JUNE "E. E."

An interview with Thomas Alva Edison, including some new photographs of the famous inventor.

Electricity and Life by Dr. Frederick Finch Strong. Part III of this interesting and valuable series.

Woman's place in the Wireless game—A page of female radio operators who have made good.

The How and Why of Radio Apparatus. Part IV. Spark Gaps.

The Calculation and Measurement of Inductance. Part III of this valuable series by H. Winfield Secor and Samuel Cohen.

Another gripping electrical tale—"In the Way" by C. M. Adams. Don't miss it!

Feature Article—"Electricity's Aid to the Fair Sex"—of interest to everyone.

Building a High Frequency Alternator for use in Radio by S. Cohen.

Experimental Physics. Fifth Paper by John J. Furia, A.B., M.A.

An Electric Player for Tubaphones.

A home-made electric searchlight for the amateur by Frank M. Jackson.

"What are the other dials for?" I asked.

"They are to give the angle of the coil, both in the horizontal and vertical planes. You see both are calibrated that way. These wheels here turn the coils about and raise and lower them, and this third wheel operates the mechanism which raises the coils clear of the conning tower."

I saw then the whole perfect simplicity and accuracy of the device. I marveled at it.

"Then you can run under water without even a periscope exposed and locate the exact position of the enemy," I said.

"Exactly, you understand it perfectly," he replied.

"Then you can aim your torpedo with accuracy," I went on.

"Torpedo!" he snorted with an exasperated frown. "Didn't I tell you that we didn't have one of those antiquated devices aboard this craft?"

"But," I went on, "you must have something to sink the enemy after locating him."

"We have," he said, his face brightening hopefully.

"Well, what is it?" I asked, puzzled.

"Look here, Dick Hartman," he said in mock seriousness, "do you mean to tell me that after seeing this feeler work, you can't understand how we could sink a ship? You, a graduate of the best technical school in the country and a practical electrical engineer, can't understand that?"

I confest that I did not.

"Then you're either asleep or haven't the least trace of imagination," he said, turning away in disgust.

"Well, how do you do it anyhow?" I asked.

"I'm not going to tell you. I'll let you find out for yourself first," he retorted with a show of his old boyish perversity, and walked into his room and left me wondering in front of the feeler dial.

But I could not follow his line of reasoning to its end. I thought of it as I tried to sleep that night, while the motors thrust us forward and our long hull swayed gently as we topt the crests and fell into the hollows. I puzzled over it as I sat at my instruments and waited for my call, or anything else my receivers could pick from the ethereal vibrations about us. But I could make nothing of it. I could see no way, no means by which we could sink an enemy ship with this curious little feeler device which with all, was exactingly accurate.

All that night we ran and all the next day. I did not ask Billy any more about our boat. Pride perhaps kept me from doing this, and impatience at my own lack of perspicuity and imagination. And then too I was busy with my own work and other things that came up, which had to be done in the crowded under-sea craft.

I prowled about it in what spare time I had, trying to see what I could between tricks at my table. I found that it was quite the usual large-sized submarine, of which the navy had an even hundred not counting ours. It was driven by electric motors supplied by turbine driven generators forward. It was provided with the usual gas absorption system which made it possible to run under water with our steam power, without discharging any exhaust gases; this, the first important invention of the Naval Consulting Board. But I found the forward torpedo room locked and none on board had gone into it since they had been on board, none save the chief engineer, Dickenson, a man from Parker's own electrical company, which had built this curious boat and sent it out

(*Continued on page 66*)

LIBRARY

U. S. PATENT OFFICE

118 VOLTS CAN KILL.

The Ontario Electrical Inspection Department of the Hydro Commission are out hot foot after delinquents who try to work in jobs without permits and convictions are being rendered every week, says a writer in the *Electrical Safety Magazine.*



Never Touch Electric Light Fittings or Wiring While Standing In a Bath-Tub or On Damp Floor, as the Consequences May Prove Fatal.

One person is to come up before the board for refusing inspector admission to premises and others for not returning to remedy defects on jobs before expiration of inspectors' notices.

In the City of Toronto, in the month of October, a young man, nineteen years of age, was in the bath-tub and, so far as his parents knew, he was enjoying the harmless and healthful pastime immensely, judging by the sounds of splashing and rubbing emanating from the keyhole.

The happy sounds were suddenly interrupted by a deathly shriek, and his parents upon breaking into the room, found him doubled up with the coils of a long portable lamp cord wound round him and the portable lamp in the bath. The lamp was an ordinary brass desk lamp provided with the silk cord.

The cord was worn, showing bare copper spots. What he was doing with a lamp in the bath no one knows.

The bathroom was provided with a brass bracket well up above the bath with a portable socket.

Test revealed that 118 volts, 25 cycle current was used, one side grounded, the fixture itself clear of ground and well insulated from both the grounded and ungrounded sides of the circuits.

The investigations show that he was killed by coming in contact with brazed cord carrying 118 volts, 25 cycle current.

This proves two things: First, that 118 volts can kill, and secondly, that indifference to bare spots on cord is dangerous.

One quarter of a dollar spent on renewing this cord would have saved a young life, a doctor's bill, an undertaker's bill, and the parents' grief. Is it not worth while? Safety First! should be the slogan of every user of electric service, whether for half a dozen lamps or for a large factory. Again—when you stand on a damp or wet floor or in a bath-tub, don't touch an electric switch or fixture!

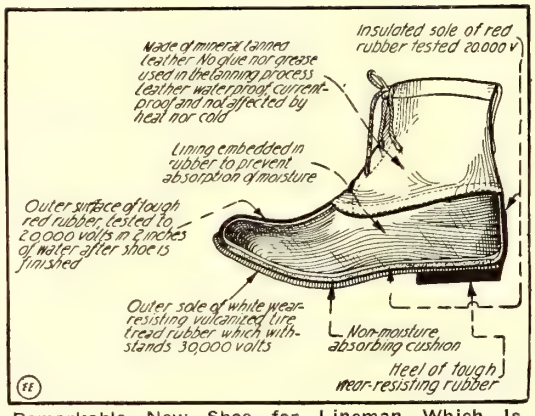
A LINEMAN'S SHOE THAT WITHSTANDS 20,000 VOLTS.

A leading American maker of lineman's protective devices, which for several years has been marketing protective shields to cover wires and cross-arms where men are working, has now developed an insulating shoe for electrical workers. Thruout their entire life a pair of these shoes, the manufacturer states, will provide the wearer protection against circuits at pressures up to 20,000 volts and will not cause the discomforts of many of the rubber soles.

The shoes are molded by a process similar to that used in making automobile tires. The shoes contain no cement and have no seams, but are vulcanized into a solid piece under high pressure on aluminum molds. No hand work is employed in the process. This method of manufacture makes it impossible for the completed shoe to peel or come apart and prevents injury from oil, gasoline or grease.

In order that the shoes may, in the interest of safety, be distinctive, they are all made exactly alike with brown heels, white soles, brown vamps and black tops. The white soles are made of a rubber composition like that employed in certain types of coal miners' shoes, which have been found to give eighteen months of constant wear. When this white sole wears thru, a layer of red rubber, which will itself withstand a pressure of 20,000 volts, is exposed The appearance of the red rubber is a signal or reminder to the wearer that, altho his shoes still will withstand 20,000 volts, a new half sole should be immediately cemented or vulcanized in place.

The brown rubber also extends under the white sole. It is this piece of material which is capable of withstanding high potentials. One of these shoes, when tested



Remarkable New Shoe for Lineman Which Is Capable of Withstanding 20,000 Volts. Note That No Nails Are Used.

in the laboratories of the Edison Electric Illuminating Company of Boston, under the direction of the accident prevention committee of the National Electric Light Association, showed the following characteristics:

"Side of shoe, dry, punctured at 31,500 volts, and again at 34,000 volts; sole of shoe between electrodes in oil punctured at 55,000 volts; 20,000 volts applied from salt water to salt water for one minute and 30,000 volts applied from salt water to salt water for forty-five seconds did not puncture the rubber."

ELECTRICITY LIGHTS NEW PIPE.

An electrically ignited pipe which lights the tobacco at the bottom of the bowl instead of at the top, thus avoiding the collection of moisture in the stem, is the newest in smokers' inventions.

PECULIAR ELECTRICAL PHENOMENA.

By Walter J. Howell.

While standing about one hundred feet away from the tracks of the New York, New Haven and Hartford Railway January 10, 1917, a large steam engine pulling a heavy freight train past at the rate of five to eight miles per hour. The railroad is electrified by overhead wires, which, at this point, were about seven feet above the locomotive, and current is sent thru them at a pressure of 11,000 volts, 25 cycles.

Directly over the engine, which was giving off a medium black smoke, the air seemed to flicker at the rate an electric light would if connected to a 25 cycle circuit. This was only noticeable when the quality of the smoke's carbon element was just right. That this flickering was not due to heat waves I proved by the fact that objects when looked at thru heat waves seem to bend or wave from side to side and move upward, while objects seen thru this vibrating air did neither, and when the quantity of carbon decreased as the wind blew, the flickering effect disappeared.

The cause of this phenomena I attribute to the attraction and repulsion of the carbon particles in the smoke and as the current reversed they were drawn upward and downward for a very short distance, while being dissipated into the atmosphere. The effect was not noticed a few inches above the wire. The weather on January tenth was slightly hazy, with no sun at 3.30 p.m., when this effect was noticed. In bright sunlight it could not have been seen. If my explanation is in error I shall be pleased to hear the views of some of your technically inclined readers.

MAKE YOUR PHOTO PRINTS BY ELECTRICITY.

The electric photograph printer illustrated has been brought out for both professional and amateur use. A feature of the device is an automatic switch which is operated only when full pressure is placed on the pad. The pressure pad is placed in position by a hand lever which controls the automatic switch, the light being turned on only when full pressure is exerted on the pad. The light is turned off before pressure on the pad is released, thus avoiding any blurring in the prints and assuring absolute contact. A locking device is provided which relieves the operator of the necessity of maintaining pressure on the lever during the exposing period. With a slight grip on the release catch, the lever can be freed. A locking device is also provided, permitting the white light to be turned on and the pressure pad elevated to permit accurate adjustment of masks or vignettes. In the light box of the smaller printer are one ruby and four clear incandescent lamps, and in the larger one there are one ruby and six clear incandescent lamps. The printers are designed to take 100-watt gas-filled lamps.



Electrically Illuminated Photograph Printer Equipt with Automatic Switch Actuated By Printing Frame.

The printer is being made in two sizes—8 in., by 10 in., and 11 in., by 14 in.

The RADIO LEAGUE of AMERICA

HONORARY MEMBERS
CAPT. W.H.G. BULLARD, U.S.N. NIKOLA TESLA.
PROF. REGINALD FESSENDEN. DR. LEE DE FOREST.

H. Gernsback, Manager *W. H. Kirwan, Master of Radio Relays*

The Washington's Birthday Relay Prize Winners

By W. H. KIRWAN, (9XE)
Master Radio Relays, Radio League of America

WELL, boys, you did it; the first official Trans-continental M.S.G. (message) No. 1 from the Mayor of New York to the Mayor of Los Angeles, went thru with the customary speed and reliability of all the Relay messages we have worked on. The special stations sent the westbound message from New York on this night from 2 ZK at New Rochelle, using 8 YI, 9 XM and 9 ZF to 6 EA, which last station is in Los Angeles, Cal. Considering the time, one and one-half hours, and the great "QRM" (interference) and the repeating of message on account of misspelt words, it was truly wonderful.



Mr. Edward B. Duvall, Who with Mr. A. P. Smith, Operating Station "3AK," Baltimore, Md., Won "First Prize" in the Washington's Birthday Relay.

The westbound message used special stations only and was as follows:

To the Mayors of Los Angeles, Cal., and Seattle, Wash.:
On behalf of New York City, I send cordial greetings to Los Angeles and Seattle, and best wishes for the success of the Radio System.
(Signed)
John Purroy Mitchel,
Mayor of New York.

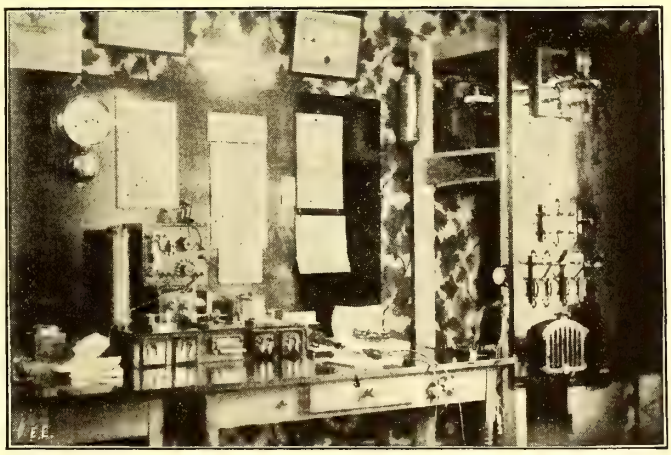
Thousands of amateurs copied this message with varying degrees of exactness thruout the country, as four heaping bushels of letters have shown. This was the first relay attempted by the writer, the necessary notices of which were publisht in this magazine. Some of you did not hear about the Relay because you are not regular subscribers. Let this be a lesson—Get your name down so that you will receive your magazine promptly and regularly.

Now, here comes the sad part. You will see "by the papers," that on this night we had good radio weather as far as the Rockies, but the writer had studied the weather man and looked for trouble southwest and west, and we had it! A healthy young cyclone was dancing merrily over Texas, Arizona, New Mexico and California, and the tail end of a regular old-time "QRM" storm was making life miserable for the boys in the war west, but with it all, 6 EA got the message direct from 9 ZF. 6 DM, who volunteered to help 6 EA, put on full power and promptly blew the fields of his gap motor, leaving 6 EA to do the honors and, by golly, he did.

Seefred Bros., delivered this message to the Mayor of Los Angeles, and promptly received his reply, but QRM and QRN were so bad by this time that it was a physical impossibility to get it thru to 9 ZF. 6 EA stuck to his post, however, and got the message thru the next night, too late for 9 ZF to find anyone out of bed. 9 XE arranged for all eastbound amateurs to be on the job, and the message came thru fine, being delivered to the Mayor of New York by Mr. Geo. C. Cannon, 2 ZK, the next morning early.

Lots of you kept me company by staying up all night waiting for the return message and now you know why it could not get back on schedule. The return message was as follows:

To the Mayor of New York City:
On behalf of the City of Los Angeles, I return your greetings and wish you continued prosperity. Congratulations to Amateur Radio on the successful message. (Signed) Fred I. Woodman, Mayor of Los Angeles.



Radio Station "3 AK," Baltimore, Md., at Which the Washington's Birthday M.S.G. Was Successfully Received in Record Time.

By counting up the total time consumed on each message, we call the race between Specials and Amateurs a tie, with the handicap of the low wave length of the amateurs, giving them a slight preference for a decision in their favor, but my former contention still holds—that the amateurs are not yet prepared to handle these trans-continental messages with as great a degree of certainty as the Specials, unless they can get together and have emergency stations in the long jumps.



Mr. A. P. Smith, Joint Operator of Radio Station "3AK," and to Whom Full Share of the Credit for the Receipt of the Relay M.S.G. Is Due.

I am not posing as an expert, but candidly believe that fifty miles, worked absolutely sure, with a great number of relay stations, is more reliable than a few with long jumps, working only when the conditions permit. This is what we propose to do now by organizing the *"Q.R.M. League."* In it, there will be a chance for all of you to help and not just a few thruout the country who want to work every night, and who want you to shut up. You know, boys, this good old U.S.A. is a pretty big place and these Relays are run for your benefit, but there are some few in this country who

(*Continued on page 61*)

Electricity and Life

The Construction of High-Frequency Apparatus for Medical and Lecture Use.

By FREDERICK FINCH STRONG, M. D.
Lecturer on Electro-therapeutics, Tufts Medical School, Boston

(Second Article)

IN the March number of THE ELECTRICAL EXPERIMENTER the author pointed out that high-frequency currents, when properly tuned, acted as "Vital Boosters," increasing all the functions of the body and helping it to resist and



Fig. 1. View of the Strong Conical Oudin High Frequency Coil Delivering a Veritable Tree of Sparks Several Feet in Length.

throw off disease. This vitalizing effect is not due to the mere liberation of heat in the tissues, for it is produced by the very high-voltage ("Tesla") currents as well as by the heavy amperage ("D'Arsonval") currents from which the thermic effects are usually obtained.

When the writer demonstrated the first therapeutic Tesla Coil and the first Vacuum Electrode—(in 1896 before a Boston Medical Society)—and suggested that this method was destined to come into general use as a vitalizing agent, he was laughed at by his colleagues; yet to-day there is scarcely a well equipt physician's office in this country or in Europe that does not contain some form of therapeutic high-frequency apparatus. Even the barber-shops of the present time have their small "Violet Ray" outfits; and these are not by any means "fakes" for they produce real results, such as the relief of headache, neuralgia, skin diseases, et cetera.

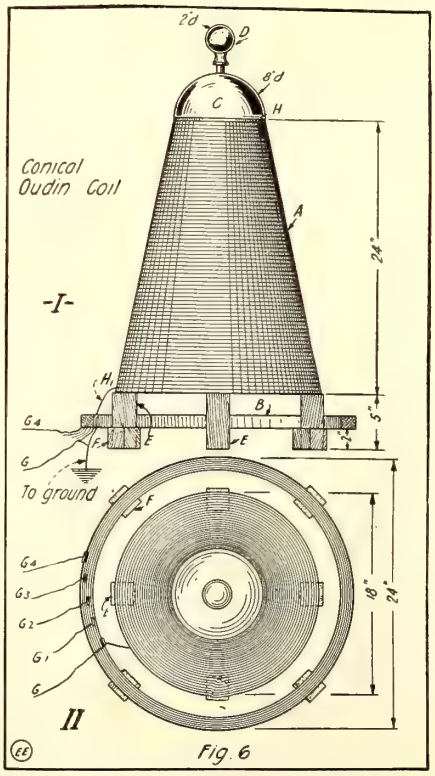
Unlike other forms of electricity, these currents may be administered to patients with perfect safety. In twenty years' experience in electro-therapeutics the author has never known of harmful results from the use of Tesla Currents applied thru a vacuum electrode. The heavy amperage ("D'Arsonval") currents, owing to their deep thermic effects, should be used only under the direction of a physician. The writer is a firm believer in the use of Tesla currents in the home—if each member of the family could receive ten-minute daily treatments from a small high-frequency apparatus, the general standard of health would be greatly increased. This has been demonstrated in hundreds of cases.

The author has interviewed a number of the more prominent authorities on medical electricity and they agree as to the vitalizing effects resulting from daily high frequency treatment.

Anyone who possesses a ¼ or ½ K.W. wireless transformer, operating on 110 volt, 60 cycle A.C., can easily construct an efficient high-frequency outfit for medical or lecture use. The complete equipment includes a .01 microfarad glass plate condenser, Tesla coil, inductance, spark gap and electrodes.

The Tesla coil is made as follows: (Fig. 3) On a paper mailing tube 2½" diam. and 14" long wind 480 turns of No. 34 D.C.C. copper magnet wire. Set up the tube in the lathe, apply a coat of orange shellac, spin on the wire, apply a second coat of shellac and allow to dry thoroly. The winding occupies twelve inches, leaving a margin of one inch on each end of the tube. Leads of light auto (ignition) cable are soldered to the ends of the winding. A strip of waxed, corrugated paper M, 5" wide is wrapt around the center of the secondary tube and on this is wound the primary, consisting of four turns of heavy high tension auto cable, and thoroly secured by tape; at least a foot of cable should project from each end of the winding to form the primary leads. Place the coil in a wax tight box made without nails and embed it in a mixture of four parts rosin and one part beeswax. It is safer to boil the coil for an hour in the insulating mixture before placing it in the box. Coils made in this way by the writer are still giving good service after fifteen years of use.

The greatest source of trouble in a medical high-frequency outfit is the spark gap; the one described below is the outcome of many years experiment. If properly



Details Are Given In This Article for Constructing a Reliable and Powerful Oudin or Tesla High Frequency Coil, Suitable for Physicians' Use. This Type of Coil is the Most Efficient Ever Designed.

made it will run daily for months without deterioration. The spark takes place between two pieces of brass rod 1¼" diam. and 3¾" long, turned and tapt as shown. The sparking surfaces are turned in annular grooves with a 60 degree tool. If

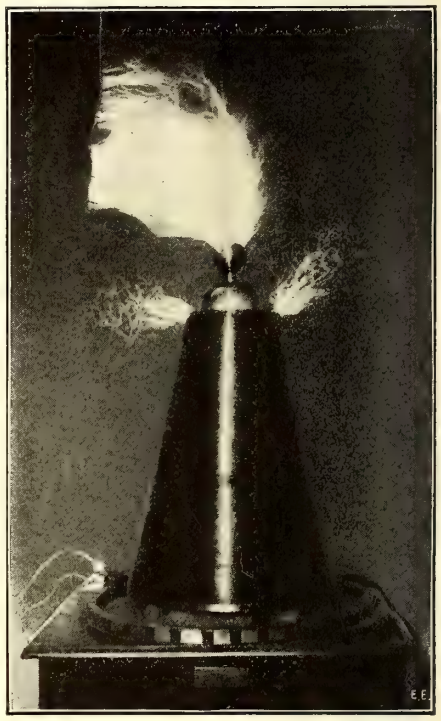


Fig. 2. Another View of the Strong High Frequency Coil Producing a Perfect Sheet of Flaming Sparks to a Grounded Conductor. The Exciting Energy Is but 1 Kilowatt.

your lathe has an automatic cross-feed you may set it to twenty turns to the inch, and turn a spiral groove instead of the annular rings. After finishing, the brass pieces are *heavily silver plated* and mounted in the usual manner as shown. (Fig. 4.) For currents over ¼ K.W., a plate of silver should be soldered to the brass before turning the grooves. This gap will also give greater efficiency in wireless work as compared with the usual stationary gap.

The connections for the various parts of the apparatus are shown in Fig. 5. An important feature is the use of an external inductance or tuning coil "d" in series with the Tesla coil. It consists of 32 turns of No. 8 bare copper wire, wound on a frame 8" diam., with ¼" between turns. Edgewise wound flat copper strip is better but more expensive. (d Fig. 8.) This coil when used in series with the Tesla primary enables us to tune the oscillating system in perfect resonance when the capacity of the patient's body is added to the Tesla terminal. Effects are produced which are impossible with any other method. The beautiful *High-frequency Effluve* or brush-discharge, so valuable in treating pulmonary diseases, and which so few modern high-frequency machines can produce, is obtainable by the use of this series inductance. It may also be used, by short-circuiting the Tesla primary, as an auto-transformer from which may be derived heavy "D'Arsonval" and "Diathermic" currents as described in the next article of this series.

For stage demonstration and public lecture work the writer employs a large high-frequency resonator which produces a tree-

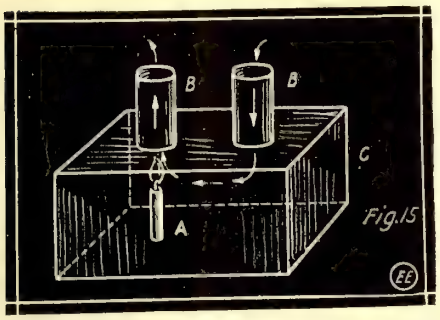
(*Continued on page 59*)

Experimental Physics

By JOHN J. FURIA, A. B., M. A.
Instructor in Physics and Science Master, Riverdale Country School

LESSON FOUR
GASES AND THE ATMOSPHERE
(Concluded)

AIR expands when heated and becomes lighter in weight. If we have a confined body of air such as in a room, for example, and there is a source of heat in the room, the air near the source will expand



Simple Apparatus Comprising Box, Candle and Two Lamp Chimneys for Demonstrating the Principle of Ventilation.

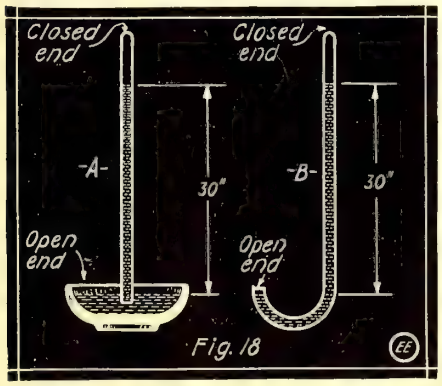
and become lighter and the heavier air at the top of the room will fall, forcing the lighter air upward. Thus it is that the air near the ceiling is always warmer than that near the floor. This shows the necessity of opening a window at *both the top and the bottom* for best ventilation.

EXPERIMENT 19—

Fig. 15 shows very simple apparatus which can be made with practically any material available, for demonstrating the behavior of air near a source of heat. C, is a box thru which holes have been cut to admit tubes (or glass lamp chimneys) B. A is a lighted candle. The arrows show the direction of the current of air.

EXPERIMENT 20—

An interesting experiment giving surprising results and having a simple explanation can be performed by the use of a spool and a visiting card. (If no visiting card is available, the ace from a poker deck which you may have "up your sleeve," will do very well.) Place the card up against the bottom of the spool as in Fig. 16-A and the mouth against t e top of the spool. Blow vigorously and then let go of the card. One would naturally expect that blowing against the card would blow

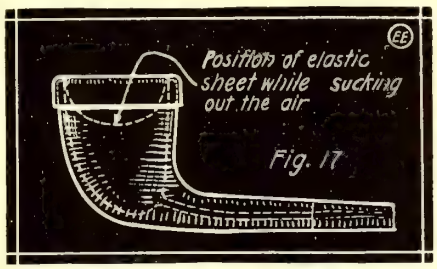


A Glass Tube, Sealed at One End and Filled with Mercury, Will Support a 30-inch Column of Mercury, Owing to Atmospheric Pressure Acting Against a Vacuum. The Principle of the Barometer.

it away whereas actually the card stays fast, close to the bottom of the spool. Sometimes, when the conditions are not just right, the card slides off perpendicular to the direction in which one blows, but to avoid this a pin should be stuck thru the card's center and then into the hole in the spool (care being taken not to stick it into the wood of the spool). Fig. 16-B shows diagrammatically what happens. The air from the mouth passes down the hole in the spool and out along the upper surface of the card. It is a well-known fact that the pressure is greatest where the speed is least and *vice versa.* The air underneath the card is practically still, while that just above the card is in rapid motion, and hence the pressure against the card from beneath is greater than that from above. Hence the card tends to get as close to the spool as possible and does not fall.

EXPERIMENT 21—

In the First Lesson we learned that at any depth in a liquid there is a pressure due to the weight of the liquid above that depth. We also learned that air has weight and consequently we conclude that the air (at the surface of the earth) has pressure due to the weight of the air above it. The higher up we go, the less air there is above us and hence the pressure is less. If one sucks in at the stem of a pipe (see Fig. 17) at the bowl of which is stretched a piece of sheet elastic, the pressure of the air above it pushes the elastic down. Suction is not a mysterious force; it is simply a removal of the air from one side so that the pressure from

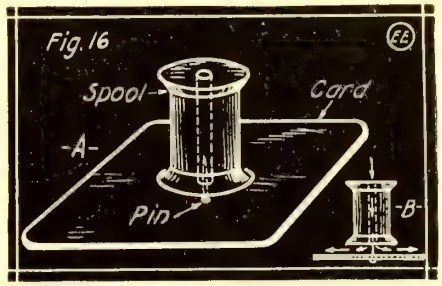


Removing the Air Within a Pipe Bowl by Sucking In Thru Stem Allows the Pressure of the Air to Push Elastic Diafram Inward.

the other side can act without being opposed. Actually, when the air is entirely removed from the pipe, the pressure above the elastic sheet is *fifteen pounds on each square inch; i.e.,* the weight of the column of air from the earth's surface t the end of the atmosphere on each square inch of the earth's surface is fifteen pounds. A column of water thirty-three feet high and one inch square weighs fifteen pounds and a column of mercury thirty inches high and the same area, weighs the same (mercury weighs 13.6 times as much as water).

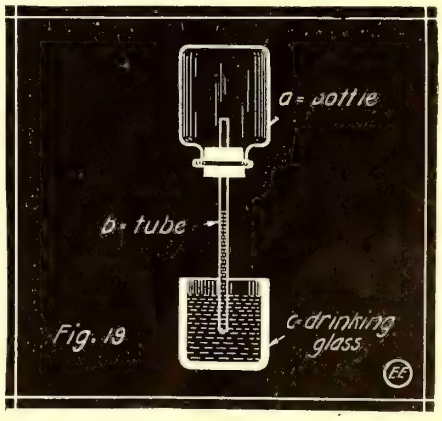
EXPERIMENT 22—

Seal one end of a narrow tube having a diameter of about one-quarter inch and about fifty inches long. Fill the tube with mercury and invert it carefully and place the open end in a cup containing some mercury. The mercury in the tube will fall until the height of the mercury in the tube is about thirty inches above the level of the mercury in the cup. The same level is kept no matter how long and how wide the tube is. The air pressure on the cup's surface acts against the mercury in the cup and it is transmitted thru the mercury to the open end of the tube. Since the tube was filled with mercury and there was *no air at the sealed end,* we get the same effect as if air was there originally and was sucked out; *i.e.,* there is no air pressure in the tube and the air pressure outside can hold up the mercury to a level of about thirty inches. If now the seal is broken the air rushes in and the mercury in the tube falls into the cup. (See Fig. 18-A.) The pressure of the atmosphere changes from place to place and from time to time. It is, therefore, im-



If You Blow Down Thru the Spool the Card Sticks to the Spool, Contrary to General Opinion.

portant to measure the exact pressure at each locality. It is possible to determine one's height above sea level by the reading of the *barometer.* Also the readings of the barometer show how the weather conditions are. The barometer is nothing but an instrument to measure the pressure of the atmosphere. Obviously our Fig. 18-A represents a crude barometer. Its great disadvantage is that when carried about from place to place one is likely to spill the mercury. An improved form is shown in Fig. 18-B. The same tube used in A is sealed again, bent at the open end and filled with mercury. The air pressure acting at the open end supports a column in the closed end, so that th height in the closed section is thirty inches above the level in the open end. In the commercial form a scale (yard stick) attached so that one can read the levels directly. This form can be carried about more freely without danger of spilling the mercury but is nevertheless cumbersome and inconvenient. The *aneroid barometer* is much more compact (it can be had even as small as an ordinary alarm clock). Instead of mercury to be acted upon, this instrument employs a diafram which is moved in and out by the atmospheric pressure just as the



A Simple Air Thermometer—Utilizes the Expansion of Air on Heating to Vary the Height of a Water Column.

sheet elastic was in experiment 21. The motion of the diafram is magnified by a system of levers and is communicated to

(*Continued on page 47*)

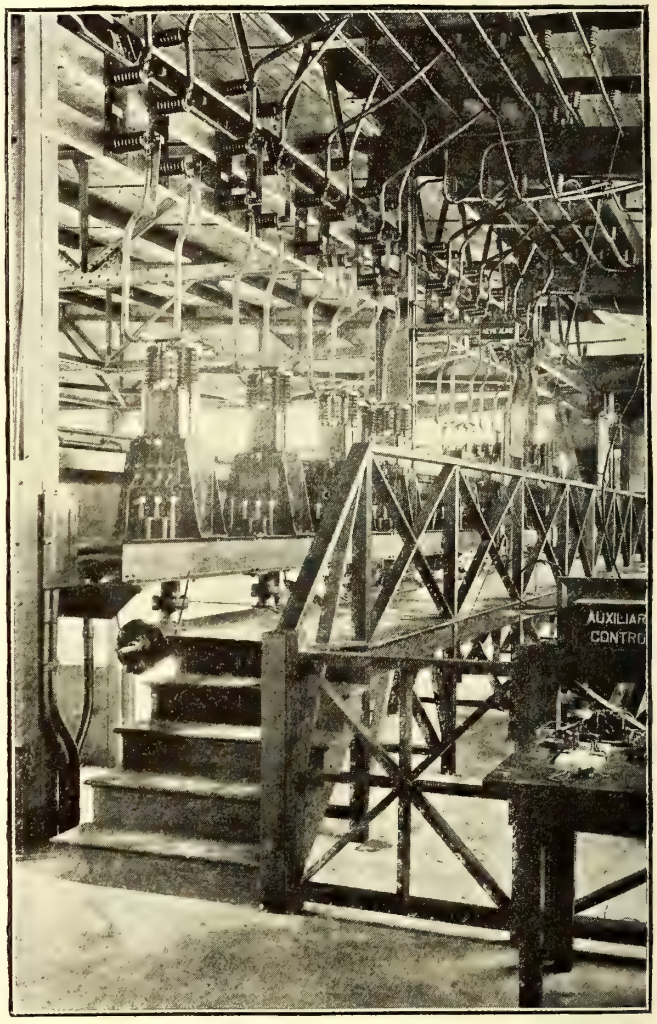


Wireless Telegraphy*

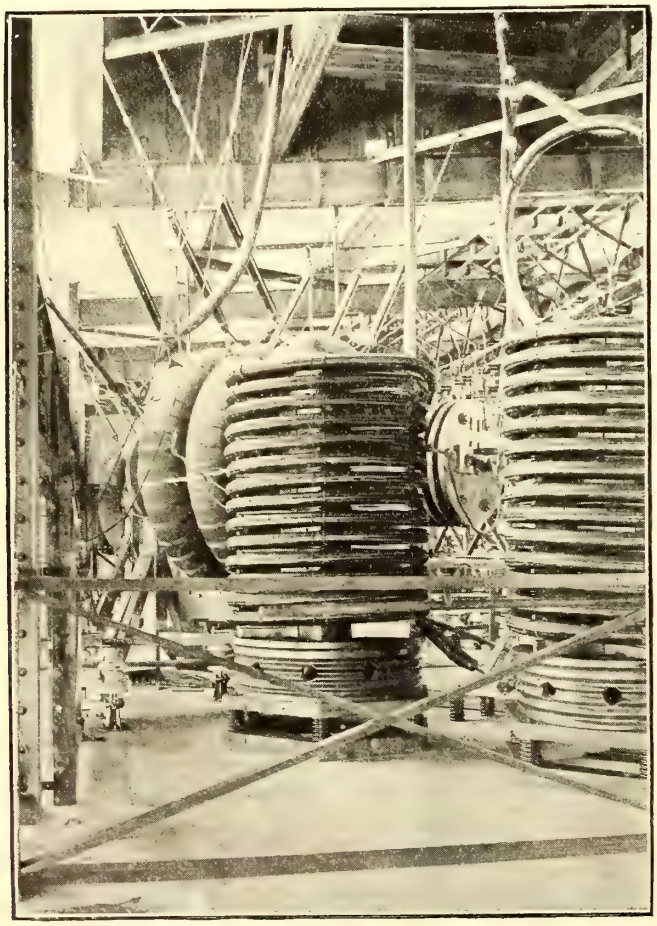
By E. B. PILLSBURY
General Superintendent, Marconi Wireless Telegraph Company of America, New York

THE history of wireless telegraphy repeats once more the old story that is so often connected with great inventions. The world being possest of a new scientific principle, many minds in many parts of the world are simultaneously bent upon its practical application, with the result that the fundamental principle finds embodiment in various methods of accomplishing a similar purpose. The startling nature of the discovery of electric waves was bound to give rise to unprecedented activity in the field of experimental investigation, and such experiments as were particularly successful were bound to prompt investigators to seek patent protection on their modifications, and this in turn gave rise to several systems of radio-telegraphy.

A voluminous list of names could be given of those who have contributed to the advancement of radio-telegraphy in regard to both theory and practise. Among the best-known American investigators are Fessenden, Shoemaker, de Forest, Clark, Stone and Massie. Each of these men has devised a system which bears his name. In England the work has been carried on by men of such unqualified distinction as Lodge, Alexander, Muirhead, Fleming, Thomson and Rutherford. Slaby, Arco and Braun are the names best known in Germany. The French are represented by Ducretet, Branly, Rochefort and Tissot, besides other men of lesser fame. Italy has contributed largely to the subject, principally thru Marconi, Bellini, Tossi and Righi. Denmark is represented by Poulsen. Spain, Austria, Belgium and Argentina have all produced systems which have been more or less used in their respective countries. The Japanese have also devised a system that successfully stood the test of service in the Russo-Japanese War.



Interesting View of a Bank of High-speed, Automatic Sending Keys and Bus-bar Connections in a Typical High-power Marconi Radio Station.



Gigantic Oscillation Transformers and Tuning Inductances In Marconi Trans-oceanic Wireless Transmitting Station.

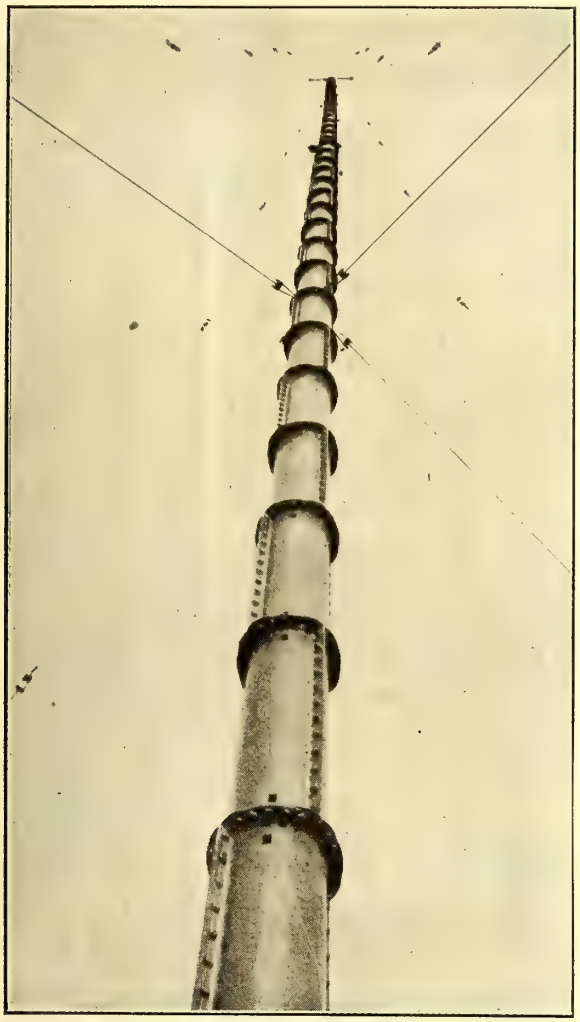
The development of the art in the various countries has been carried on largely by representative investigators, and in many instances the governments have adopted a system exploited by their subjects. The United States government, however, has experimented with most of the prominent systems offered, and, as a result, the army and navy equipments are comprised of quite a variety of apparatus of different inventors.

Wireless telegraphy was the subject of earnest experimentation as early as 1838, but, as far as the public mind is concerned, the science began when Marconi sent his first message across the Atlantic from Cornwall to Newfoundland in 1902. This wonderful accomplishment had so much of the spectacular element in it that wireless telegraphy and Marconi became famous at once and, measured by results, he has eclipsed all other inventors.

Marconi first interested himself in the problem of wireless telegraphy in 1895. In the following year he took out the first patent ever granted in England for a practical system of wireless telegraphy by the use of electric waves. In 1897 he successfully communicated across Bristol Channel, a distance of nine miles. At the invitation of the Italian government, Mr. Marconi subsequently went to Spezia, where his system was put to practical test on board two Italian battleships. A station was erected on

*International Cable Register Supplement.

land, and the ships were kept in constant telegraphic communication with the shore up to a distance of twelve miles. Returning to England he made further experiments and succeeded in communicating between Salisbury and Bath, a distance of thirty-four miles.



Looking Up One of the Towering 450-Foot Tubular Steel Masts, Which Support the Immense Aerials Used to Bridge the Ocean-wide Signaling Spans.

Mr. Marconi came to the United States in 1899, in connection with the America yacht cup race between *Columbia* and *Shamrock I.* In the same year a number of ships of the British navy were equipt with his apparatus. Early in 1901 telegraphic communication was established between two points more than 250 miles distant. In February, 1902, he received, on board the steamship *Philadelphia,* in the presence of the ship's officers, good messages on a recording tape when at a distance of over 1,500 miles from the transmitting station. In December, 1902, he establisht a station at Cape Breton for transatlantic service, and maintained communication with the Cornwall station at Poldhu, transmitting inaugural messages to the King of England and the King of Italy, the London *Times* and others. A year later, during the voyage of the steamer *Lucania,* Mr. Marconi maintained communication between the ship and the Marconi station at Glace Bay, in Cape Breton, and Poldhu, in England, and a newspaper was publisht and issued daily to each passenger. A powerful station at Clifden, on the west coast of Ireland, was opened early in 1907, by means of which public communication across the Atlantic was establisht, which has been maintained ever since.

The importance of wireless equipment of sea-going vessels has been recognized by all nations, the United States law requiring two licensed operators on any ship carrying fifty or more persons and sailing between ports 200 or more miles apart. It is estimated that upward of 5,000 ships are now equipt, and a large number of freighters carry wireless for their own protection, altho not required to do so by law. In fifteen years wireless has placed to its credit the saving of thousands of lives and property valued at several millions of dollars. It is an inestimable boon to mankind that we can go to sea with the knowledge that we are kept in touch with home and can summon aid in case of disaster by means of the S. O. S. signal.

Radio-telegraphy is a most potent factor for naval, military and airship use in the present war. On July 30, 1914, five days before the actual declaration of war, the English fleet, which had just left Portland, was recalled by wireless; and on August 4, 1914, Germany flung around the world on its chain of wireless stations this vital message to its mercantile marine: "War declared on England; make as quickly as you can for neutral port." This first dispatch unquestionably saved Germany many millions of dollars of property and secured for possible future use a fleet of passenger and cargo boats which may yet play a great part in her recovery from war's ravages.

As long distance wireless rang up the curtain on the greatest war the world has yet witnessed, so it has continued to play a great part therein. One of the most striking points in connection with wireless, which has been developed by the war, is that public attention has been directed upon it as never before, owing to the fact that so much of the official communications, particularly German information, has been brought to the notice of newspaper readers thru this medium, owing to obstruction of the German cables.

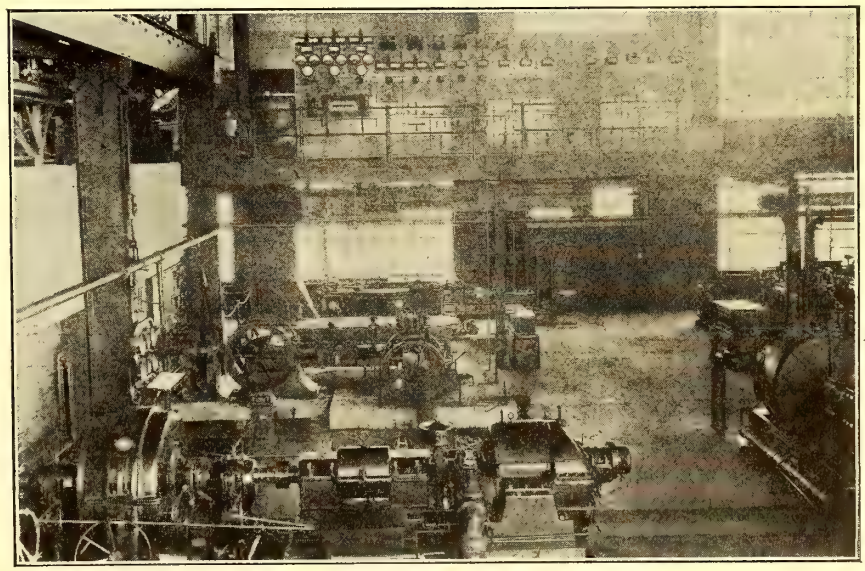
One of the objections made against wireless telegraphy is in regard to the possibility of interference between various stations and the confusion likely to arise when a number of stations are simultaneously operated in the vicinity of one another. Altho this confusion does rarely arise in practise with proper up-to-date stations and apparatus, yet even with the old instruments when it did occur it was not by any means such a serious matter as generally appeared to the imagination of the public. In most countries the operation of wireless telegraph stations in regard to ship and shore communication is subject to judicious rules tending to prevent mutual interference. It is well known that without proper organization and discipline, serious difficulties due to interference would occur with the great majority of ordinary land wire telegraphs which work several offices by means of a single wire. In the case of wireless telegraphy it is often an advantage that any station should be able to pick up a message which may not be actually addrest to it, as, for instance, in the case of a ship in distress calling for assistance. The most practical method of isolating any particular receiver so as to make it sensitive only to signals coming from a certain station lies in the principles of resonance; that is, to tune the sending and receiving circuits in exact correspondence.

When the war broke out a German company had high-power stations in communication between Sayville, L.I., and Nauen, Prussia (3,262 miles), and between Tuckerton, N.J., and Eilvese, Prussia (3,383 miles). In order to protect our neutrality the American government took over these stations and is now operating them in the interests of the owners.

The government has erected a high-power station at Arlington, within sight of the Capitol at Washington, with a radius of 3,000 miles under ordinary conditions. It represents the first step of the Navy toward the establishment of a great chain of high-power wireless stations to girdle the earth and bring the Navy Department into direct communication with the fleet thruout the length and breadth of the seas. Unless a war vessel be in the Arctic, Antarctic or Indian Oceans, it will be at all times within the range of one of the seven contemplated stations, the other six of which are to be located at San Francisco, Honolulu, Manila, Guam, Panama and Samoa.

From the Arlington station messages can be sent to vessels stationed beyond the

(*Continued on page 77*)



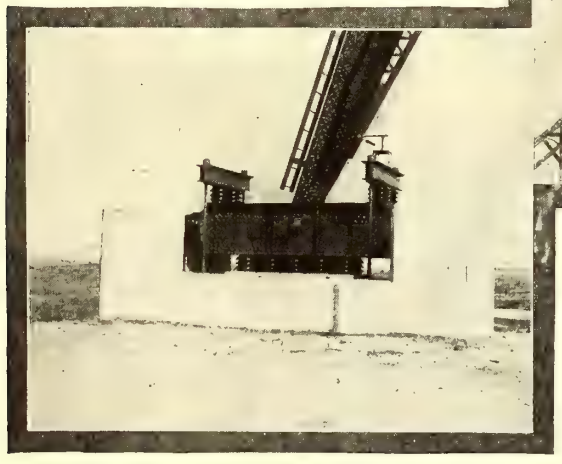
500-horsepower Steam Turbines and Generators in Marconi Trans-oceanic Radio Station.

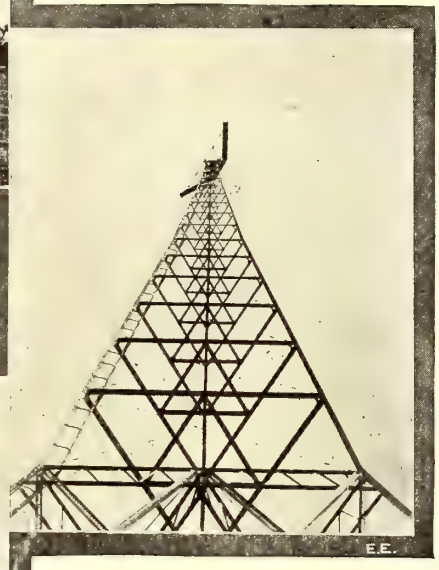
San Diego—Largest Radio Station in U. S.

By J. BASSETT

THE new $300,000 wireless telegraph station at San Diego, Calif., has just been completed and officially put in commission January 26, 1917. It is the largest and most powerful radio station in the western hemisphere. It is capable of flashing messages 12,000 miles. Messages from the British high seas fleet cruising in the North Sea, from the high powered German plant at Berlin and from Australia have been intercepted thus far.







View Above Shows Mission Style Operating Building and Fan-Tail Lead-in at Powerful New U. S. Radio Station, San Diego, Cal.

At Right:—Looking Up One of the Gigantic 600-Foot Latticed Steel San Diego Wireless Towers.

Below:—Concrete and Porcelain Base Support for Insulating the Steel Tower Legs.

The three 600 foot aerial towers form a triangle. They contain one million pounds of fabricated steel and are the *largest radio towers in the world.* The towers are triangular in section, 150 feet in width at the base and eight feet at the apex. They are placed 1,100 feet apart. Porcelain insulators imbedded in concrete form the base of each leg of the towers.

The receiving room is absolutely *sound proof,* the walls and floor being padded with asbestos. There are four distinct and complete controlling sets installed in the receiving room, enabling any one of the four operators or all four at once to send and receive messages.

The aerial or antennae weigh 16 tons and has a sag between towers of 100 feet. The aerial is twice as large as that strung from the Eiffel Tower in Paris. The helix is 14 feet in diameter and 11 feet in height or 9 feet higher than the helix used in ordinary naval and commercial stations.

The generator weighs 60 tons and the three 100 kilowatt transformers 2,800 pounds each.

Establishment of a distant control system will enable operators at any naval radio station on the Pacific Coast from Point Loma to Alaska to operate its sending instruments. This is accomplisht by a system of land telegraph lines. The radio apparatus is what is known as the Federal Poulsen arc transmitter and was manufactured by the Federal Telegraph Co., of San Francisco. The Poulsen arc employs a direct current arc of 600 to 1,000 volts, burning in a closed chamber of hydrogen, the terminals being placed at right angles in a powerful magnetic field. Electric current for the radio set is furnished by a 200 kilowatt—1,000 volt direct current generator, driven by a 300 horsepower 2,200 volt 60 cycle induction motor.

Six buildings costing $39,590, in mission style architecture, form the quarters for those on duty. Here we find a large, airy dormitory, gymnasium and well-furnished library.

A silver plated telegraph key was presented to Commander Hooper after he had dispatched the first message. The following inscription was on the key: "High Power Radio Service, First Message, Com'd'r S. C. Hooper, Jan. 1917, San Diego." At exactly 11.02 January 26, 1917, Commander Hooper called the station at Arlington and sent this message from the Mayor of San Diego to Secretary J. Daniels:

"In behalf of the citizens of San Diego I have the honor of extending to you the season's greetings and their good wishes and congratulate you upon the completion at San Diego of the world's most powerful radio station. Space has been completely annihilated and the Atlantic and Pacific seaboards are as one."

Arlington acknowledged the message at 11.05 o'clock. It was immediately transmitted by telephone to Secretary Daniels. His reply was returned at 11.18. It was thus:

"Your greetings and congratulations much appreciated. The navy department rejoices with San Diego that the completion of the new radio station at San Diego places Washington in closer touch with the Pacific Coast and particularly with the navy's larger development at San Diego. It must be gratifying to California to know that the apparatus installed is the product of a California company."

This was followed by a message from Congressman Kettner. It was as follows:

"Washington salutes San Diego, first port of call by wireless. Felicitations extended thru you to people on completion of the greatest radio station in the United States made possible by your esteemed friends, Secretary Daniels and Admiral Griffin."

It was answered by Howard Veeder, vice-president of the Federal Telegraph Co., as follows:

"Please accept the felicitation of the Federal Telegraph Co. and myself personally upon the successful opening of this great radio station. It is a great pleasure to our company that the first example of this most remarkable advance in the radio art, which has been developed by us in San Francisco should be installed in San Diego, a sister city."

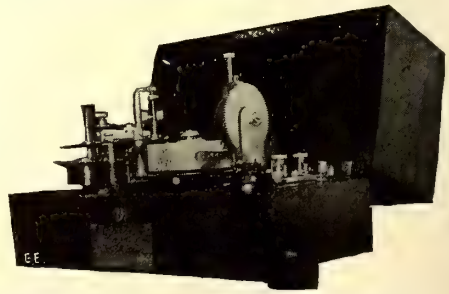
The radio plant is located in a section called Chollas Heights, ten miles from the business center of San Diego, on an elevation of land, reached by auto.

U.S. RADIO INSPECTORS USE CODE MACHINE IN TESTING APPLICANTS.

All applicants for U. S. Government Radio Operator's License must pass a test in receiving messages in the telegraphic code, i.e., in the form of dots and dashes. The accompanying illustration shows a new complete automatic telegraphic code transmitter, known as the Omnigraph, complete with high-note buzzer and exciting batteries, which latter are contained in the base of the cabinet. The various discs, which are properly notched on their periferies to correspond with the dots and dashes of the different letters of the alphabet, are placed one above the other on a rotatable drum or plate, which is driven by a strong spring motor provided with a suitable governor, in order that the discs may be caused to rotate at any desired speed.

The toothed disc makes contact with a special light spring brush connected with the high-note buzzer circuit. Thus, as the discs slowly rotate, the buzzer circuit is made and broken in accordance with the long and short notches on the edges of the discs.

This instrument has been used for a number of years by the government officials in examining applicants for Radio Operator's License and has been found very satisfactory. The messages may be signaled with this apparatus at any speed from 12 words up to 30 words, or more, per minute, thus giving it a wide range of usefulness.



Automatic Code Apparatus Used by U. S. Radio Inspectors in Examining Applicants for Operator's License.

A large variety of code disc are available and the machine may be set up to give different code combinations as often as desired.

WIRELESS OUTFIT ON MOVING VAN TRACES MESSAGE.

After a search of three months for an amateur wireless operator who sent out unsigned "SOS" messages in the neighborhood of New York and caused great annoyance to the New York Navy Yard and navy vessels the federal authorities recently arrested William F. Eckoff, sixteen years old, who had a wireless station on the roof of his home in Brooklyn.

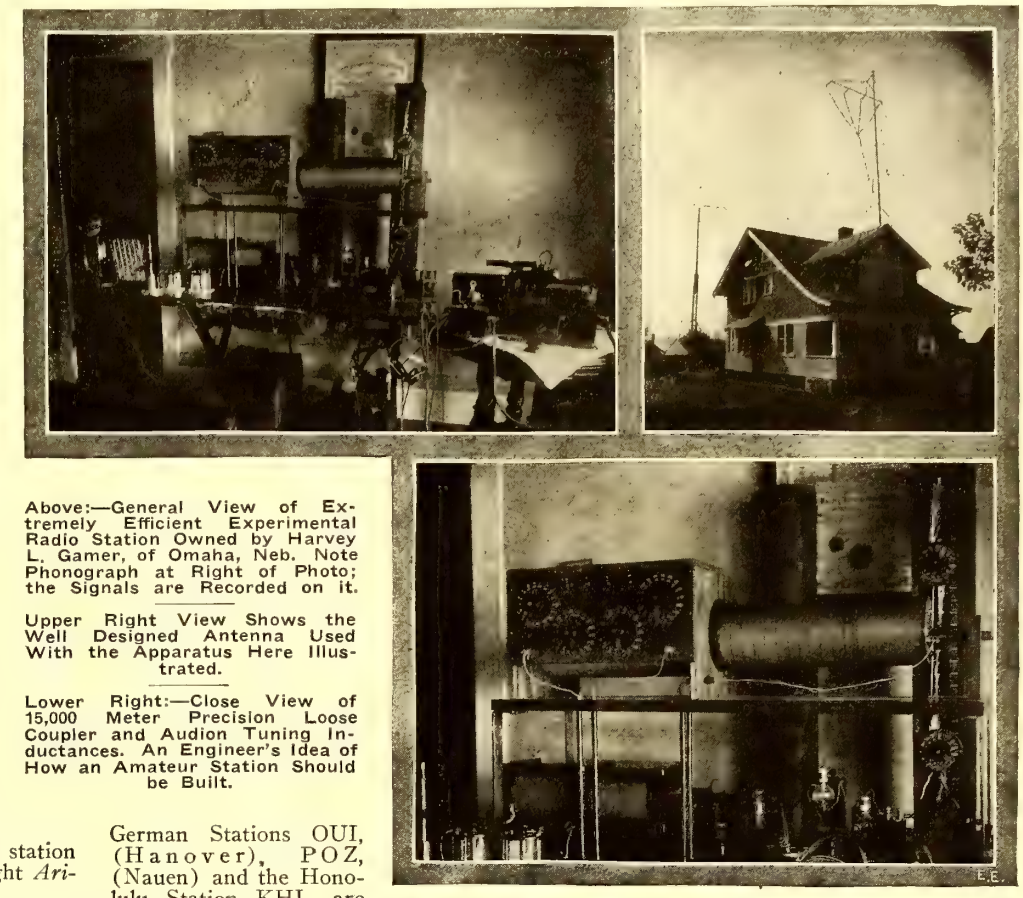
When the messages were first heard there were reports in shipping circles of submarines operating near New York. After several of these calls stations nearby recognized them as the work of an amateur. The New York *Herald's* wireless station worked with the operators at the New York Navy Yard in an effort to locate the station. The log at the *Herald's* wireless station shows that these distress messages were sent at all hours of the night. The mysterious operator used the calls of the Navy Yard and naval vessels.

Louis R. Krumm, chief radio inspector of the Department of Commerce, engaged a moving van and installed in it a small wireless set which could detect messages within the radius of only a block. Operators had traced the messages to Brooklyn, and, with the moving van, Mr. Krumm went about Brooklyn until he arrived in front of the Court Street house.

It is alleged that Eckoff used a United States code signal on the night of January twenty-first last, sending an "SOS" call which which was picked up by the *Herald* station and relayed to the super-dreadnought *Arizona* at the New York yard.

Eckoff was arraigned before United States Commissioner Louis Bick and admitted he had been sending messages, but asserted that if he had used the United States code he had done it innocently, for he did not understand the code thoroly enough to commit a nuisance.

The efficiency of such portable radio stations has been markedly improved in recent years by the advent of spiral aerials.



Above:—General View of Extremely Efficient Experimental Radio Station Owned by Harvey L. Gamer, of Omaha, Neb. Note Phonograph at Right of Photo; the Signals are Recorded on it.

Upper Right View Shows the Well Designed Antenna Used With the Apparatus Here Illustrated.

Lower Right:—Close View of 15,000 Meter Precision Loose Coupler and Audion Tuning Inductances. An Engineer's Idea of How an Amateur Station Should be Built.

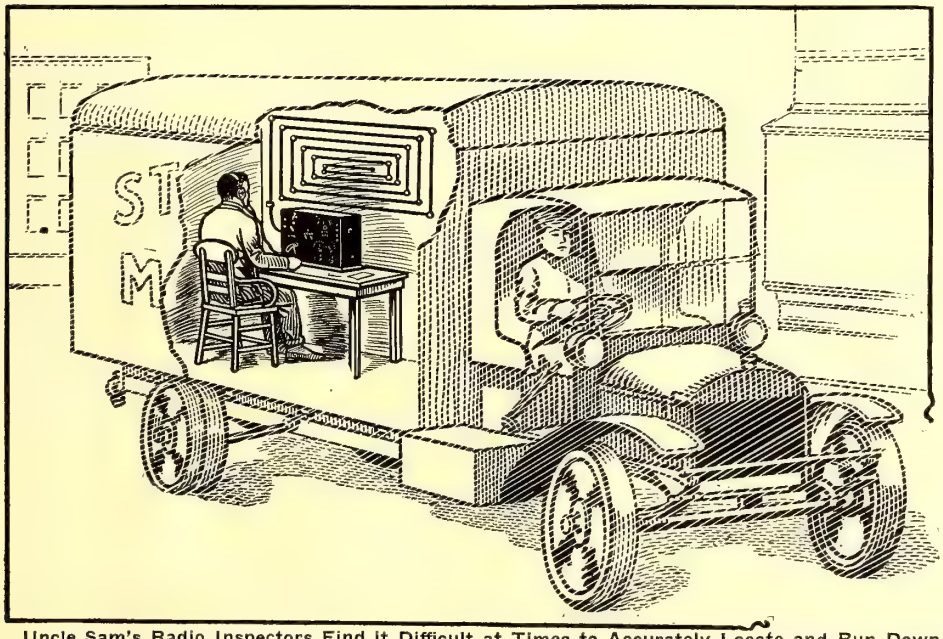
An Exceptional Amateur Radio Station

The accompanying photographs show the long distance, undamped wave receiving set owned by Harvey L. Gamer, Electrical Engineer of Omaha, Neb., with which the German Stations OUI, (Hanover), POZ, (Nauen) and the Honolulu Station KHL, are easily heard.

Some of the stations in the United States, WSL (Sayville), and especially WGG (Tuckerton), when the Goldschmit alternator is used, come in so loud that the signals can be transmitted over the telephone to any part of the city or vicinity. Also wax phonograph records have been made with a special recorder, as shown in the photograph.

The amplification feature is obtained by the use of inductances and capacity in the wing circuit of an Audiotron, then a further amplification with two ordinary Audions and their respective coils and circuits as well as a micro-phone arrangement leading to the recording machine.

The large loose coupler was designed to tune to wave lengths up to 15,000 meters when used with this particular aerial system.



Uncle Sam's Radio Inspectors Find it Difficult at Times to Accurately Locate and Run Down Stations which Disobey the Law, but a Radio Set and Aerial Erected Inside an Auto Van Helped to Solve One Problem.

SECRETARY OF COMMERCE SUSPENDS ISSUING OF LICENSES

Issuing of licenses for amateur wireless apparatus was suspended on March twenty-seventh by Secretary Redfield. Virtually none of the amateurs have sending equipment, so the military and naval authorities have not considered them a source of immediate danger, but Mr. Redfield decided that no more should be licensed for the present. Sending wireless plants are under the strictest possible surveillance now, and if a state of war is declared efforts will be made to locate apparatus of every description.

Many of the amateurs now licensed by the Government belong to the Navy radio reserve and will be called upon to perform certain duties in war.

TO TEACH GIRLS WIRELESS

At a meeting of the National Special Aid Society recently, a school offering a course in wireless telegraphy for young women was organized. Instruction will be given at the society's headquarters, 259 Fifth Avenue, New York City.

Miss Daisy Florence, chairman of the new branch, urges that all young women who would like to take up this class of work send in their applications. E. T. Bicak, a New York radio expert, has been retained and will have entire charge of the classes. This new department, the society says, is the first of the kind.

How the Audion Repeater Repeats

A Twentieth Century Fairy Tale, Wherein the Mystery of the Audion Relay Is Explained for the Benefit of Radio "Bugs" of All Ages—From 9 to 90

YOU all remember what you learned at school about matter being made up of *molecules* and molecules being made of *atoms* beyond which matter is indivisible. That is, with a meat axe, you can divide a substance into small pieces like hash; and with a microscope and hair-splitting equipment you can divide a substanc into pieces smaller than the naked eye can distinguish; after that by means of chemicals you can separate molecules from eac other altho you can't see them, even with a microscope; then with more chemicals you can separate the atoms from each other, but beyond this no treatment has any effect; at least that's what we learned at school and that effectually proves that there are no such things as fairies or daemons.

But now come our highbrows with another story. Mind you, you don't have to believe it. They say that atoms may be made to *throw off particles* like a small boy throwing gravel at the passing trolley car, only the kiddies do it voluntarily for the fun of the thing, whereas the atoms must have some provocation; for example, if they get good and hot they commence to throw gravel like a terrier pup at a woodchuck hole.

Now, all ordinary people know how to take such talk as this. It's just like Arabian Nights and Dr. Cook stuff about stones talking and mountains splitting open, or the beautiful stripes around the North Pole. Nevertheless one of our cloister experts will draw you a picture like Fig. 1, to represent the interior of a vacuum bulb repeater, and says that "F" is a filament, which is heated red hot by the electric current from battery "A," and "P" is a plate which is connected to the outgoing line. In the space between the filament and the plate is the piece of picket fence "G," which is connected to the incoming line, and this gridiron is what puts the *fire* in amplifier.

To make the matter perfectly clear, as a fairy tale should be, look at Fig. 2, where instead of a filament there is an iron stepladder on which you can see a lot of atoms, or daemons—it doesn't matter which you call them—and on the other side you see the plate as in Fig. 1. Between these two is an ordinary window blind with slats which are all operated together by the usual center stick. Now, suppose a strong electric current is past thru the iron stepladder so that it heats up like the filament in Fig. 1, then each little daemon gets as mad as a hen on a hot griddle and begins to throw pebbles at the window shutter. What's that! Where do they get the pebbles? Say, this is a fairy story and you must not ask foolish questions. Lord Kelvin thought the atoms were made of these pebbles or corpuscles, and that these pebbles or corpuscles were, in fact, electricity itself, hence the name *electrons*. In other words, matter is made of electricity and electricity is imponderable; therefore, there is no matter, and if there is no matter, it doesn't matter, and we should worry.

If while the daemons are bombarding the shutter we should open the slats, enough pebbles would go thru and strike the plate to make a noise like a hailstorm on a tin roof and the number that strike the plate would be in proportion to the amount the slats are opened. Therefore, if the slats are opened and closed in time with music it would be possible to play a tune on the plate, and if each *electron* carried a little bit of electricity with it, the effect would be like a current from the stepladder to the plate, and this current would pulsate, increasing when the slats are opened and decreasing when they are closed.

This is just what happens in the vacuum repeater bulb shown in Fig. 1. The filament is heated red hot by the current from battery "A," and at this temperature millions of corpuscles or *electrons* are thrown off. The electric current is not necessary to cause this; the same thing would happen if it were heated by a gas flame. These electrons are considered to carry charges of *negative* electricity itself. Here again we should worry, because the result is the same, no matter what anyone thinks; because a current actually does flow from the filament to the plate.

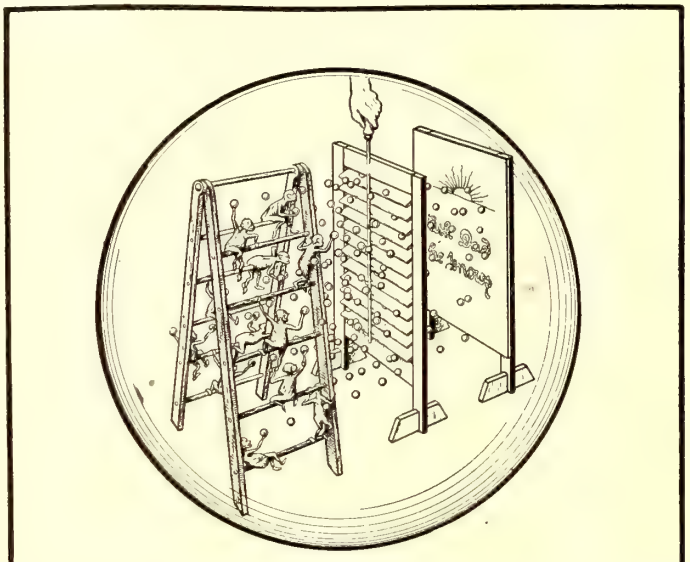
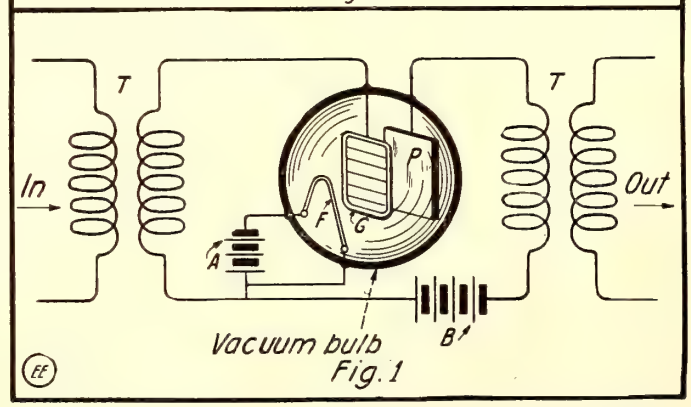


Fig 2



The Above Illustrations Help to Make Clear in the Most Simple Manner, the Action of the Audion—That Mysterious Radio-electrical Device. Considering the Top View, Just Imagine That the Host of Daemons on the Ladder (the Filament) Start Throwing Pebbles Thru the Movable Slats (the Grid) at the Target (the Plate). How Do They Get the Pebbles?—Oh! Well—Read This Remarkable Tale.

You all remember that *unlike* polarities of electricity attract each other while *like* polarities repel, and so if the gridiron is made negative to the filament the electrons will be repelled by it and very few will get thru between the slats; in fact, if the slats are too close together no electrons at all will get thru to the plate. The effect would be the same as tho the slats in Fig. 2 were entirely closed.

It is generally known how the sound waves produce electrical pulsations in a telephone line; and you have only to imagine these pulsations of current coming to the induction coil "T" at the left side of Fig. 1. These pulsations are, of course, very weak because of the long line over which they have traveled and the purpose of the repeater is to amplify or strengthen these pulsations.

Now, while it takes considerable power to open and close the slats of a window blind, especially if you painted them yourself last spring, the operation of the electric shutter is frictionless and even the weak impulses of speech transmitted over 500 miles of line are sufficient to give the desired results so that as each increase or decrease of current raises or lowers the negative potential of the grating "G," more or less electrons each with its infinitesimal charge of electricity get thru from the red-hot filament to the plate and give the exact same, but much stronger, impulses of current from the plate to the induction coil at the right side of the picture, and so out on the line for another 500 miles, the amount of additional *pep* put in the impulses, depending on the strength of the battery "B."

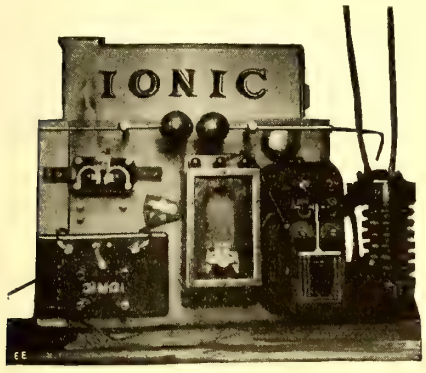
Now you are probably wondering why this apparatus is put in a glass case. The reason is that the scheme will only work in a very good vacuum because a clear space is necessary for the electrons to travel in. You must remember that everything, even an invisible gas, is composed of atoms, so if there was air or any kind of gas in the space between the filament and the plate, the electrons would bump the atoms of the gas while the daemons might put a good many across, the number would not be constant from minute to minute, depending on how successful they were in dodging the atoms and the result of this would be a jerky current which would entirely mask the telephonic pulsations. Therefore, in order to obtain the required accuracy of control of the rate at which the electrons strike the plate, it is necessary to pull out of the space between the filament and the plate every loose atom that it is physically possible to get hold of.

This is so important that our highbrows have developed an extremely interesting method of inducing daemons themselves to call the game when the space is cleared, but that is another story to be told when you have recovered from this one.—*"W.E.N."*

The Ionic Radio System and Theory of Ionic Tuning*

By Otto E. Curtis
Associate Member of the Institute of Radio Engineers

THE physico-chemical science pertaining to the elemental constitution of matter and the relation of the *ion* to the organization of matter dates back to the time of Thales of the so-called "early school of Ionic Philosophers," which came into existence about six centuries B.C. Thales, and



The Apparatus Used in Ionic Tuning of Radio Messages According to the Method of Mr. Curtis, as Described Herein.

the other scholars of this time, made little real progress toward a scientific development of the subject, altho in the light of recent discoveries many of their heretofore seemingly crude experiments and theories appear to have surprising significance.

For example, the ancient Alchemists of this period made many attempts at "transmutation," that is, at converting basic metals such as lead into precious metals such as gold, and in connection with these experiments they developed theories which, while entirely too vague to lead to useful conclusions, bear similarities to the modern theories pertaining to the transmutation or transformation of various radio-active compositions of matter into other compounds having different *ionic groupings*. However, the secrets pertaining to the part played by ions in the constitution of matter have not, at least up to the present time, been discovered and subjected to the use of man.

During the past eleven years I have been continually striving to fathom some of these secrets and it is my present purpose to disclose one of the more important discoveries which has resulted from my investigations, this particular discovery forming the basis of one of my earlier patent applications. And in order more clearly to set forth this discovery I shall first describe some of my experiments and the apparatus employed.

The first machine I built with the object of recording messages was completed in 1906. It consisted of an E. I. Co. "Autocoherer" connected to a "Telimco-meter" galvanometer with contacts on the needle. Impulses received by the auto-coherer were intended to deflect the needle and close relay contacts, but they did not do so and this machine failed to operate. This was an attempt to find a self-restoring coherer, but, while the coherer was self-restoring, it was not sufficiently responsive to current of the magnitude which I then employed.

A later machine, completed November 25, 1916, and shown in the accompanying photograph, follows the same original idea but its special parts have been much more highly developed. It receives perfectly the time from Arlington at a distance of 200 miles, *ticking it off clearly on a buzzer and making tape records of the same,* but as yet it is not quite fast enough to copy actual commercial messages. It was originally designed as a *chemically tuned* call-bell for a wireless telephone, for which it works excellently. (This process of *chemical tuning* or *Ionic tuning* will be explained further on.)

The apparatus illustrated in the photograph is made up as follows: The device shown in the upper left-hand corner is a Multi-audi-fone pocket wireless set. The wooden base in the lower left-hand corner carries two of my *ionic* detectors constructed as shown in Fig. 5, and as hereinafter described, the one on the left comprising a zincite crystal and the one on the right a silicon crystal. The rectangular instrument in the center is a Weston relay, which comprises an extremely sensitive galvanometer having a very short needle which, when deflected, contacts with one of the platinum-iridium points disposed on opposite sides of the needle. The instrument on the right is an E. I. Co. polarized relay of 1,000 ohms resistance which may be connected to an indicating or recording or other device such as a buzzer, tape recorder, motor, lamp or explosive device.

In the accompanying figures, Fig. 1 shows the circuit connections for the apparatus shown in the photograph, the various instruments being diagrammatically illustrated in the figure in the same relative positions as in the photograph for the sake of clearness. The antenna 1 is connected to ground 2 thru the primary 3 of the Multi-audi-fone set, the secondary 4, of which is arranged to be connected to the Weston relay by means of double throw switch 5 either thru detector 10 or thru detectors 7 and 8. When the switch 9 is to the left, the zincite detector 7 is connected in circuit; when the switch 9 is to the right the silicon detector 8 is in circuit, the detectors 7 and 8 being connected to the secondary 4 by leads which *are not shown*. The circuit connections as existing when the switch 5 is in upper position, are shown in simplified form in Fig. 2, reference to which may be had in following out the operation.

The alternating current of radio frequency received by the open antenna circuit 1-3-2 is induced into the secondary circuuit, where it is rectified by the detector 10 and conducted to the Weston relay 6. This produces a deflection of the relay 6 which in turn closes the local circuit containing the polarized relay 11 and source of e.m.f. 12. This actuates relay 11, which closes the circuit thru a second source of e.m.f. 13 and the indicating, recording or power apparatus 14. By employing one of my improved *ionic* detectors at 10, very feeble impulses may be detected; and by employing a series of relays in the manner described, the feeble impulses may be magnified to any desired extent, each consecutive relay controlling a heavier current so that the last circuit 11-13-14 may comprise a power circuit carrying current of any strength.

When using the machine for lecture purposes, with the sender in the same room a "Hertz" lineal resonator is used instead of an aerial and ground, as shown in Fig. 3. This consists of two ⅛ inch brass rods fitted on adjacent ends with brass balls of equal size and separated a short distance, this distance bearing a direct ratio to the length of the spark gap of the sender. The free ends of the rods are fitted with the movable metallic plates 15. Moving these plates together with the similar ones on the oscillator of the spark gap tunes the system. This "resonator" serves the same purpose as the "catch wires" used on the E. I. Co. "Telimco Coherer Set." The resonator,

(*Continued on page 73*)

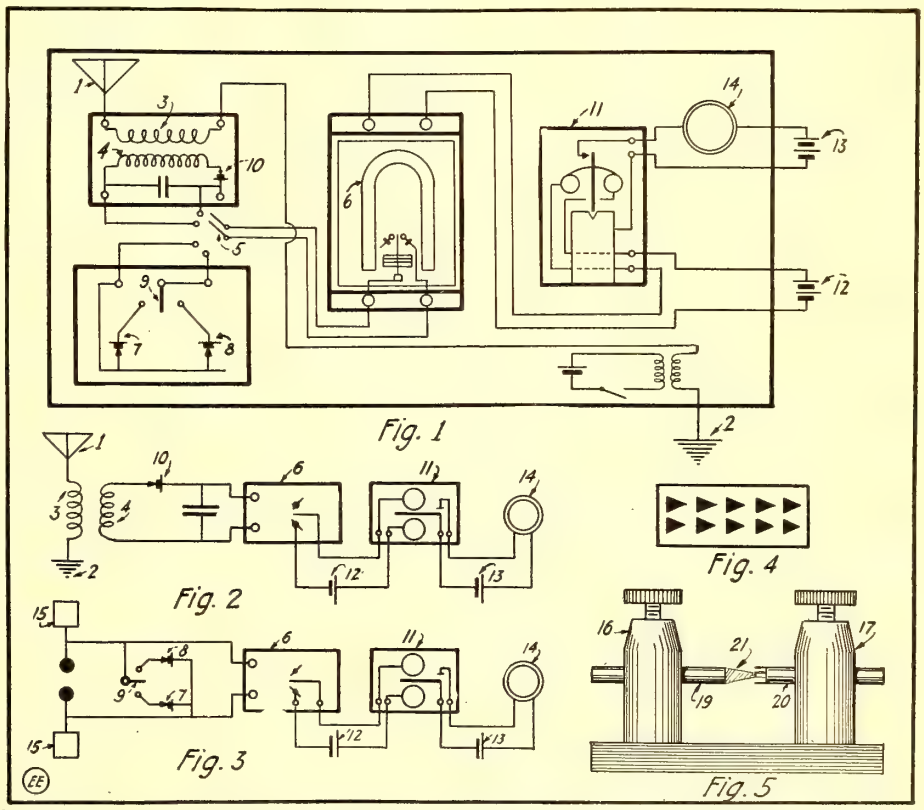


Diagram of Connections Used in the Curtis Scheme of Ionic Tuning, Whereby It Becomes Possible to Realize the Highest Efficiency in Radio Transmission and Reception, It Is Claimed. Besides, It Enables the Operator to Record the Messages if Desired.

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Receiving Marconi 300 K.W. Spark Stations with Oscillating Audion

By SAMUEL CURTIS, Jr.

IT is a widely known fact that the Marconi Wireless Telegraph Company has in operation a number of 300 K.W. spark stations, used for the purpose of handling their enormous traffic between different countries. The stations of this character which are actively engaged, to my knowledge, in transacting business at the present time, are: Clifden, Ireland; Glace Bay, Nova Scotia; Bolinas, California; Koko Head, Hawaii, and Funabashi, Japan.

The wave length used in transmission ranges from 4,000 to 8,000 meters, but the most common is 6,100; this is used extensively at the Koko Head and Bolinas stations.

In receiving the signals from these stations, any Audion receiver capable of attaining the wave length may be used, and it may be well to state that the undamped wave receiver described on page 575 of the December issue of THE ELECTRICAL EXPERIMENTER has been used in this respect with marked success. The writer wishes to state, however, that since the publication of his article relative to this receiving set, a fixt condenser of .005 m.f. has been added to the circuit. This is hooked up across the telephones and high potential battery of the Audion, and by its use allows the bulb filament to be burned at a much lower brilliancy, and yet get strong oscillations therefrom.

It is, of course, easily possible to receive these stations on a crystal detector, but unless an extremely large antenna is available, this cannot be accomplished over any great distance. It has been found by experiment that a heterodynic action on the incoming signals produces a remarkable increase in audibility, therefore making it feasible to incorporate the use of an oscillating Audion in this respect.

The series of graphs shown in Fig. 1 clearly illustrate the character of the momentary currents produced by a feebly damped wave train, in the circuits of a receiver during the process of heterodyning. In graph "A" we have the feebly

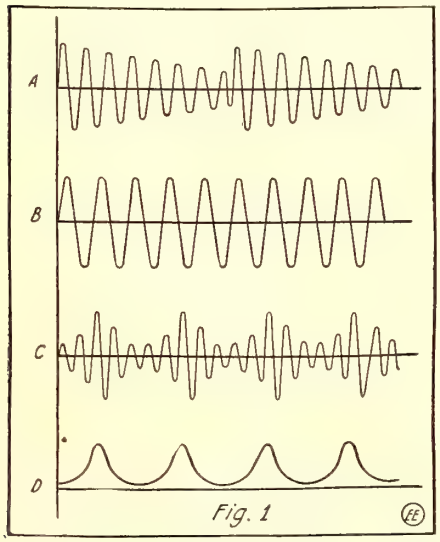


Fig. 1

The Series of Graphs Shown Above Serve to Illustrate the Character of the Momentary Currents Produced by a Feebly Damped Wave Train, in the Circuits of a Radio Receiver During the Process of "Heterodyning."

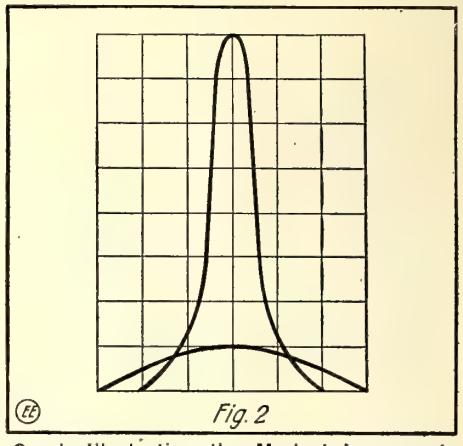
damped wave train, such as is sent out by the above mentioned high-powered stations. In graph "B" we have the local or Audion oscillations, which are used in heterodyning the wave train of graph "A." These Audion oscillations are tuned to a frequency either *higher* or *lower* than that of the incoming wave, so that an audible note is obtained in the telephones. In graph "C" we have an illustration of the current produced after "A" and "B" have coincided with, or heterodyned each other. In graph "D" is shown the resultant current after it has been rectified. It should be understood that the tone of this current in the telephones is proportionate to the difference in frequency of the incoming wave, and the Audion oscillations; for instance, a wave length of 6,000 meters would have a frequency of 50,000 cycles. In order to get an audible note of 500 cycle pitch, we would have to have an Audion frequency or either 49,500 or 50,500 cycles. This is assuming that we are heterodyning an undamped wave. Of course when a damped wave is heterodyned it cannot be expected that a pure note will be obtained, owing to its irregular form. In actual practise the note obtained in heterodyning the Marconi signals is very near the same as that obtained by using a crystal, only a little distorted.

The beauty of the use of the heterodyne reveals itself in an astonishing increase in the amplitude of the telephonic current, as illustrated in sketch No. 2. It can be seen by observation of this sketch that the mere rectification of a wave train does not in any way amplify it. Now, if the same wave train is heterodyned, an increase in amplitude similar to that illustrated in sketch No. 2 is obtained. The reason for this is best explained by the fact that in the mere rectification of a damped wave train, only the first few oscillations are utilized, and the rest of the energy is hopelessly wasted. In subjecting a feebly dampt wave train to heterodynic action practically all of the energy is utilized, manifesting itself in an enormous increase of audibility. To those who are more or less familiar with the action of the heterodyne, this brief explanation will suffice, but to go into a detailed description thereof would be out of the scope of this article.

It might be of interest for the reader to know that at the present time, at a certain experimental station on the Atlantic Coast, signals are being received daily from the Marconi station at Koko Head, Hawaii. The receiver used is of the type described in the December issue of this journal with the single exception that an Electron Relay is used instead of the usual spheric Audion bulb for producing the oscillations. Glace Bay, Nova Scotia, comes in with remarkable audibility, while Bolinas, California, is read nearly as loud. The stations at Clifden, Ireland, and Funabashi, Japan, have not as yet been pickt up, but it is expected that in the near future Clifden will be copied, as this station is not nearly as far distant as Koko Head, who is read in the daytime in good weather. The aerial used at the above mentioned station has a natural period of 276 meters, and is none too elaborate.

The results made possible by the oscillating Audion in receiving dampt waves are not however confined to such long waves as are used by the Marconi stations. With careful adjustments and the use of low resistanced inductances, an Audion can be made to oscillate on 200 meters or less, depending of course upon the skill and perseverance of the operator.

No one can fully appreciate the efficiency of such a method of reception until he has actually used it himself. At the present time there are a number of *Regenerative* receivers on the market. These instruments are without a doubt the peer of anything in their line, but for many experimenters the price of such an outfit is prohibitively high, and the chances are they have to do without. One advantage, however, is that these receivers are not so intricately designed as to make it impossible


Fig. 2

Graph Illustrating the Marked Increase in the Amplitude of Received Radio Signals Due to "Heterodyning" by Means of the Oscillating Audion.

for the experimenter to make one for himself. This is being done with great success by a large number of amateurs thruout the country. If the reader cares to take the trouble to consult page 575 of the December issue of this magazine, he will see a neat little regenerative hook-up given in set "B" of the diagram on that page. Set "A" is used for long waves, and set "B" for waves from 200 to 2,500 meters.

[*We are informed by Mr. Curtis that in some tests conducted in the laboratories of the General Electric Co., at Schenectady, Dr. White has succeeded in making an Audion oscillate (heterodyne action) on a wave length as low as ½ meter. Of course this requires some elaborate tuning and even more elaborate apparatus.—Ed.*]

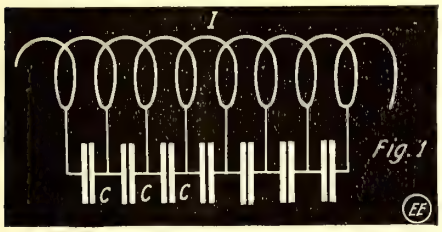
RADIO EXHIBIT AT NEW YORK AERO SHOW.

At the recent Aeronautical Exposition held in New York City, serious consideration was given to radio equipments for aeroplanes and balloons. A large space was set aside for the exhibition of different types of sets, such as are used now in the European countries for directing the artillery from aeroplanes, for interfering with stations and for long distance communication to be used by observers. Models of the different types of wireless equipments using direct and alternating current generated by small dynamos which get their power from the air by means of a small propeller were shown. The Marconi Company was invited to exhibit the set which was recently purchased by the Navy Department for hydroaeroplanes. This instrument has one K.W. capacity and it is stated that up to 300 miles will be obtained. That is to say, the aeroplane can signal for a radius of 300 miles. The total installation will come within 100 pounds. Other sets made by the Sperry Gyroscope Company, De Forest Radio Telephone & Telegraph Company; William Dubilier, Wireless Specialty Apparatus Company, Cutting & Washington, Manhattan Electric Supply Company and Mr. A. B. Cole. The wireless operators were supplied by the East Side Y.M.C.A. under the direction of Mr. Boehm.

Distributed Capacity and Its Effect

By SAMUEL COHEN

DISTRIBUTED capacity may be defined as the capacity existing between turns of a helical coil. It may also exist in straight conductors where the electrostatic capacity is between the conductor and the



Theoretical Relation of Distributed Capacity to Inductance Coils. The Effect Is the Same As if a Number of Small Condensers Were Connected Across the Turns on the Coil.

earth, or between two adjacent conductors.

It can be shown by actual experiment that a difference of potential exists between adjacent turns. This potential difference creates an electrostatic field and energy is stored between the conductors.

A condenser is a device which stores electrostatic capacity. It is evident therefore that a condenser is formed, the plates of which are the adjacent conductor turns. The capacity is stored in the space between each turn of the coil and over all of the turns, therefore the capacity is distributed over the entire conductor.

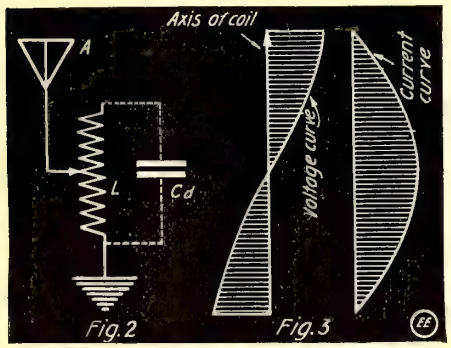
Referring to Fig. 1, it will be seen how distributed capacity is related to coils. Increasing the length of the coil, increases the distributed capacity as it is seen that the number of condensers are increased. Since increasing the number of condensers in parallel increased the capacity, therefore we may consider all the parallel condensers as one large capacity shunted across the inductance, as indicated in Fig. 2.

When capacity and inductance are linked in a circuit we have an oscillatory circuit, and the period of vibration of such a system is directly proportional to the square root of the product of the inductance and capacity multiplied by a constant. Expressing the above in an algebraic form we have:

$$n = \frac{1}{2\pi\sqrt{L \times C}} \qquad (1)$$

Here n = period of vibration of the system. The wave length of the above current is,

$$\lambda = 59.6\sqrt{L\,C} \qquad (2)$$



Representing the Relation of Distributed Capacity in a Coil (Fig. 2) and the Voltage and Current Distribution in Inductance Coils (Fig. 3).

where L and C are the inductance and capacity.

It is evident therefore that since the coil has distributed capacity that the coil is an oscillatory circuit in itself, and it was found by actual experiment that when properly excited by a high frequency current, it will oscillate, the period of which depends upon the magnitude of the units of inductance and capacity.

The true wave length of a circuit containing a large inductance and shunted with a capacity is not the same when calculated with formula (2) but the exact wave lengths will be as exprest in the following relation:

$$\lambda = 59.6\sqrt{L\,(C + C_x)} \qquad (3)$$

Where C is the capacity of the shunted condenser and to it we add the distributed capacity of the coil Cx. Solving for Cx we have:

$$C_x = \frac{\lambda - LC}{(59.6)^2 L} \qquad (4)$$

Calling the total capacity Ct equation (4) becomes:

$$C_t = \frac{\lambda^2}{(59.6)^2 L} \qquad (5)$$

It has also been found by actual experiment that whenever a large coil was excited by radio frequency current it will

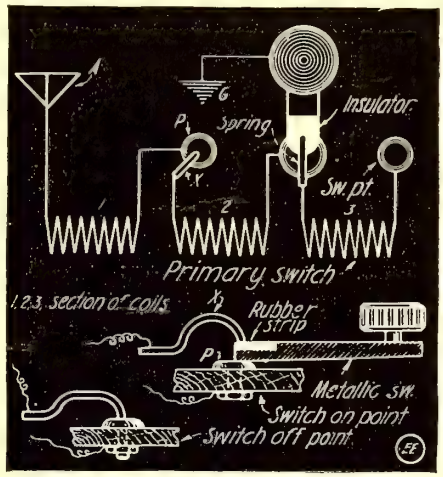
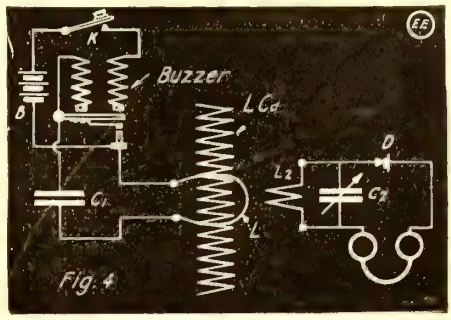


Fig. 5. Dead-end Elimination Switch for Loose Couplers Which Has Proven Very Effective in Reducing Distributed Capacity in the Windings.

oscillate in its own period just the same as a coil shunted with a condenser and excited. The current and voltage relation of this coil is exactly the same as for a Hertz oscillator, where the current value is a maximum at its center and minimum at the ends, while the voltage is maximum at the ends and minimum at the center. Fig. 3 shows grafically this relation of the coil.

The best means for determining the distributed capacity is by actual measurement. The essential instruments necessary for this kind of work are calibrated inductance and capacity which may be obtained from a wave meter, a high frequency buzzer and an additional condenser. The instruments are connected as indicated in Fig. 4. The coil, whose distributed capacity is to be determined, is placed in a single loop of wire L, Fig. 4, which is excited by the buzzer, Placing the wave meter inductance L_2 near the excited circuit the condenser C_2 is turned for indicating resonance. When the point of resonance is obtained the period of vibration of both circuits are the same $T = T$. Substituting the observed values in the equation,

$$Cd = \frac{L_2 C_2}{L_2} \qquad (5)$$



Arrangement of Apparatus for Measuring the Distributed Capacity in a Coil. A Buzzer Serves for Excitation of the Coil Under Measurement, While a Wave Meter Is Used to Ascertain the Wave Length of the Coil.

Where L_2 = the inductance of wave meter coil in centimeters.
C_2 = capacity of condenser at point of resonance in m.f.
L_1 = inductance of coil, the distributed capacity of which is to be found.

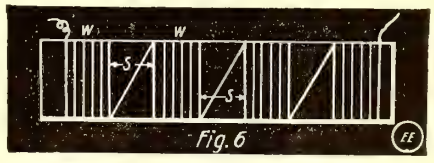
It is advisable before starting to measure the distributed capacity of a coil, to determine before-hand the magnitude of the figures so as to enable us to procure approximately the proper inductances and capacity in the wave meter circuit. It can either be found by judging it from experience or else by actually calculating its value. An approximate formula has been derived by Drude for the calculation of the distributed capacity as follows:

$$Cd = 2K\,\frac{2 + \frac{h^2}{r^2} + \frac{r^2}{h^2}}{10 + 4\frac{h^2}{r^2} + 3\frac{r^2}{h^2}} \qquad (6)$$

Where "h" and "r" are the length and radius of the coil respectively. The constant K is obtained from the following table, which is for air core coils.

$h/2r$	K	$h/2r$	K
6	1.81	0.8	1.10
5	1.64	0.6	1.07
4	1.74	0.4	.94
3	1.37	0.2	.69
2	1.26	0.1	.49
1	1.12	0.05	.28

Having determined the distributed capacity of a coil, what are we going to do with this? The only thing that we are trying to do with it is to decrease its value in the coil as much as possible. There are several methods of decreasing the so-called *dead-end effects* in radio coils. The



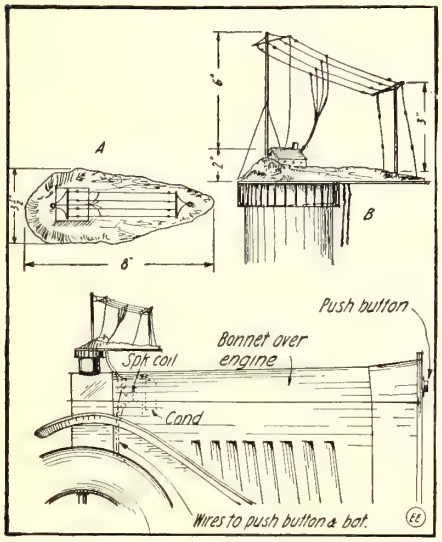
Radio Inductances Have Their Distributed Capacity Reduced by Winding the Coils in Groups, With a Space Between.

best and most practical way is to disconnect the portion of the winding which is not in use and this is what may be accomplished by employing a special switch arrangement on the coil. A highly ingenious switch which serves the purpose very nicely was described in the "Question Box"

(*Continued on page 65*)

A "WIRELESS" AUTO RADIATOR EMBLEM FOR AUTOS.

The base of this nifty and appropriate auto emblem is made from an irregular shaped piece of wood, ¼ inch thick and about 8 inches long, by 3½ inches wide at the broadest end. The rocky effect is ob-

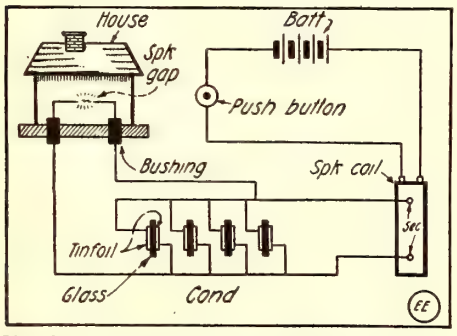


Something New in a "Wireless" Radiator Emblem for Radio Enthusiasts Who Own a Car. By Pushing a Button on the Dash, Sparks Are Caused to Jump a Small Gap Inside the Miniature House.

tained by mixing thin glue and plaster of paris and water to a thick paste and moulding it on the base, which has several quarter inch holes bored through it, to give the plaster a secure foundation. Papier-maché is very good for the purpose or the base can very well be moulded from white metal or lead and afterward painted. The radio masts and connections will then, of course, have to be especially well insulated. The coil and condenser must be kept close to the spark gap.

One of the masts is 8 inches long and the other 4 inches long, made of 3/16 inch brass or steel. The longer one is sunk into the plaster about two inches and the shorter one about 1 inch. The spreaders, ⅛ by 2½ inches, are equally divided for the four wires which are of No. 24 bare copper. The lead in rattail is soldered to the middle of the aerial. The insulators are tiny drops of black sealing wax moulded in ball fashion about the wire.

Ropes of fine fish line and guys of silk cord are put on, also a station constructed of cardboard is placed at the base of the



Circuits of Miniature Radio System Used as Radiator Decoration for Autos. Be Sure to Show Your Credentials to the Village "Constabile," or By Heck, He May Take You for a "Spy," with a Consarned, New-fangled "Wireless." Yessiree.

taller pole. The whole, except the aerial, is given two coats of enamel, the poles being white and the ground and rocks of green and gray respectively. The copper wires are lacquered after being polished. Two heavily insulated wires (secondary cable) are then run up thru the hood of the car from a spark coil and condenser, which are operated from a push button on the dash or wheel, the same as a horn is controlled. These wires are connected to a brass wire spark gap of about ¼ inch, which has been previously moulded into the plaster and which the station building conceals. If an ordinary ignition coil is used, then a suitable condenser may be formed of about four 4x5 glass plates, coated on both sides with tinfoil leaves 1 inch smaller all around. Connect as shown in cut.

The rest is easily imagined. The surprise at the sight of the tiny flashing windows and the crash of the spark gap is bound to command attention from anyone. Try it boys and see if I'm right.

Contributed by LES GLEIM.

A Study of the Law of Response of the Silicon Detector

THE special form of silicon detector receiver designed by E. Merritt for use with short electric waves, and reported upon at the meeting of the Physical Society, February 27, 1915, showed certain peculiarities which made desirable a further study of the device. The investigation described in the following paper by Louise S. McDowell and Frances G. Wick in the *Physical Review*, includes, first, a study of the receiving device and the conditions under which it can be used to best advantage, and, secondly, a study of the law of response of the silicon detector with a variation in the energy of the incident wave produced by the rotation of a screen of parallel wires.

The oscillator, receiver and screen were arranged as shown in diagram. The oscillator *S* consisted of a small spark gap in kerosene, extended by two straight aluminum wires *WW*, to a length of 51 cm., and connected thru water resistances, *HH*, to the secondary of a small automobile induction coil, *K*, using about 6 volts. The water resistances introduced served to damp any oscillations from the coil which might have produced disturbances.

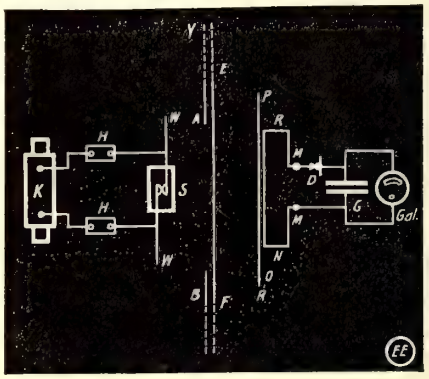
The receiver consisted of a silicon detector, *D*, in series with a paper telephone condenser, *C*, of 1 mfd. capacity, and with a loop of wire, *NR*. The connections to this loop were made by mercury cups, *MM*. A sensitive galvanometer, Gal., Leeds & Northrup type H, was shunted around the condenser. An aluminum rod, *OP*, acting as a resonator, was supported parallel and close to the outer wire of the loop. The length of the resonator was 44.5 cm., giving the maximum response to the wavelength used, about 100 cm.

Between the receiver and the oscillator and parallel to them was placed a screen, *EF*, which could be rotated thru known angles. It consisted of iron wires stretched parallel to each other about 3 cm. apart, upon a wooden frame 2 metres square. An additional fixt screen of tin and wire netting, *YAB*, 3 metres high and 4 metres broad, completely divided the room, except for an opening, *AB*, left in the center. The rotating screen was placed close to this opening, on the side toward the receiver, at distances varying from 5 cm. to 10 cm. for different sets of observations.

Merritt, in his experiments with the receiving device, had noted that when the screen was placed with its wires parallel to the oscillator, the position which should allow no transmission, there was still considerable effect upon the receiver, amounting at the least to about one-fifth of the maximum effect, when the wires were vertical (the position for complete transmission). The cause of this residual effect was unknown. He observed, also, that as the wire screen was rotated thru 360 deg. there was a variation in the response in the different quadrants. Early in the present experimental work it was found that when the resonator *OP*, Fig. 1, was removed the receiving apparatus still responded, although weakly, to waves from the oscillator. The receiver was then studied in order to discover what changes in the design would affect the response without the resonator, and how it could be reduced to the minimum consistent with sensitiveness of the receiver as a whole; also to discover the cause of the residual effect when the screen was in the position of no transmission. Experiments were made with the plane of the receiver both vertical and horizontal.

Receiver in the Vertical Plane.

The receiver was mounted on a T-shaped board and suspended by rubber bands from a cross-bar rigidly fastened to the ceiling. To prevent reflections, practically all removable metal was taken from the room and from the adjoining rooms. To reduce any difficulties arising from reflections from surrounding metal objects, the room was completely divided cross-wise by the fixt screen described above, and the rotating screen was placed in front of the



Miniature Radio Transmitter and Receptor, With Screen E-F Interposed Between Them and By Which Means the Law of Response of the Silicon Detector Was Studied.

opening. The residual effect was then found to be considerably reduced.

The screen was then rotated thru 360 deg. and readings were taken every 20 deg. both with and without the resonator. From the observations made three curves were plotted, in which the ordinates were galvanometer deflections and the abscissae the angles between the parallel wires of the rotating screen and the vertical.

The curve obtained with the resonator had a maximum at 15 deg. and a minimum at 100 deg., whereas without the resonator four maxima at the 45 deg. positions were obtained. Curves taken out of doors were similar in form to those obtained indoors.

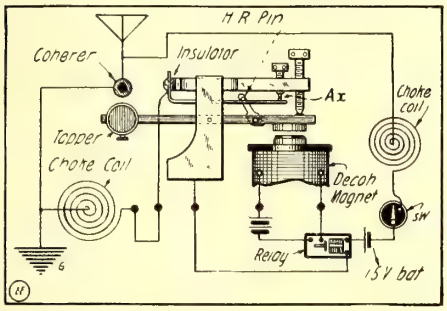
To determine the effect of the design of the receiver upon the response without the resonator, series of observations were made with loops of various shapes and sizes. To get the effect upon the loop alone, the receiver was screened by a tin cylinder up to the mercury cups *MM*. To test the response to the vertical and horizontal com-

(*Continued on page 74*)

AUXILIARY RELAY BREAK FOR COHERERS.

While the coherer is used but little in modern radio receiving sets, still, it is quite invaluable in making wireless demonstrations at lectures and for other radio control experiments.

One of the principal troubles developing in the operation of the filings coherer is that, it is so extremely sensitive to every



An Auxiliary Contact Fitted on the Relay of a Coherer Set Serves to Cut Off Local Oscillations from the Coherer.

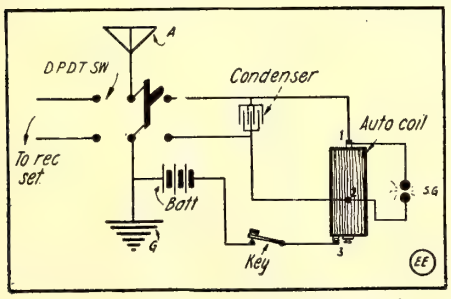
little spark discharge in its immediate neighborhood and it is invariably found that the sparking at the relay contacts or at the decoherer contacts, will set up oscillations which will pass along the connecting wires of the coherer circuit and tend to act on it the same as an incoming wireless wave.

This trouble is overcome to a great extent by shunting the relay and decoherer contacts with high resistances, of the order of 2,000 to 4,000 ohms (wound non-inductively), and also by the insertion of choke coils in the lead wires between the coherer and main relay.

However, there is another scheme, not so well-known, perhaps, and which works very favorably indeed with the above purpose in mind. This consists of an auxiliary contact on the relay or decoherer, which so functions that the coherer circuit is opened as the relay or decoherer circuit "breaks," and thus the possibility of locally produced oscillations affecting the coherer are greatly reduced. Choke coils are not necessary with such an arrangement, but if used as an extra precaution, they can be made up of a fine, soft iron wire core 4 inches long by ¼ inch diameter, wound with four layers of No. 26 gage insulated magnet wire, connected as shown in diagram.

USING "AUTO" SPARK COIL FOR RADIO.

This is a handy "hook-up" for those using an auotmobile ignition coil with three terminals, one of them being common to both primary and secondary. By using this connection scheme with an ordinary



How to Hook Up an Auto Ignition Coil for Wireless Transmitting.

D.P.D.T. knife switch, it becomes impossible to press the key accidently and knock the detector out of adjustment when receiving.

Be sure to connect that blade of the switch which connects with the common terminal of the coil to the ground wires; otherwise a severe shock will be received if the uninsulated part of the key is touched while sending.

Contributed by
GEO. F. HARRINGTON.

SINGLE VS. MULTI-LAYER RADIO INDUCTANCES.

In the protection of radio frequency apparatus one of the most important points is the insertion of choke coils to localize properly the radio-frequency energy. I do not think it is as fully appreciated as it should be that multiple-layer coils are almost useless for this purpose, says Benjamin Liebowitz in the February, 1917, Proceedings of the *Institute of Radio Engineers*. Because of their large effective distributed capacity, radio frequency currents are propagated with great ease thru such coils, and often with disastrous results. Thus, in one instance, I employed as a choke coil an inductance of about 600 turns of number 18 B. and S. wire wound in 30 turns per layer, and burned out a generator in consequence. I replaced this coil by six single-layer spirals, about twenty-four inches (61 cm.) in inside diameter, each spiral having eighty turns of copper ribbon 0.50 by 0.01 inch (1.27 by 0.025 cm.) in section, insulated by paper ribbon of the same section. The six spirals in series had somewhat less inductance than the multiple-layer coil first used, but to currents less than 100,000 cycles in frequency they were an almost perfect barrier. It cannot be too strongly emphasized that distributed capacity is just as undesirable in choke-coils as it is in radio frequency circuits.

A "COIN" RADIO DETECTOR.

Wireless Bugs, try this on your detector. Procure a ten cent piece; if not handy try five cent piece. Put either of the coins in the detector cup and proceed to adjust for a sensitive spot, as you would with galena. If your are not satisfied with the results, try another coin.

The writer has experimented successfully with both coins, but prefers the DIME as it does finer work than the NICKEL.

(Evidently quality counts, for dimes are said to be more expensive than nickels!! Next!!!—Editor.)

Contributed by WILLIAM MILLER.

A SINGING SPARK INTERRUPTER.

Many amateurs, like that King of long ago, have muttered "My kingdom for a real musical spark," as they struggled with the stuttering, stammering interrupters usually attached to small spark coils. The mere note stamps them as beginners and the big fellows don't want to bother listening to the low-pitched code emitted from such stations.

But a great obstacle lies in their path in obtaining the oft wisht for, high pitched note. Beside the mechanical difficulties there remains the fact that when the interrupter is speeded up, the range is shortened, due to the fact that the core of the coil does not become thoroly saturated with magnetism in the short time that the circuit is closed, with the result that the induced currents in the secondary circuit are not as powerful as they should be.

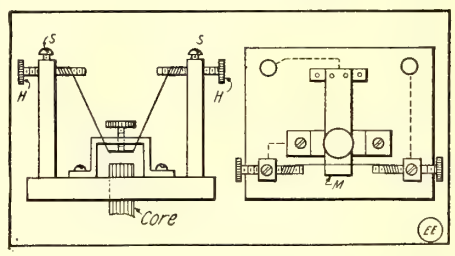
The interrupter described herewith does away with mechanical difficulties in a simple and effective manner, the only cure for the above mentioned condition being to increase the voltage of the supply current. By doubling the voltage very good results will be obtained with the following device.

The regular spring interrupter is removed from the spark coil and mounted on a conveniently sized base. Two uprights are cut from ¼ inch square brass rod 4 inches long. Both ends of these rods are drilled and tapt for an 8-32 screw. One-half inch from one end of each rod a ⅛ inch hole is drilled to pass the two small round rods H H, as shown in the illustration. The square rods are mounted on the base as shown. The round rods put into place while screws, S S, clamp the latter in position.

The end of the interrupter spring is covered with small strips of mica held in place by thick shellac. This mica is to insulate the spring from the length of German Silver wire which passes under the spring and is wrapt around the two small brass rods as illustrated. The wire used may be No. 26 or No. 28 bare German Silver. The wiring under the base is shown in dotted lines.

To adjust, turn the vibrator screw all the way out to tighten the German Silver wire until it raises the spring slightly. Close the key and slowly turn the vibrator screw down till the desired note is obtained.

The operation depends upon the expansion and contraction of the wire which takes place at an unbelievably high rate of speed. The note obtained is very musical and in connection with the higher voltage in use, will increase the range of the set.



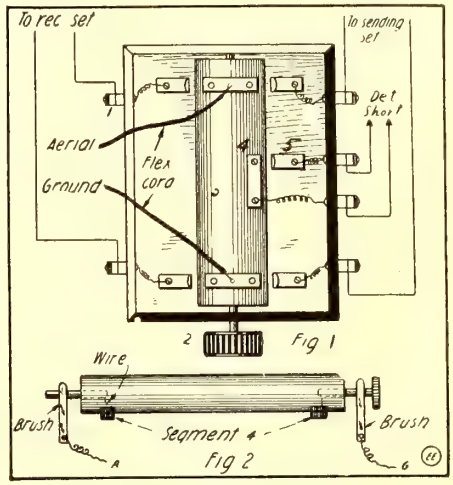
We All Desire to Have a High Note Spark. Here's How—A Piece of German Silver Wire Serves to Hold Back the Free End of the Vibrator Spring, Reducing Its Swing and Raising the Frequency.

It is advisable to renew the wire occasionally, as the heating crystallizes the molecules and after a certain length of time will refuse to respond.

Contributed by THOS. W. BENSON.

A DRUM TYPE ANTENNA SWITCH.

Herewith is a diagram of an aerial switch for use in small stations. It is of the rotary drum type as seen. By referring to Fig. 1, it will be noted that the



A Rotary Control, Drum Type Antenna Switch Is Easily Made on the Above Plan.

parts are numbered as follows: 1—binding posts; 2—electrose knob; 3—wooden cylinder; 4—brass segments on cylinder; 5—brass contact brushes; 6—box (wood or rubber 4x3x2 inches). The best job is made by using a hard rubber cylinder, supported on two small pins as shown at Fig. 2. The current for A and G is then carried thru the two shafts to segments 4.

Contributed by HAROLD DAVIE.

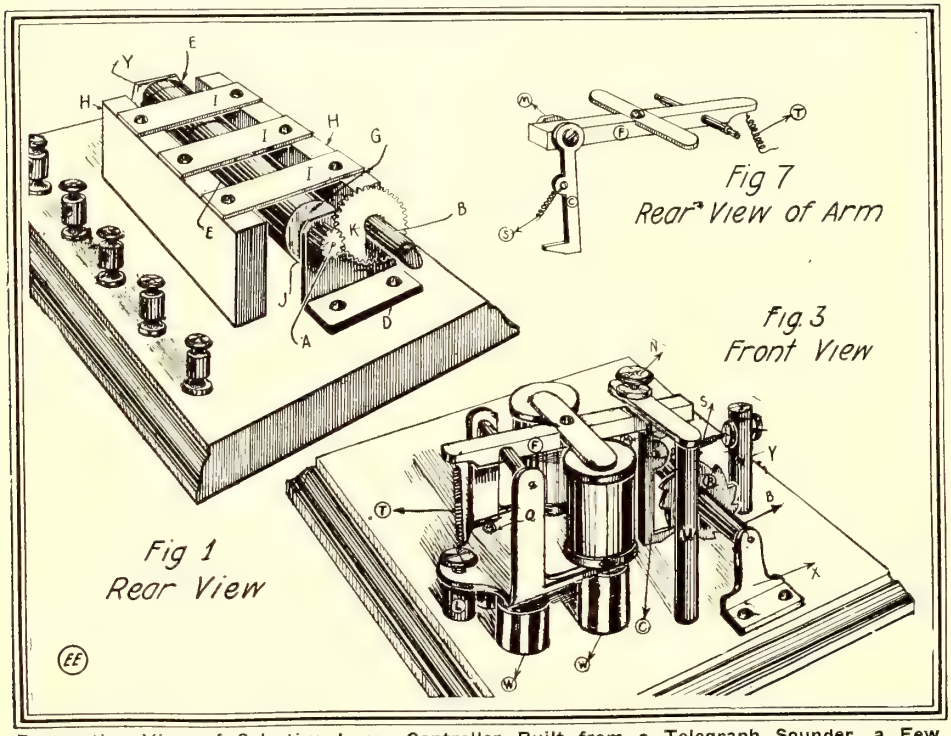
THE CONSTRUCTOR



An Electrical Paradox or Selective Lamp Controller

BY ALBERT H. BEILER

THE average person is always interested in a puzzle. When that puzzle is electrical, it is certain to appeal to the amateur experimenter. Can any of you think of an arrangement by means of which a single pole, single throw, knife switch may be made to operate three different lamps individually, during three successive intervals that the circuit is closed? For example, if the switch is closed once, light No. 1 will light and remain lit until the switch is opened again. It will then go out. If the switch is again closed, light No. 2 ONLY will light and remain lit until the circuit is again opened. Similarly with light No. 3.



Perspective View of Selective Lamp Controller Built from a Telegraph Sounder, a Few Gear Wheels and Other Odd Parts. At the Left Is Shown the Brushes and Commutator Unit with Gear Attachment for Rotating the Segment Drum.

To secure the result described, an arrangement is employed somewhat similar to that used on the automatic block signaling systems of single-track electric railroads, and elsewhere. A commutator is made to move from one contact segment to another every time an electro-magnet draws its armature down (or up).

Referring to Figs. 1 and 3, when the circuit is closed, the magnets attract the armature, pulling it down. The hook C catches over a tooth of the ratchet wheel R. By noting the direction of pitch of the teeth, it will be seen that the movement of the hook will not cause the ratchet to move. The ratchet is rigidly attached to a shaft B, on which a gear wheel K is also firmly fastened (Fig. 1). This cog meshes with a smaller one, J, which is tight on shaft A. A wooden cylinder, G, is fixt on A, which has brass segments fastened along its perifery as shown at E. It will be seen that E touches one of the brass strips I. This closes a circuit and lights a lamp. If some means could now be employed to move the wooden cylinder ⅓ of a revolution, another segment seen slightly under the middle brass strip would touch the strip, while the first segment would have moved away from the end strip. Another third of a revolution would cause the foremost segment to touch the foremost I and close another circuit, while the other two circuits would remain open. When the switch is closed, the cylinder with the brass segments, called the commutator, will not move, but the hook will engage a tooth of the ratchet. Simultaneously a lamp will light. When the switch is now opened, the lamp will go out and the same instant the retractile spring T will pull the armature up again, since the magnets have lost their power of attraction. Hook C will pull the ratchet up a distance equal to its (the hook's) travel. This distance is such that the ratchet will have completed 1/12th of a revolution when the armature shaft F strikes its stop screw N. It must here be stated that the ratchet has 12 teeth, gear K, 48 teeth, while gear J has 12 teeth; the ratio between the two latter being 4 to 1. When the ratchet makes 1/12th of a turn, K will also turn 1/12th of a revolution. Thus the third of a revolution movement, which is necessary to bring each segment under its respective contact, is accomplished.

It is possible that the reader who has followed this explanation carefully will ask why the movement of the ratchet should be accomplished by the retractile spring T when the magnet exerts a greater force. In other words, why should not the segments change on the *down stroke* of the armature instead of on the *up stroke?* The answer is this: Suppose the commutator turned if a circuit was closed instead of when it was opened, then, for an instant the lamp would light which had just previously been lit. It is true that almost immediately it would go out and the required lamp would light but the result would very obviously be unsatisfactory. The time taken for the cylinder to commutate would be the time required for the magnets to pull the armature down. As this does not occur instantaneously, the above described result would occur. Another objection to having the commutator rotate on the down stroke of the armature is that a segment and a brass strip, each carrying current, would be separated from each other by the movement of the commutator and create a spark which would soon pit the segments and brass contacts and thus interfere with the satisfactory operation of the device. With the device arranged as just described the commutator moves an instant AFTER the circuit has been opened, thus preventing any arc from forming.

The wiring diagram is shown in Figure 8. B B B are the strips I of Figure 1. C represents the commutator segments. M is the electro-magnet. R is the rheostat, made of salt water with carbon electrodes, or sulfuric acid, and carbon or lead electrodes. Two 100 watt lamps in parallel may be connected in series with the magnet instead of the rheostat. The magnets must receive from 1½ to 2 amperes, since they have quite a pull to make. The smaller circles B show where the wires from the device are connected to the binding posts seen in Fig. 1.

Anyone sufficiently interested may make one of these contrivances by following the diagrams and instructions which follow.

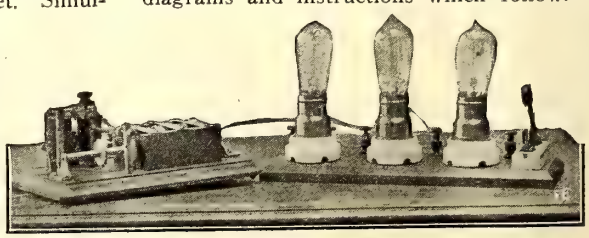


Photo of Selective Lamp Switch or Controller as Built by the Author, Together with Three Lamps to Be Controlled and Main Circuit Switch.

Secure an old telegraph sounder of the sort that is generally sold to amateurs for practising telegraphy. Unscrew the parts from the base and mount the frame, mag-

nets and armature on 4 columns consisting of six ⅛ inch fibre washers, the whole being mounted upon a suitable baseboard of 9 inches by 6 inches oak (Fig. 3). The piece L is of ½ inch brass ¾ inch long and is threaded at both ends so as to receive the adjusting screw of spring T at one end and a screw that holds L to the base at the other end. One-and-one-half inch stove-bolts, Q, hold the frame of the sounder to the base. The machine screws to hold the magnets must be 2 inches long in order to go thru the base, the washers, the yoke of the magnets and finally screw into the magnets themselves.

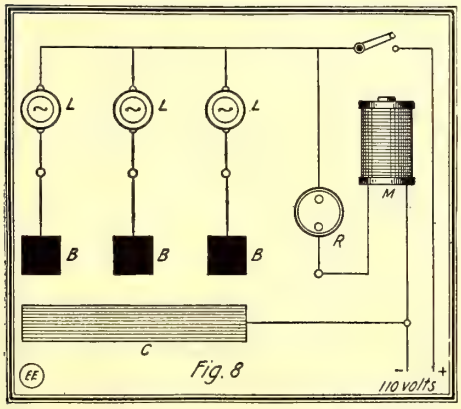
Then shape a hook of ⅛ or 3/32 inch stock, as shown in Fig. 2. A fret saw may be used to cut it out with, but any one at all handy with a file can shape the hook quite as well.

Now remove the armature of the sounder by pressing the uprights outwards. Drill and tap a hole for an 8/32 screw ¼ inch from the end of the armature shaft (Fig. 7). Slip an 8/32 machine screw into the upper hole of the hook and screw it into the armature, so that the hook swings easily but has very little play. Lock the bolt on the other side of the armature by a nut M. The armature now looks as in Fig. 7.

The commutator is made from a small wooden cylinder having a hole bored thru it longitudinally. Brass segments are screwed round it, in a manner to be described. The author found considerable difficulty in securing a cylinder of suitable size, but he finally used one of the small wooden rollers on which the paper for adding machines is wound. Such a cylinder is 3⅜ inches long, ⅞ inch in diameter and has a 7/16 inch hole thru it, and will answer very well for the purpose.

Cut a piece of 1/64 inch brass as shown in Fig. 4 and drill small holes near the corners as indicated. The brass is attached to the cylinder by small ¼ inch brass screws. Screw one segment of brass down on the cylinder near one end, then bend the brass around the cylinder and screw the second segment on. A reference to E and G of Fig. 1 will serve to make this clear. Before screwing the last segment down, drill a small hole diametrically thru the roller to meet the central hole, and pass a thin wire thru it, so that the wire is underneath the last segment. The other end of the wire should come out thru the last hole in the cylinder. It will now be evident that there is an electrical connection from the protruding wire to every commutator segment.

The shaft for the commutator is made of



Wiring Scheme for the "Electrical Paradox" Which Enables the Manipulator to Successsively and Individually Light and Extinguish Any One of Three Lamps, by Simply Operating the Main Switch Three Times.

7/16 inch steel or brass, 4⅜ inches long. The details for it are shown at A (Fig. 5). Force the shaft into the hole in the cylinder so that it projects the same distance from either end. While putting the shaft in, the wire that comes thru the hole will be caught between the shaft and the inside wall of the cylinder, so that an electrical circuit is established from the shaft to all the segments of the commutator. The brushes I (Fig. 1) that bear against the segments are of ½ inch wide spring brass. Three of these are needed, 3 inches long. They are supported on the two oak blocks H H, 3⅜ inches long, by 1½ inches wide and ½ inch thick. One of the oak blocks must have three small holes thru it so that the holes are vertical as the blocks stand on end. The outer two holes are 9/16 inch from the end, and the inner one is in the center. These holes are for the wires which connect the brushes to the binding posts. Drill ⅛ inch holes in the brass strips as shown (Fig. 1) but do not fasten them to the oak blocks until later.

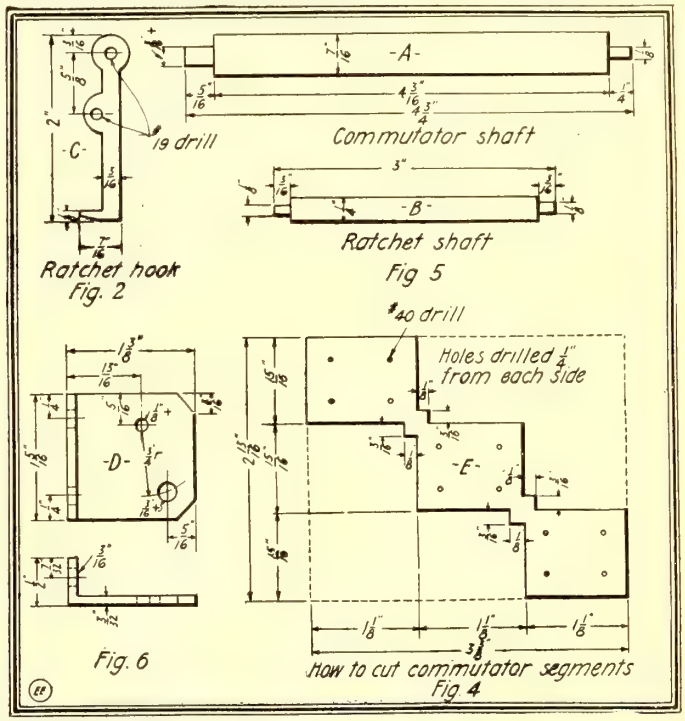
Procure a ratchet wheel R (Fig. 3) 1⅛ inches in diameter, and ⅛ inch thick, also two cog wheels, J and K (Fig. 1), K being 1¼ inches long and having 48 teeth, and J having 12 teeth. The larger cog and the ratchet should each have a ¼ inch hole thru their centers, the smaller cog a 3/16 inch hole.

Then turn a shaft B, the details of which are given in Figure 5. The end bearings for the two shafts are made of 3/32 inch or ⅛ inch wrought iron. They may be shaped as shown at X (Fig. 3) or Y (Fig. 1). Bearing X has a ⅛ inch hole drilled 13/16 inch up, and Y has a ⅛ inch hole drilled 1 1/16 inches up from the bottom. The center bearing D (Fig. 1) must be wider than the other two since it supports both shafts. The details for its construction are shown in Fig. 6. The holes should be laid out very carefully and accurately, as upon them depends the proper meshing of the two cogs, and consequently the smooth operation of the contrivance.

The uprights U and Y are made of ⅜ inch brass or steel. They are threaded at the lower end so as to be held down to the base by nuts. U should be about 2½ inches high and Y, 2 inches. Three-eighths inch from the top of Y, drill and tap a hole diametrically thru it, to receive an 8/32 spring adjusting screw. On U solder a cross-piece which has an adjusting screw and lock nut N in it. Place U so that when it is screwed down, N will touch the center of the armature shaft. Y is directly in front of the ratchet, but far enough away so as not to interfere with the ratchet's operation.

The parts are now ready for assembling. First put the armature shaft back into its supports. Then place the small bearing X in such a position that when the ratchet is put on the shaft and the shaft into the bearing the hook will engage a tooth of the ratchet. (Be careful to have the direction of pitch of the ratchet just as shown in Fig. 3 and not the reverse way.) When the position of bearing and of the ratchet have been determined, solder the latter to shaft B in the required position, and also solder cog K to B, about 1/16 inch from the end of the shoulder. Bearing X may now be screwed down.

Pass the long shoulder of shaft A, i.e., the left end (Fig. 5), thru the upper hole of bearing D. Then force the small cog J on to this long shoulder far enough so that there is very little play, but not so far as to cause the cog to bind on the bearing. Now place the cog wheel end of shaft B into the lower hole of D, and if the work has been done correctly, the cogs will mesh with each other. Then slip bearing Y on to the other end of the commutator shaft.



Detail Working Drawings of Parts Necessary in Constructing the "Electrical Paradox."

After a little experimenting to place the bearings in such a position as to make the parts turn with as little friction as possible, screw bearing D and Y down (after shaft B is in position of course). Before screwing Y down, drill a small hole thru the base directly beneath it and pass a thin wire thru this hole so that the bearing will press on the wire. Connect the other end of the wire underneath the base to a binding post. It will now be noticed that contact is established from the binding post to bearing Y, from Y to the shaft A, and from there to the commutator segments E E E.

Place the oak blocks parallel to the commutator, at equal distances on either side of it and 3 inches apart. Drill 3 small holes thru the base at places to correspond with the 3 holes in one of the blocks. Then fasten the blocks down to the base with screws. (It must be clearly understood that the screws DO NOT go thru these holes, but thru other holes which may be bored for the purpose.) Pass a wire thru each of the holes in the base and thru the block, so that they project from the top. Now screw the brushes down on the blocks (this time the screws go thru the holes in the block). Connect the three wires from the under side of the base to three binding posts. Contact is now established from each binding post to each brush and to that commutator segment which happens to be touching that brush at the moment. Connect one of the wires from the magnet to a binding post and the other wire splices on to the wire coming from bearing Y. (Refer to Fig. 8.) Put a light brass spring S thru the hole in C and hook it over the spring adjusting screw in Y, so that it can be adjusted to any tension. The spring T is of fairly heavy steel, since it is its tension that really drives the

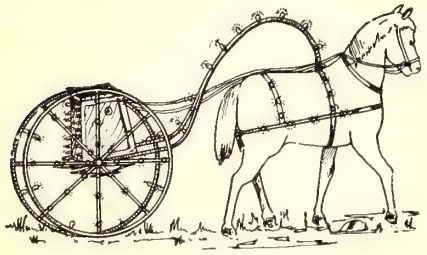
(*Continued on page 74*)

An Illuminated Stage Sulky

By HARRY S. TOWNSEND

SEVERAL years ago the author of this article had occasion to work up an illumination scheme for a small two-wheel sulky and harness to be used in a stage act.

Owing to the fact that the horse in this act performed many difficult tricks, with the result that the sulky was pitched at



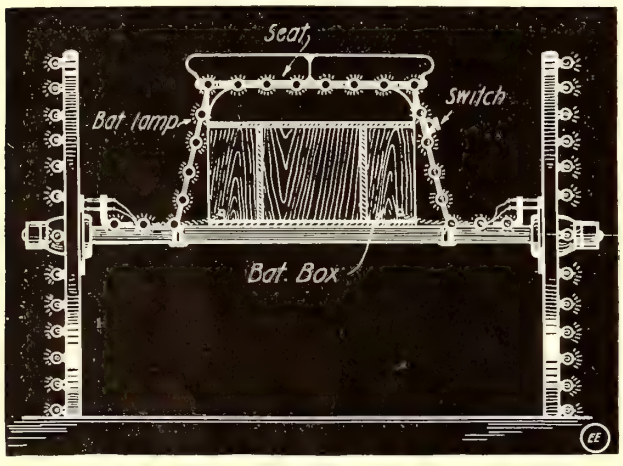
Appearance of Electrically Illuminated Stage Sulky and Harness.

many different angles and also for other reasons, storage batteries were not allowable. The scheme shown diagrammatically herewith was successfully developed and applied and the results were very satisfactory, particularly when the display of the illuminated harness and vehicle was shown on a darkened stage before black velvet drop curtains.

Briefly considered, the battery comprised 36 dry cells of standard size, connected in series-parallel to give 18 volts. The feed wires in the battery box, which was painted white to correspond with the trimmings of the balance of the vehicle and placed beneath the seat, were led to the various circuits about the sulky body and wheels and also to the harness.

The harness display consisted of a number of 16 volt battery lamps connected on parallel, the terminal wires ending in a separable connector, so that it could be instantly detached from the vehicle when desired.

A small switch placed in one of the main battery leads and arranged on the side of the seat frame, enabled the driver to switch on the lights at the critical moment when the stage had been properly darkened.



Rear View of Sulky Showing the Battery Box and Control Switch Within Easy Reach of the Driver.

One of the most difficult problems was to convey the current properly to the rotating lamp strips secured to the spokes of the wheels. This was accomplisht by means of two brushes and a two ring commutator fitted to the side of each wheel.

The commutator disk was made of fiber and not more than 9 inches in diameter so that it would be unnoticeable to those in the audience. The rear (facing the audience) side of the disk was painted white, the same as the wheels.

Three sixteen volt lamps were placed on every other spoke and several lamps were also secured to the fiber disk on its rear face so as to form a circle in conjunction with the inner lamps of the spoke strips. Lamps were also spaced in between, around the rims of the wheels, as seen in the illustration.

A detail of the round woven-wire brushes and brush holders is given in the illustration. The wiring was done with No. 14 rubber covered conductor for the main battery leads, and with No. 16 R.C. fixture wire for the independent circuits.

This arrangement, as will be observed by the reader, does away entirely with the nuisance of a trailing stage cable, which many electrical acts are burdened with. Altho not shown here, the various circuits were specially arranged so as to permit grouping into series—parallel on 110 volt lighting circuits when the occasion demanded. This required 4 contact rings and 4 brushes on each wheel, also a special disposition of the harness and vehicle circuits.

HOW TO MAKE CARDBOARD CYLINDERS.

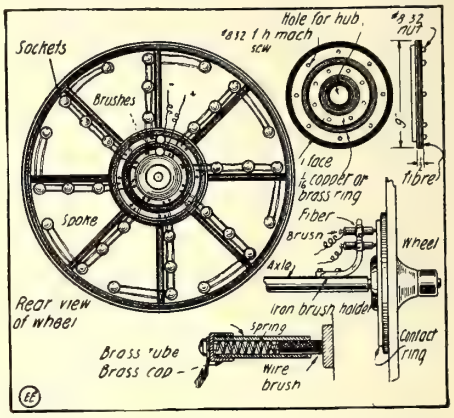
Those radio-bugs who construct their own loose couplers and loading inductances are generally hampered by not being able to construct suitable forms on which to wind the wire. The following method I have found satisfactory and it takes but a few minutes to construct a serviceable tube of any desired size and thickness.

Having the plugs of the desired diameter ready, cut off a strip of thin cardboard slightly greater in width than the required length of the tube to be made. Now lay the cardboard on the table and proceed to roll the plugs. After making one revolution spread glue liberally over the remaining part and finish rolling it up. If the tube is not as thick as desired, another strip of cardboard can be wound over the first. It is well not to have the tube fit too tightly over plugs, or trouble will be experienced with shrinkage during further treatment. The tube is now wound with tape or cord and placed in a moderately hot oven for fifteen minutes or more.

After removing from oven, trim edges carefully and while still hot give it a thoro coating of orange shellac inside and out. While the shellac is still fresh, take your blow torch and with a sweeping movement burn the shellac into the tube and repeat the process. It is well to make sure you are using pure shellac, not cheap glue, as some *so-called* shellacs are (I make my own shellac out of orange shellac flakes dissolved in grain alcohol). If you do not have a blow torch handy, a good heating in the oven will do altho it requires more time.

The appearance of the tube is greatly improved by blackening the ends. A thin paste made up of black aniline dye, dissolved in white shellac, gives a glossy black. A black looking luster can be made of lampblack mixed with orange shellac. The former is preferable, having better insulating qualities than the latter.

A little experience in tube making will soon make you proficient in the art. At a small cost moisture proof tubes can be made quickly, saving valuable time in waiting.



Details of Sulky Wheels and the Metal Contact Rings and Brushes Whereby Current Is Conducted to the Lights on the Spokes.

Contributed by

CHARLES M. FITZGERALD.

HOW TO FROST LAMPS QUICKLY.

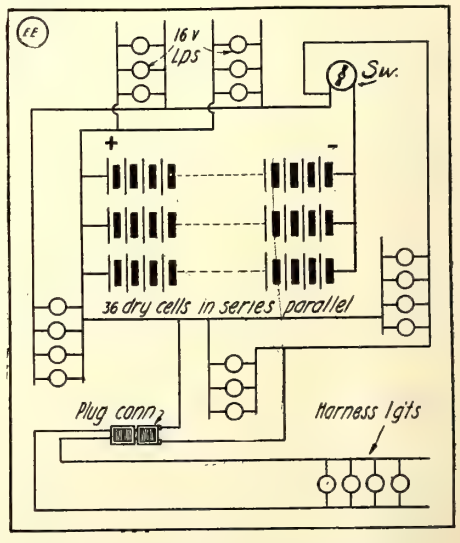
Take the bulb and smear over thoroly with a good library paste; after which dip into a cup of sugar or salt crystals. Then let stand for awhile. Do not use glue for an adhesive as this has a tendency to dissolve the salt or sugar.

Contributed by JOHN T. DWYER.

TO USE OLD BATTERY ZINCS.

When the lower half of a battery zinc is eaten away by the action of the electrolyte, the remaining portion can be utilized by suspending it from a wire, so that the zinc is covered by the battery solution.

A very good electrical connection should be made between the wire and the zinc and the joint covered with melted paraffin. This last precaution is necessary as otherwise corrosion would soon occur from the action of the salammoniac or other chemical. The wire may be held at the top of the jar by twisting around a small piece of wood.

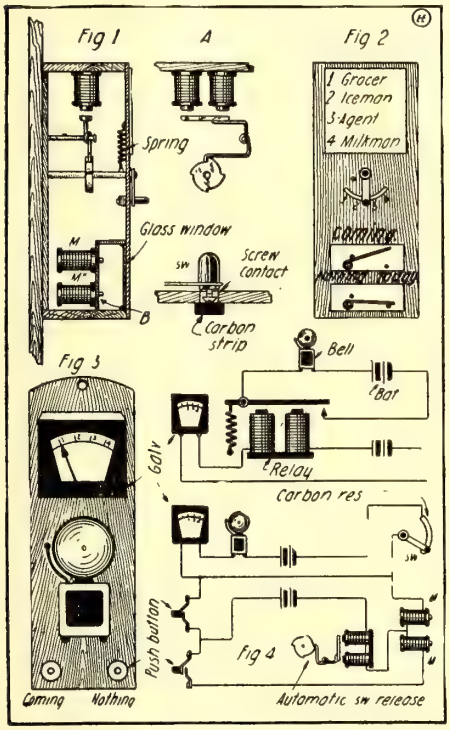


Wiring Diagram for 36 Dry Cell Battery and Various Lamp Circuits on the Sulky and Harness.

Contributed by K. M. COGGESHALL.

UNIQUE INDICATOR SYSTEM WHICH ANNOUNCES THE ICEMAN AND GROCER.

A "step-saver"—that's just what this device is, for, when constructed, it will save Mother or the housekeeper many a fruit-



The Women Folks Need Not Run to the Door for the Iceman and Grocer, When This Apparatus Is Installed. The Tradesman Turns the Switch Lever to the Proper Number; the Kitchen Indicator Shows Who Is Calling and the Cook Pushes the Button Marked "Coming" or That Labeled "Nothing To-day."

less trip to the door in response to the ever-ringing bell, because it enables her to know *who is calling,* whether the milkman, baker, etc., and signal to them if their goods are needed or not—all without requiring any more effort on her part than merely pushing a button.

The first thing required is a wooden frame or case, similar to that shown in Figs. 1 and 2. Inside of the same are arranged the indicator magnets and also the magnets controlling the automatic switch release (A in Fig. 1). This latter may be simply the armature and tapper rod of an ordinary battery bell, bent as illustrated in order to allow the extremity to act as a check pawl on the four-cam wheel, which is centered on a shaft manipulated by the switch handle. It will be seen that this prevents the switch, when once set at the point desired, from falling back to its original position after pressure has been removed. The cam wheel, if not procurable from old clock works, can be easily turned out of wood by a jig saw or of brass in a lathe. By the same methods any other parts of this device may be constructed when lack of simpler means prevents otherwise. The carbon strip (another form of resistance may be used if this is not handy) can be cut out from the carbon electrode of an old battery cell and should be placed on the inside of the box directly over the groove, by means of which the switch makes contact with it. The partition B, in Fig. 1, should have two holes for the insertion of the core ends of the electromagnets M′ and M″, which, on being actuated, raise up one or the other gravity indicators, Fig. 2. These latter are merely short lengths of steel wire bent as shown, so as to allow them freedom of motion upwards. As can be seen one is for the purpose of signaling to the waiting tradesman that the housekeeper *is coming,* while the other performs an *opposite* function, as the case may be.

Fig. 3 shows the *indicator* panel proper, which includes simply a low resistance galvanometer or ammeter, two push buttons, and a bell. If the reader cannot make such an instrument, he will find an admirable one described in the *August* issue of the "E. E." Of course, it is understood that the scale card is not marked off in amperes but instead into four divisions, numbered from one to four—each division representing the title of such tradesmen as call most frequently. The *front door device* is also marked with corresponding numbers (see Fig. 2) and a printed card like that shown should be placed on it. It will be necessary to experiment for a while in order to have these numbers correspond; that is to say, when the switch is turned to *Grocer,* which is No. 1, the resistance traversed must be such as to move the needle on the indicator also to No. 1. Full electrical connections are shown in Fig. 4.

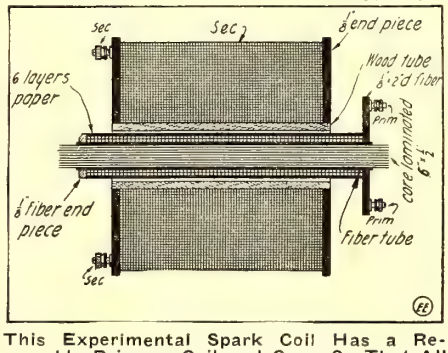
Assuming that everything has been completed, let us suppose the *Milkman* comes and turns the switch to No. 4. Such action allows more or less current to flow with the result that, at the same time the bell is rung, the indicator needle is turned also to No. 4 and all the lady of the house need do is to glance at the same to ascertain that fact. If milk is not wanted, she has only to push the button designated—*Nothing To-day.* The current set up actuates the electro-magnet controlling the lower signal and the latter is raised upwards, thus acquainting the tradesman with the fact that his goods are not required. At the same time, it will be noticed by following out the electrical diagram carefully, that the armature of the switch return mechanism is attracted upwards, thereby releasing the check pawl and allowing the switch (which has a coil spring exerting tension upon it) to resume its original position. The device is then ready for the next caller.

Contributed by JOHN T. DWYER.

[*Editor's Note:—We would suggest the use of a low resistance relay in place of the vibrating bell, the local circuit of the relay being connected to a bell and battery. This permits the action of the INDICATOR system to be much more even and accurate. This change in the layout is shown in supplemental diagram Fig. 4.*]

AN EXPERIMENTAL SPARK COIL.

I have just completed a small "spark coil," of my own design, which embodies a special feature of regulation. The full strength of this coil, when the primary is all the way within the secondary, is ½-



This Experimental Spark Coil Has a Removable Primary Coil and Core, So That All Sorts of Experiments Can Be Tried With It.

inch heavy spark, and the minimum strength is "0," when the primary is drawn all the way out.

The drawing explains all details. The primary is made separate and complete from the secondary with binding posts attached. The secondary is wound upon a spool, which also has binding posts attache .

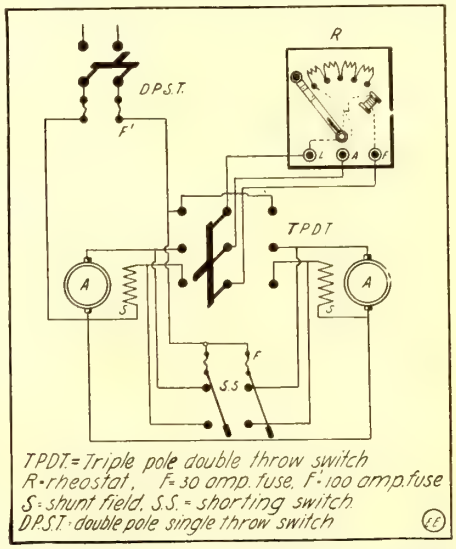
The primary unit comprises an iron wire core 6 inches long by ½ inch diameter. The primary winding is of two layers No. 18 D.C.C. magnet wire. This is covered with several layers of waxed paper. The primary terminals are mounted on a fiber disc, 2 inches diameter, as shown. The completed primary is soaked in molten paraffin wax. The secondary coil consists of 1¼ lbs. No. 34 S.C.C. magnet wire, wound in layers onto a wooden or fiber spool, measuring 4 inches in length. The starting or inner lead of the secondary should be well insulated by passing thru a glass or rubber tube outside the spool or else by passing it thru a hole drilled radially down thru the spool cheek, this one being made ¼-inch thick or more for the purpose.

Contributed by CHAS. S. PORTER.

HOOK-UP FOR STARTING UP TWO MOTORS WITH ONE RHEOSTAT.

Emergency making necessary the use of limited equipment for connecting up two 10 horsepower direct current shunt field motors, with one starting box, I made use of the hook-up herewith reproduced to start up each machine and connect it on the main line.

The first step was to provide ample pro-



Useful Kink Utilizing One Starting Rheostat for Starting Up Two Motors. After Each Motor Has Been Accelerated in Turn, the Proper Switch Is Closed, Throwing It Directly on the Line.

tection against overloads and failure of power, which was overcome by properly fusing as per diagram.

With T.P.D.T. switch in neutral or straight out position, connections to the motor are broken. Throw main switch in, then T.P.D.T. to either side to start respective motor. Bring rheostat lever up slowly to no-voltage release and lock; next throw in respective shorting switch, when handle on starter should drop, thus connecting one motor on the line.

To start the second motor, throw T.P.D.T. switch to opposite side and start as before, after which close the proper shorting switch. Both motors now on the main supply line; pull T.P.D.T. switch to neutral position.

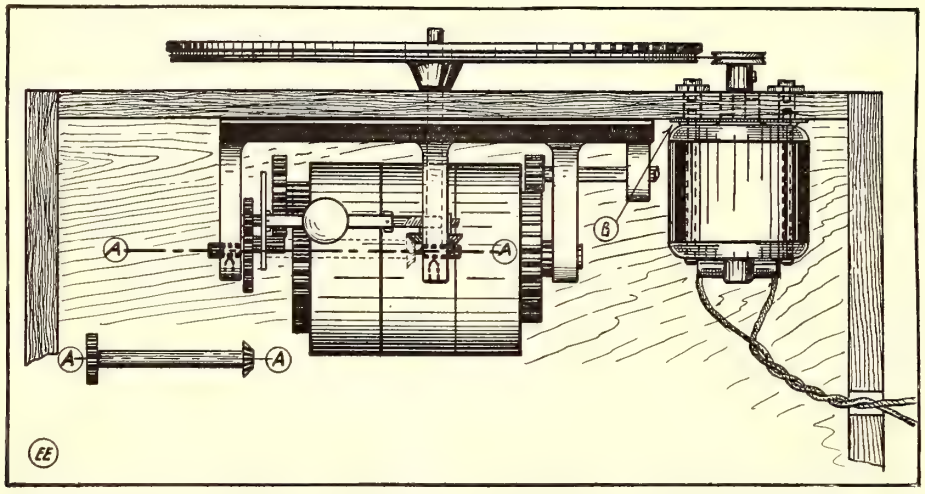
I have had entire success in running both motors by this method for a period of 30 days, depending exclusively on the 30 ampere fuses for overloads and manually opening the circuits in case of generator shut-down or cutting off of the power.

Contributed by RAY J. BUTTON.

A Simple Electric Motor Attachment for Phonographs

By R. U. CLARK, 3rd

THE phonograph is without doubt one of the greatest of all pleasure giving instruments. This fact is amply demonstrated by the large number of these machines in use at the present time. It is, however, like many other articles, appreciated most when new, and is little used after its novelty wears off, owing to the constant attention required to operate it. Winding up the spring to keep the motor going is the one thing which detracts most from the pleasure which should be derived from any good talking machine.



Illustrating How the Author Devised a Simple and Effective Electric Motor Drive for a Disc Style Talking Machine. The Old Governor Mechanism Is Retained and the Motor Drives the Record Table by Means of a String or Cord Belt. (Fig. 1.)

By means of a simple electric motor attachment it is at once possible to do away with practically all the bother incident to the operation of the talking machine, with the exception of changing the records.

Most of the standard machines on the market today lend themselves very readily to the attachment of an auxiliary motor device, so that, by the employment of a little care and ingenuity, it is a simple matter to remodel a phonograph so as to run it by electric motive power.

The actual amount of power required to drive the turntable of most any phonograph at the proper speed is very small, although it may not appear so to the person who has to be continually winding up the ordinary spring motor. Just how little power will suffice depends more or less on the machine to be driven, but for most machines a universal electric motor of 1/40 H.P. will be found quite sufficient. These motors can be purchased new in most cases for as little as $4 complete, and can be attached by a flexible wire direct to the ordinary lamp socket, without using any extra resistance. The motor used by the author with considerable success was bought originally as a fan motor for $4; the fan, guard, and base which came with the motor were removed.

The motor mentioned above was designed to drive a six-inch fan at about 3,000 r.p.m. Under this load the makers claim it can be run at a cost of about 1 cent per 6 hours, the rate per K.W. being 10 cents. This motor is equipped with special patented bearings which require no oiling; for about 2 months, during which time the author's machine has been run a great deal, no oil has been placed on the bearings.

The use of such a small motor, as mentioned above, for such exacting work as running a large turntable, which is held at a constant speed by the governor with which the talking machine is fitted, may appear rather inappropriate, but, altho some heating does take place in this motor it is not sufficient to cause excessive wear or shorten its life materially.

The actual method of driving the talking machine turntable on which the records rest, as described in this article, is by direct belt connection, which method requires perhaps the least accuracy in construction. The author after considerable experimenting with a simple friction drive, direct from the electric motor shaft, which was fitted up with various rubber and composition friction wheels, was forced to give up this method in the favor of belt drive. Friction drive applied to such a mechanism as the phonograph requires very accurate construction, and even then direct friction drive on most machines would prove noisy and unsatisfactory, due to the notoriously imperfect, peripheral arc described by most talking machine turntables.

The first step in the preparation of the talking machine for the addition of an electric motor is to run the machine until the spring is completely unwound. This requires about fifteen minutes time. The spring motor and top board is then removed temporarily from the phonograph, if possible, by removing the crank handle. In some machines it is possible to get at the motor from the bottom. As soon as access to the motor is obtained, the gears and shaft, which form the connecting link between the turntable shaft and the spring motor gears are removed. The unit to be removed is clearly indicated in Fig. 1, A—A. The heavy center line A—A which passes thru the lower part of the spring motor casing indicates the position of the unit to be taken out. Removing this piece, by letting up on the set screws, which hold the pivot bearings, on which the shaft mentioned above runs, simply disconnects the turntable and its shaft from the spring motor, but does not effect the *speed governing* mechanism, which is left in place, for use with the electric motor, to control the speed in the usual manner.

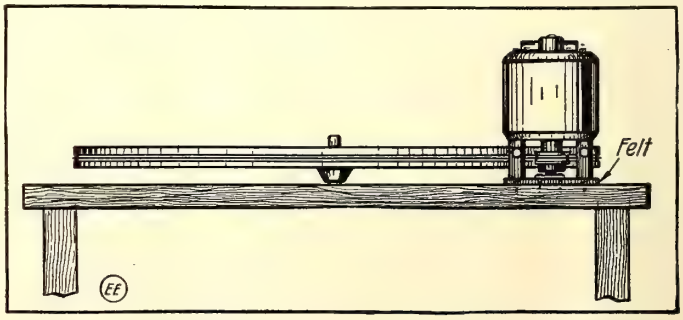
After disconnecting the spring motor from the turntable shaft, the table should be removed and a small groove from 1/32 to 1/16 of an inch deep, the actual depth depending on the thickness of the turntable rim, should be made for the belt to run in around the outside of the rim. This groove should be about ⅛ of an inch wide, and should not be too near the top edge of the rim. On certain machines there is a narrow shoulder located under the rim, which in some cases will hold the belt.

As the phonograph is to be driven by a belt a small grooved pulley wheel for the motor is necessary. This wheel is best made of metal with a small groove about ⅛ inch wide, either V or semi-circular in cross-section, and about 1/16 inch deep. The greatest diameter of the pulley should be about 1 inch or under. The author has used experimentally several sizes from ⅝ inch up to 1 inch, all with considerable success, but when a 1 inch wheel is used, the motor which then turns at about 800 r.p.m. seems to run the quietest, and with practically no belt slippage. Within the sizes mentioned the diameter of the pulley will have little effect upon the speed of the turntable, which is still controlled by its own governor as mentioned above, but of course the motor pulley-belt speed will be decreased by the use of a small pulley and increased when a large pulley is employed. A 10 cent pulley from a mechanical toy set is satisfactory.

The method to be used in mounting the motor will necessarily depend somewhat upon the type of talking machine used. There are two simple ways of attaching the motor, one of which should be applicable to nearly any machine made. Wherever the construction of the talking machine permits, the motor can be hung out of sight, from the top-board of the body of the phonograph, with the shaft extending thru this board about ½ inch, so that the pulley wheel can be mounted with ease from the top side of the board on which the motor is hung, as shown in Fig. 1. This mode of mounting is possible only with a certain class of phonographs, mostly the larger sizes. For use with small machines, where the motor cannot be hung out of sight, it can be inverted and fastened to the top board, in such a manner that the pulley groove, which comes next in position to the motor bearing, with the hub near the outside end of the shaft, comes in line with the grooved portion of the turntable. (See Fig 2.)

To use the method of attachment first described it is necessary to drill three holes in the top board spaced about 2 inches from the edge of the turntable. The center hole is made to accommodate the main bearing and shaft of the motor. The

(*Continued on page 76*)



Where it is Not Possible to Conceal the Motor in the Cabinet, as in Small Machines, the Motor Can Be Readily Mounted Above the Cabinet Shelf as Shown. (Fig. 2.)

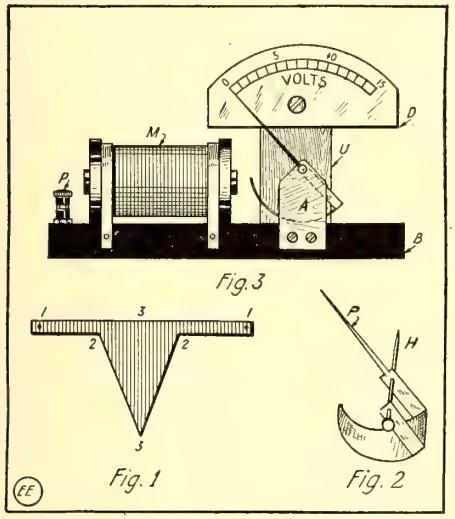
HOW TO MAKE IT

This department will award the following monthly prizes: **First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.**
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of **$3.00** is awarded; for the second best idea a **$2.00** prize, and for the third best a prize of **$1.00.** The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

A VOLTMETER FOR THE AMATEUR ELECTRICIAN.

Herewith is described an easily constructed voltmeter, which will accurately register,



A Simple Voltmeter for the Student, Comprising an Electro-magnet and a Pivoted Piece of Sheet Iron With an Indicating Needle Attached as Shown.

if properly constructed and adjusted. It is very simple and requires few materials, all of which are found around the experimenter's shop.

The base was made 5 by 1½ by ½ inches. The upright U was made from the same material 1 inch shorter. Next I cut out a piece of tin from a cocoa can in the shape shown in Fig. 1; 2 inches from 1 to 1, 1 inch from 2 to 2 and 1½ inches from 3 to 3. Two small holes are put one in each end. Then I bent it into the shape shown in Fig. 2, over a hammer handle. The pointer P was made from a piece of fine wire and soldered on. A large pin served as an axle, H. The piece of tin A, Fig. 3, holds one end of the pin while the other end is driven into the upright, U. The magnet M was taken from an old bell and held in position by tin strips as shown. After putting the binding posts, P, on and fastening the upright and disk into position, the instrument was complete.

The best way to mark the disk is with a transformer; mark where the pointer stays in a natural position with an O Then connect five volts to the binding posts and mark where the pointer stays with a 5. Do the same with ten and fifteen volts. Mark off spaces of one volt each between the numbers. This instrument will be an interesting as well as useful addition to the shop for measuring various voltages.

Contributed by FRANK M. JACKSON.

GOLD LEAF SUBSTITUTE FOR ELECTROSCOPES.

Coat lightly one side of a piece of tissue paper with lamp black and turpentine with a brush. Cut a 2½x¼ inch piece from it for your electroscope. Electroscopes may be used to test insulators.

Contributed by
CLARENCE MELOTZ.

SECOND PRIZE, $2.00

USING COMMUTATOR FOR WIND DIRECTION INDICATOR.

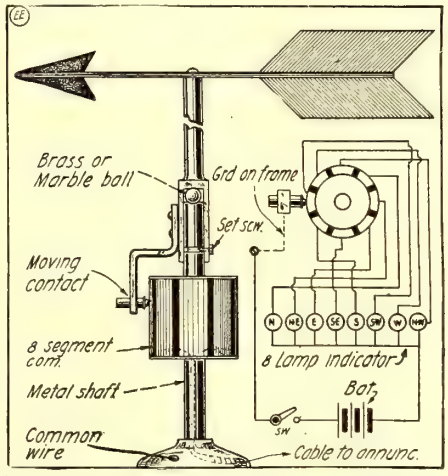
Many people find an electrical wind direction indicator both useful and practical. It is very convenient to have such an installation in the home, office or laboratory, so that by simply glancing at the electrical annunicator, one may know just how the wind is blowing, so far as its direction is concerned.

Most of those described in the "How-To-Make-It" columns of electrical journals, involve the construction of a commutator or segmental switch. This difficulty is readily overcome by utilizing a small size motor commutator, which can be purchased at little cost from any electrical supply house or dealer, and having eight or more segments.

The commutator is made stationary on the shaft standard supporting the weather vane, while the moving lower part of the device attached to the weather vane proper, carries at its lower end an electrical contact brush (preferably a rolling ball or wheel contact) which of course will turn with the vane.

The moving part of this apparatus should not be too stiff, and the best ones now in use are equipt with ball bearings. With a little ingenuity on the part of the builder, it will be found possible to incorporate the ball bearing feature with very little trouble, and the vane will be many times more accurate and reliable than the ordinary one. The circuit connections between the moving brush, commutator and flash lamp annunciator are shown.

Contributed by PETER BROWN.

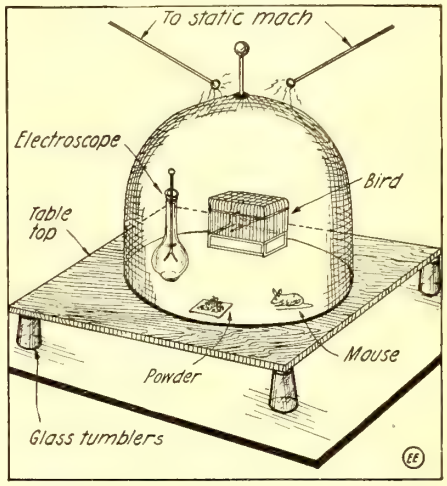


Many Experimenters Desire to Build an Electrical Weather Vane, But Hesitate to Do So, Owing to the Difficulty in Constructing a Suitable Multiple Contact Switch. A Motor Commutator Solves the Problem.

THIRD PRIZE, $1.00

WHAT IS A SAFE RETREAT DURING A THUNDERSTORM?

Place a mouse, a bird, an electroscope and some gunpowder inside a wire gauze cover, such as is used for protecting meat.



To Prove That a Person Is Invariably Safe from Lightning When Inside a Metallic Cage, Mr. Weinbrot Places Some Powder, a Mouse and a Bird Within a Metal Cage. Heavy Static Sparks Jumping to the Cage from a Wimshurst Machine Have No Effect on Any of Them.

The whole, being placed on a board is supported on four warm, dry tumblers placed on the top of a table.

Connect it with a static machine and set it working. Altho an abundance of sparks may be made to play all over the outside, the living things, the gunpowder and even the electroscope will not be affected in the least.

From this experiment one may therefore deduce that the safest place in a thunderstorm is in the metal lined meat safe, provided, of course, that it is large enough. This also demonstrates the theory of Lodge regarding the design of lightning rods for protecting buildings. Lodge recommends for first-class protection that the edifice should be entirely enclosed under a perfect network of wires, resembling in effect an ordinary bird cage. Modern installations of lightning rods follow this theory as nearly as possible. The important part to bear in mind is, that you should not touch the metal, otherwise fatal results will occur.

Contributed by E. F. WEINBROT.

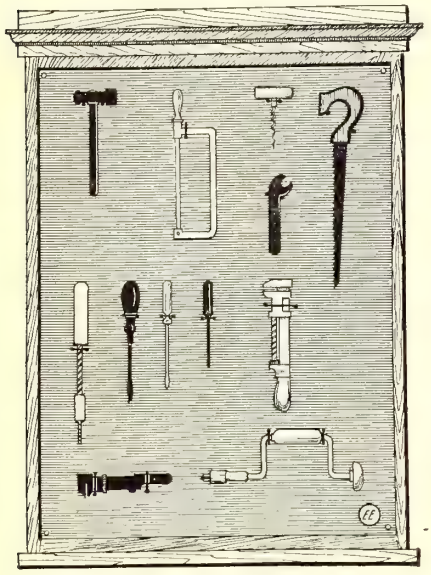
FROSTING GLASS WITH BEER.

Secure ½ pint of lager (light or dark) beer, and to this add enough epsom salts, so that when stirred up it will be the consistency of cream. Apply this cream to the glass to be frosted with a sponge. This frosting will not readily wear or rub off under any conditions.

Contributed by EUGENE RUCKMAN.

HOW TO KNOW WHEN TOOLS ARE RETURNED.

Every experimenter knows that people who come in and borrow tools never, by



To Tell at a Glance Whether or Not a Certain Tool Has Been Returned, Simply Paint Its Outline in Black or White on a White or Black Board as Shown.

any chance, replace them in their proper place.

The accompanying illustration shows a very simple method of overcoming this annoyance. The outlines of the tools are painted in white or black on the cabinet wall in the positions which the tools normally occupy. When this is done a person has only to glance at the cabinet and can tell immediately just where each tool belongs.

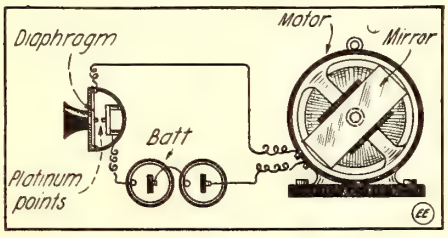
Contributed by

AN EXPERIMENTER.

A SOUND OPERATED MOTOR.

Take any telephone transmitter and remove the carbon granule cup, solder a platinum point to any metal piece and fasten in place of the granule cup. Solder a platinum point to the center of the diafram. The two platinum points should be as near each other as possible without touching. The battery motor is equipt with a wooden block fastened to the axle shaft. A mirror can be fastened on either side of the block. A beam of light can thus be reflected, which should prove interesting to those experimenting with sound waves. The motor and transmitter are placed in a circuit with a battery.

Any word spoken into the transmitter



Novel Scheme for Controlling Revolving Mirror by Means of a Microphone.

will vibrate the diaphragm, and cause the motor to spin around at different speeds, according to the words spoken.

Contributed by LEE A. COLLINS.

PRACTICAL HELPS FOR THE AMATEUR.

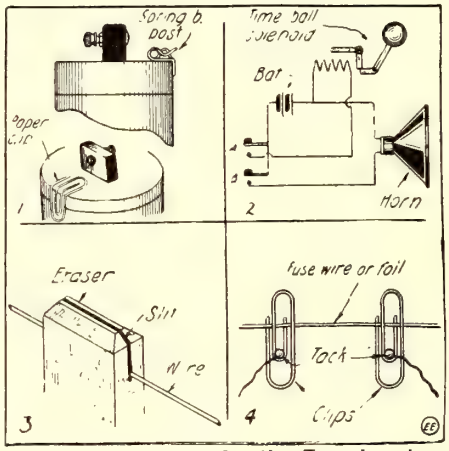
Repairing Dry Cell Terminals.—A simple method is to solder a 6-inch length of flexible wire to the zinc container of the dry cell for making connections. If a binding post is necessary, solder a spring binding post in place as shown. In emergencies paper clips may be used, bending as shown and slipping wire into them.

Shocking Machine from Alarm Clock.—Since a clock is generally used as an interrupter best results can be obtained by arranging a spring to press against one of the wheels which revolve at fairly high speed, when the balance wheel is removed. A higher rate of interruption results, giving a constant tingle instead of a series of jerks. The spring and gear are connected in series with two handles, an electromagnet and two to three dry cells.

Simple Time Signal.—The relay and resistance shown in a previous issue of this journal may be done away with by simply rewiring the time ball solenoid and horn as shown herewith. This likewise does away with an extra set of batteries. Key B operates the electric horn and A controls the semaphone.

Removing Enamel from Magnet Wire.—The easiest method is to use an ink eraser for this purpose. The wire is cleaned quickly and perfectly without excessive abrasion. To do this easily, slit one end of the eraser and run the wire thru the slit several times.

Fuse Clips.—This fuse is in the same class as the above hints, being made from



Some Handy Kinks for the Experimenter.

paper clips. Fasten to board with screws or tacks and slip fuse wire, fine copper wire or tinfoil under clip.

Contributed by T. W. BENSON.

A CLEVER USE FOR SPEED INDICATORS.

In constructing a metal pattern recently in order to determine the amount of metal needed for a wall, it became necessary to find the perimeter of a figure similar to that shown in Fig. 1. The work was held up until a way of doing this could be found. I at last thought of the following device:

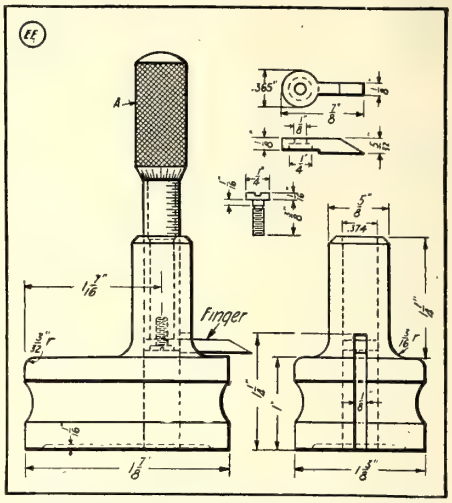
A brass wheel, ¾ inches in diameter, was soldered on the shaft of an "Electro" Speed Counter as shown in Fig. 2. The counter was then grasped in the hand and the wheel was run around the edge of the design. The diameter of the wheel was multiplied by 3.1416 to obtain the circumference of the wheel, which was then multiplied by the revolutions shown on the indicator. This gave the distance around the figure. The size of the wheel can of course be altered to suit different conditions.

Contributed by J. C. GILLILAND.

[*Editorial Note:—Another useful dodge in this direction consists of making a brass wheel as shown at Fig. 3, having a small groove in its perifery; in this groove is placed (glued) a rubber band which is slightly smaller than the wheel. Knowing the dimensions of this wheel and noting the revolutions on the dial, it becomes an easy matter to measure railroad lines, state border lines, conduit and pipe runs on blueprints, et cetera, by simply rolling the wheel along these lines. In one of these devices which we used some time ago, the wheel was made so as to have a circumference of 5 inches, or a maximum diameter of about 1⅝ inches. The diameter multiplied by 3.1416, gives the circumference and the latter term, divided by 3.1416, gives us the diameter.*]

A HANDY HEIGHT GAGE.

The sketch gives dimensions for making this useful height gage. The micrometer head is of Brown & Sharpe make and will give a forced fit in the .374" hole. It will be necessary to anneal the spindle end to tap a No. 3-48 thread, so as to hold the



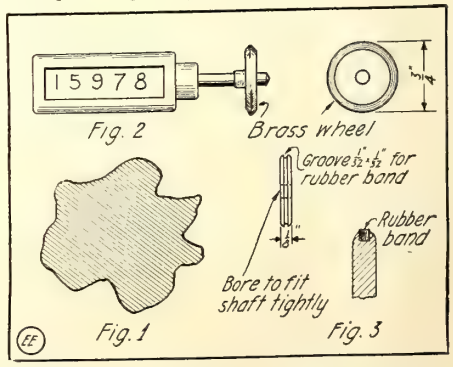
An Effective Precision Height Gage May Be Constructed from a Standard Micrometer Head Fitted in a Steel Base of the Dimensions Indicated.

finger shown in detail at the right, also the screw. The bottom surface of the base is undercut 1/16 leaving a 3/16 foot all around.

Harden the finger, screw and base, and when finger is attached to spindle it is moved all the way to zero on barrel; that is, when tapping, base and finger are together, the micrometer head is set at zero, all moving parts having a free sliding fit with no shake.

This gage has one advantage over the great number of other height gages in that you can scratch a line from O to any reasonable dimension.

Contributed by JAMES McINTYRE.



Attachment for a Speed Indicator Making It Available for Measuring the Perimeter of Irregular Surfaces, Map Routes, etc.

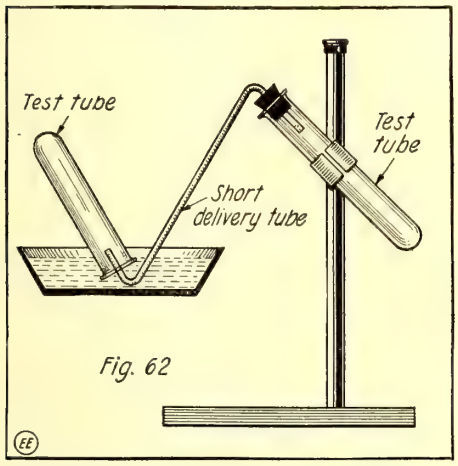
Experimental Chemistry

By ALBERT W. WILSDON

Twelfth Lesson

ACIDS, BASES, AND SALTS.

IN this lesson we shall take up the study of the various acids and characteristics. These form one of the most important studies in the realm of chemistry. A resume of the general properties of acids are briefly as follows:



How Apparatus Is Arranged in Experiment of Collecting the Product of Acetic Acid.

1. An acid is a substance composed of *hydrogen* and a *non-metallic element* or radical, the hydrogen being replaceable by a metal or a group of elements equivalent to a metal. The fact that hydrogen is a constituent of all acids, explains why they are sometimes called *Salts of Hydrogen.*

2. Acids usually have a sour taste.

3. If soluble in water, as most acids are, they turn blue litmus paper (or solution) red. They also change the color of many vegetable substances.

4. They react readily with a base to form a salt and water.

5. They react readily with some metals to form salts, liberating hydrogen.

6. Most acids are soluble in water.

7. They also have the power to decompose most carbonates, like limestone, liberating carbon dioxid which escapes with effervescence.

The common acids are: Hydrochloric (HCl); Nitric (HNO_3); Sulfuric (H_2SO_4); Acetic ($C_2H_4O_2$); Oxalic ($H_2C_2O_4$); Tartaric ($H_2C_4H_6O_4$) and Citric ($C_6H_8O_7$);

Of these common acids, Hydrochloric is a gas (the Hydrochloric or Muriatic acid of commerce is only the gaseous acid in solution); Sulfuric and Nitric acids are liquids; while Oxalic, Tartaric, and Citric acids are solids.

To illustrate the many familiar substances which are acids or contain them, we will take the following few:

Vinegar, Pickles and Relishes, when Acetic acid is present, attributes to the agreeable sour taste.

Vinegar is simply a dilute solution of acetic acid, containing coloring matter and other substances, obtained by the acetus fermentation of poor wine or wine residues, of beer which has turned sour, and of other dilute alcoholic liquids.

The sourness of fruits being due to the presence of citric acid, as in the lemon, apple, currant, raspberry, gooseberry, etc.

During fermentation many acids are formed, as in the case of sour milk, lactic acid is present

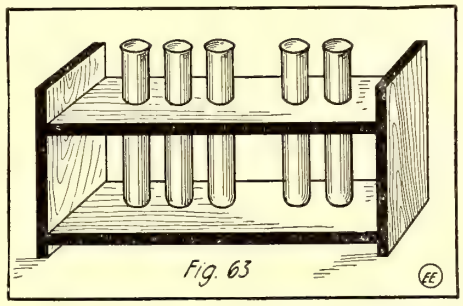
Soda water is a solution of Carbonic acid (Carbon Dioxid), and *acid phosphate* is a solution of a sour calcium phosphate. Mineral waters frequently contain Carbonic acid.

Hydrochloric acid is present in the gastric juice of the stomach, and performs an important part in the process of digestion.

From the above we can see that many acids are of importance, and many are used by us every day in some form or other. We can, therefore, see that all acids are not to be scorned as *dangerous,* as doubtless many readers of this article have heretofore believed, when the word *acid* was mentioned.

NOMENCLATURE OF ACIDS—

Oxygen is a component of most acids, and the names of these acids correspond to the proportion of oxygen which they contain. The best-known acid of an element usually has the suffix *-ic,* as Sulfuric, Nitric, Phosphoric. If an element forms another acid containing less oxygen, this acid has the suffix *-ous,* as, Sulfurous, Chlorous, Phosphorous. Some elements form an acid containing less oxygen than the -ous acid; these acids retain the suffix -ous, and have, also, the prefix *Hypo-,* as, Hyposulfurous, Hypophosphorous, Hypochlorous. The prefix Hypo- is derived from the Greek word, meaning lesser or under. If an element forms an acid containing more oxygen than an -ic acid, such an acid retains the suffix -ic and has, also, the prefix *Per,* as, Persulfuric, Perchloric. The Latin prefix meaning beyond or over. The few acids which contain no oxygen have the prefix *Hydro-* and the suffix *-ic,* as, Hydrochloric, Hydrobromic, Hydrofluoric. It should be noticed that these suffixes are not always added to the name of the element, but often to some modification of it.



In Conducting Experiments With Various Acids it Will be Found Convenient to Place the Test Tubes Containing the Acids in a Wooden Rack. The Tubes May Be Suitably Labeled.

Acids having the prefix Hydro- and ending in *-ic* form salts with names ending in *-ide* and having no prefix.

All other acids with names ending in *-ic* form salts with names ending in *-ate.* [Final "e" dropt in simplified spelling.]

All acids whose names end in *-ous,* form salts whose names end in *-ite.*

ACIDS AND THEIR SALTS.

Hydrochloric acid, HCl; Form Chlorids, NaCl; Sodium Chlorid.
Sulfuric acid, H_2SO_4; Form Sulphats, $CuSO_4$; Copper Sulphat.
Nitric acid, HNO_3; Form Nitrats $Pb[NO_3]_2$; Lead Nitrat.
Sulfurous acid, H_2SO_3; Form Sulphits, K_2SO_3; Potassium Sulphit.
Hydrobromic acid, HBr; Form Bromide, AgBr; Silver Bromid.
Carbonic acid, H_2CO_3; Form Carbonats $CaCO_3$; Calcium Carbonat.
Hydrosulfuric acid, H_2S; Sulphids, ZnS; Zinc Sulphid.
Hydroiodic acid, HI; Form Iodids, KI; Potassium Iodid
Nitrous acid, HNO_2; Nitrits, $NaNO_2$; Sodium Nitrit.
Phosphoric acid, H_3PO_4; Form Phosphats, $FePO_4$; Iron Phosphat.
Hydrofluoric acid, HF; Form Fluorids, CaF_2; Calcium Fluorid.
Chloric acid, $HClO_3$; Form Chlorats, $KClO_3$; Potassium Chlorat.

The nomenclature of acids is well illustrated by the series of chlorin acids:

Name.	Formula.
Hydrochloric	HCl
Hypochlorous	HClO
Chlorous	$HClO_2$
Chloric	$HClO_3$
Perchloric	$HClO_4$

Not all elements form a complete series of acids, but the nomenclature usually agrees with the above principles.

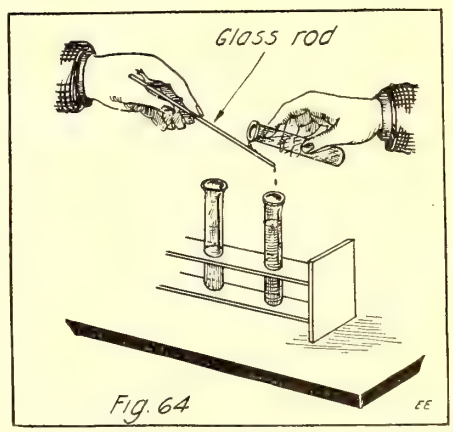
An examination of the formulas of acids show that all do not contain the same number of hydrogen atoms. Acids are sometimes classified by the number of hydrogen atoms which can be replaced by a metal. The varying power of replaceability is called *Basicity.* A *Monobasic Acid* contains only one atom of replaceable hydrogen in a molecule, as Nitric Acid HNO. A molecule of Acetic acid ($C_2H_4O_2$) contains four atoms of hydrogen, but for reasons which are too complex to state here, only one of these atoms can be replaced by a metal. *Dibasic* and *Tribasic Acids* contain two and three replaceable atoms, as, Sulfuric acid (H_2SO_4) and Phosphoric acid (H_3PO_4). Obviously, monobasic acids form only one class of salts, dibasic acids form two classes, tribasic acids form three, etc.

EXPERIMENT NO. 51

Fill a test tube one-third full of either Hydrochloric Acid (diluted), or Sulfuric Acid (diluted). Fill another test tube one-third full of concentrated acetic acid. In some manner label the tubes for identification of the contents.

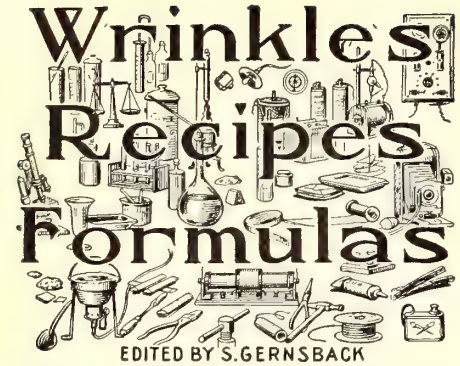
Try the action of a drop of the acid on both red and blue litmus paper.

Drop a small piece of zinc or other metal into each tube successively. If no chemical action results, warm gently. Test for the most obvious product (hydrogen) by holding a lighted match at the mouth of each tube. If no decisive action results, provide the test tube with a stopper and simple delivery tube, and collect any product in a test tube over water. This latter method will probably be unnecessary except with the acetic acid.



Simple Method of Dropping Liquids by Means of a Glass Rod Held in the Hand.

(Continued on page 52)



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

EXPERIMENTER'S APHORISMS

In the following, we wish to give to the Experimenter some hints as to the use of the different ingredients and how to work them:

(1) Always bear in mind that exact working of a formula requires ACCURACY, CLEANLINESS, PATIENCE, and SKILL.

(2) Know what you are about, before you start to experiment.

(3) "THE HISTORY OF FAILURES IS THE HISTORY OF SUCCESS" goes an old adage, and it applies well to the experimenter.

(4) Many times impure, wrong or deteriorated raw materials, spell FAILURE instead of SUCCESS.

(5) A great many of the chemicals and ingredients required, cannot be obtained from drug stores; buy them at a reputable supply house.

(6) BEFORE CONDEMNING A FORMULA, be sure the fault does not lie with the manner of handling it, or the purity of the ingredients.

(7) Be sure to mix the materials comprising a certain formula in the proper sequence.

(8) When starting to prepare a mixture, especially one containing liquids, ask yourself: "IS THE SPECIFIC GRAVITY CORRECT, AS INDICATED BY A HYDROMETER? IS THE TEMPERATURE RIGHT? IS THE QUANTITY OR WEIGHT RIGHT?

(9) Acids and water, when mixed, should be manipulated in the proper manner, i. e., THE ACID SHOULD BE POURED INTO THE WATER, and not vice versa, as the solution is liable to be forcibly ejected from the containing vessel and into the mixer's face.

(10) For any kind of SYSTEMATIC WORK, a floating THERMOMETER and HYDROMETER, as well as measuring glasses and scales, should always be provided, as GUESSWORK is EXPENSIVE, and SOMETIMES FATAL.

(11) Put labels on ALL bottles, boxes and packages with FULL INSCRIPTION as to their contents, it will avoid troubles and mistakes.

(12) Remember that a beginner cannot expect to make articles AT FIRST, which will compare with regular manufactured products. S.G

CHEMICAL EXPERIMENTS.

I have been experimenting a little and have found that an infusion of logwood chips and water will change color when other chemicals are added.

Take three glasses Nos. 1, 2 and 3 and prepare them as follows: Rinse No. 1 with strong vinegar; Dust No. 2 with powdered alum; Rinse No. 3 with a solution of copper sulfate. The next step is to pour the logwood into each. If the glasses have been prepared correctly the logwood in No. 1 will fade to a pale yellow. That in No. 2 will become almost black and that in No. 3 will change to a pale purple. This is the principal set of changes but following is a list of changes using not only logwood but also other chemicals. Some of them can be used as stated above but in the case of ammonia for instance, the odor would give it away.

Color changes that are due to chemical action:

1.—Logwood, ammonia and copper sulfate gives a brown.

2.—Logwood, vinegar and ammonia gives purple.

3.—Logwood, alum and ammonia cause a red precipitate.

4.—Logwood, vinegar and copper sulfate gives a brown.

5.—Logwood, ammonia and common salt gives a light brown.

6.—Logwood, copper sulfate, common salt, and alum mixed give a pink.

7.—Phenolphthalein and ammonia gives a bright red (test for free ammonia).

8.—Copper sulfate and ammonia gives a bright blue (test for copper sulfate).

9.—Logwood and hydrogen peroxid gives a pale yellow.

10.—Logwood, copper sulfate and caustic soda gives a pale blue precipitate.

These are the results as far as I have gone but I hope to continue my work and get different results.

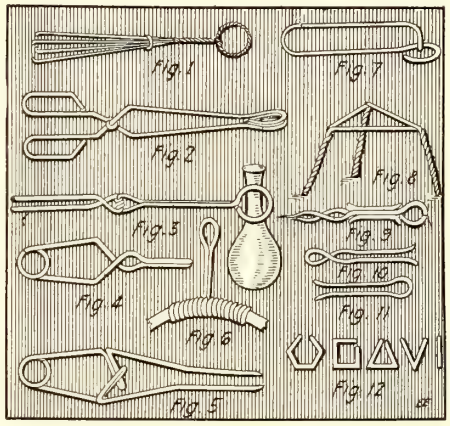
Contributed by W. B. SPURRIER.

HANDY APPARATUS FORMED ENTIRELY OF WIRE.

As shown in the accompanying sketches a number of useful articles of constant service to the experimenter may be constructed of ordinary wire with the aid of a few common tools.

Obtain a few feet of galvanized iron wire, or if the item of expense is not important, brass wire; 3 or 4 gage numbers are required, depending upon the size of the apparatus to be constructed.

Provide a pair each of flat, round and cutting pliers, some wood sticks about the dimensions of a lead pencil, and a few



Numerous Handy Devices for Holding Test Tubes and the Like Can be Easily Constructed from Wire with a Little Ingenuity.

short lengths of tubing to aid in bending and forming the wire; after a few experiments you will be able to determine the size of the wire best adapted.

Cork Puller.

Figure 1.—Cut two pieces of wire the desired length, twist together and form ring. Now twist the four ends to about one-third the length of the shank. Make separately a ring of sufficient size to fit loosely over the shank, cut wires of shank to same length and bend ends to a right angle about ⅛ inch. Slip on the ring and spring the four ends apart to keep ring in position. The completed article will be found of service in removing corks which have fallen into the container, and by placing a piece of cotton in the jaws a most useful instrument is formed for the cleaning and drying of test tubes.

Holders.

Figures 2 and 3.—Follow outline of sketch to obtain good results. Twist wires together 3 or 4 times, allowing but very little play. Bend the four ends at a straight angle and form the ring at the end of tool by bending wire around a rod of the required size.

CHEMICAL SUBSTANCES—THEIR TECHNICAL AND COMMON NAMES.

Nearly all of the chemicals in common use to-day have more than one name, and the purpose of this list is to classify some of the most common ones in use for the benefit of the amateurs who sometimes become confused in the different names. The

Aqua Fortis	Nitric Acid.
Aqua Regia	Nitro-Muriatic Acid or Nitro-Hydrochloric Acid.
Blue Vitriol	Sulfat of Copper.
Cream of Tartar	Tartrate of Potassium.
Calomel	Sub-Chloride of Mercury.
Chalk	Calcium Carbonate.
Salt of Tartar	Carbonate of Potassium.
Caustic Potassa	Hydrate Potassium.
Chloroform	Chlorid of Formyle.
Common Salt	Chlorid of Sodium.
Copperas, or Green Vitriol	Sulfate of Iron.
Corrosive Sublimate	Bi-Chlorid of Mercury.
Dry Alum	Sulfate Aluminum and Potassium.
Epsom Salts	Sulfate of Magnesium.
Ethiop's Mineral	Black Sulfid of Mercury.
Galena	Sulfid of Lead.
Glauber's Salts	Sulfate of Sodium.
Iron Pyrites	Bi-Sulfid of Iron.
Jewelers Putty	Oxid of Tin.
Kings Yellow	The Sulfid of Arsenic.
Laughing Gas	Protoxid of Nitrogen.
Lime	Oxid of Calcium.
Lunar Caustic	Nitrate of Silver.
Muriate of Lime	Chlorid of Calcium.
Niter of Saltpeter	Nitrate of Potash or Potassium Nitrate.
Oil of Vitriol	Sulfuric Acid.
Realgar	Bi-Sulfid of Arsenic.
Red Lead	Lead Oxid.
Rust of Iron	Iron Oxid.
Sal-Ammoniac	Muriate of Ammonia.
Slacked Lime	Hydrate Calcium.
Soda	Oxid of Sodium.
Spirits of Hartshorn	Sesquicarbonate of Ammonium.
Spirits of Salt	Hydrochloric or Muriatic Acid.
Stucco of Plaster of Paris	Sulfate of Lime.
Sugar of Lead	Acetate of Lead.
Verdigris	Acetate of Copper.
Vermillion	Sulfid of Mercury.
Vinegar	Acetic Acid (dilute).
Volatile Alkali	Ammonia.
Water	Sub-Oxide of Hydrogen.
White Vitriol	Sulfate of Zinc.

chemicals in the two lists opposite each other are the same under a different name.

Contributed by EARL BOTTEN.

Spring Holders.

Figures 4 and 5.—Use very thick and springy wire; will be found of service in holding articles to be soldered or cemented. It will be observed from sketch that device in figure No. 4 holds by itself, while the reverse is true of No. 5 design. The ends of these holders can be made pointed or flattened as preferred.

Figure 6.—Holder for rubber tubes. Obtain a piece of thin wire. First bend it in two, making a loop to allow a hook to hold it in place. Then wind wire around a rod of proper size. Slip tube thru spiral so formed. This device will not permit tube to kink or bend at an angle sufficient to kink or to fracture.

Figure 7.—Holder for articles to be soldered or heated. The slight pressure obtained by allowing the straight bend to pass a little thru the ring will be found sufficient to hold the articles in a position convenient for operation.

Figure 8.—Tripod to support retorts. This article is formed by twisting three wires together forming a stand as shown in sketch.

Figure 9, 10 and 11.—Battery connectors. Figure 10 can be fastened to table by putting a screw or nail thru ring at its end. In the event of the contact jaws becoming loose they can be adjusted by drawing the ends closer together. The line wires can be soldered to the connectors, and if desired the connection on figure 11 can be covered with insulating tape.

Figure 12.—Very light weights. Each bend increases 1 centigram or 1 decigram, varying according to the size of wire used.

Contributed by AN EXPERIMENTER.

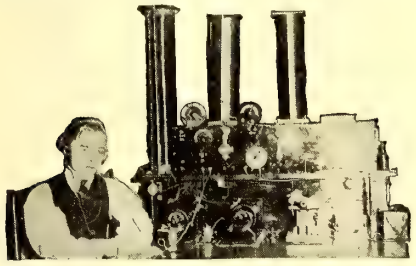
WITH THE AMATEURS

Our Amateur Radio Station Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of stations unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

AMATEUR RADIO STATION CONTEST.
Monthly Prize, $3.00.
This month's prize-winner.

RADIO STATION OF FRED DIETZ, PHILADELPHIA, PA.

I present here a flashlight photo of my station. The aerial is forty feet high, one hundred feet long, composed of three wires spaced six feet apart.



Long Wave Radio Station of This Month's Prize Winner—Mr. Fred Dietz, of Philadelphia, Pa. He Hears the German Stations and Many Others.

The sending set consists of a 1½ inch Manhattan spark coil, Murdock sending condenser, spark gap and key. I also have a six volt storage battery, and can send fifteen miles.

The receiving set consists of two loose couplers, one tunes up to two thousand meters and the other to three thousand meters. The small loose coupler is used with a crystal detector. The large loose coupler is used on the Audion and Audio-tron. I use three Bunnell variable condensers, three loading coils and a pair of Murdock 'phones. I can hear OUI, POZ, NBA (Darien, Panama), NAT (New Orleans), NAR (Key West); and a great many other land and ship stations on undamped waves. I can hear as far as Key West on a crystal detector. My call number is 3GA.

Philadelphia, Pa. FRED DIETZ.

THE FIRST "RADIO" MESSAGES.

At the battle of Ishtib a Bulgarian cowherd signaled news to his military countrymen relative to the position of the Serbian battalions by moving five cows about in various ways on the top of a hill.

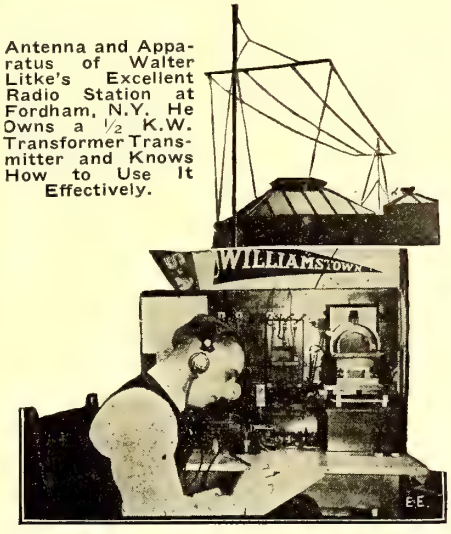
The Basutos, by the way, practically anticipated "wireless telegraphy" in a crude fashion. That is, by striking heavily on a huge drum of goat skin, which is placed on a special spot, another Basuto at a distance can gather the purport of the message by placing his ear close to the ground to catch the vibrations, and he in turn passes the message on.

Of course, given suitable climatic conditions, the military heliograph can transmit messages over enormous tracts of country, and the record is probably held by an Englishman, Captain Sadler, of the Sixth Dragoon Guards, who, by this means, succeeded in South Africa in sending a message direct a distance of 130 miles.

WALTER LITKE'S EFFICIENT RADIO STATION.

I have been reading your valuable magazine for the past two years, and have been greatly interested in the photos of amateur stations which you publish monthly. I submit two photos, one of my station and one of my aerial. My sending set consists of an E. I. Co.'s ½ k.w. transformer, a Murdock oscillation transformer, a Marconi key, straight spark gap, a photographic plate condenser consisting of ten plates, 8 by 10 inches, with tin-foil between cut 6 by 8 inches.

The receiving set consists of an Arnold Navy type loose coupler of 2,500 meters, Holtzer-Cabot 3,000 ohm 'phones, Clapp Eastham fixt condenser, Murdock variable condenser, Bunnell detector, and an aerial switch. My aerial is made of seven strand copper wire with a twenty foot mast at one end and a thirty foot one at the other. The



Antenna and Apparatus of Walter Litke's Excellent Radio Station at Fordham, N.Y. He Owns a ½ K.W. Transformer Transmitter and Knows How to Use It Effectively.

aerial is 75 feet long. I have not received my official call from the Government yet, but have my application in.

WALTER E. LITKE.

Fordham, N.Y.

ELECTRIC HAND GENERATOR DETONATES DYNAMITE.

An electric generator small enough to be carried in a man's pocket, yet powerful enough to discharge dynamite blasts, has been invented.

ATTENTION!!!

Has your station photo appeared in "The Electrical Experimenter"? Why not purchase the electrotype and have some "real" stationery printed with your station picture on it? All of the "regular radio-bugs" are doing it.

RADIO JOINS SAMOAN ISLANDS WITH UNITED STATES.

Construction of another government wireless plant, connecting the United States with its insular possessions, has been completed at Tutuila, placing the Samoan Islands in direct communication with the outside world for the first time since their acquisition by the U.S.

The station at Tutuila connects with Honolulu, where a great plant communicates with San Diego, Cal. Governor Poyer, of the Islands retired naval officer, advised Secretary Daniels on February seventeenth of the completion of the plant and transmitted a message from the native chiefs.

LEONARD NIESSEN A COMING "RADIO-BUG."

The sending set consists of a one-half inch spark coil, plate and Leyden jar condenser, oscillation transformer, spark gap and key.

The receiving set consists of a Murdock loose coupler, fixt condenser, galena and silicon detectors, Brandes' 2,000 and E. I. Co.'s 2,000 ohm 'phones and a buzzer test.

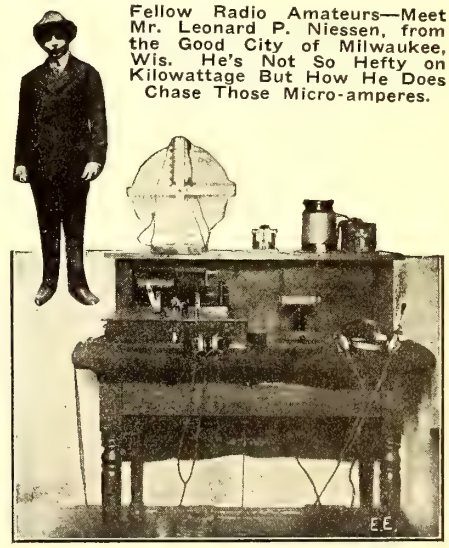
The vertical rod seen under the center of the table is an automatic closing lightning switch, operated by a foot lever, the switch itself being outside on the wall of the house. Most of the apparatus is of my own construction. The aerial consists of six wires spaced two feet apart on twelve feet spreaders, fifty feet long and forty feet high.

I am a member of the Milwaukee Radio Association, also the Central Radio Association and hold a first grade Amateur License. Call "9AKC."

Have been a subscriber to THE ELECTRICAL EXPERIMENTER for the last two years and have benefited greatly by reading it.

LEONARD P. NIESSEN.

Milwaukee, Wis.



Fellow Radio Amateurs—Meet Mr. Leonard P. Niessen, from the Good City of Milwaukee, Wis. He's Not So Hefty on Kilowattage But How He Does Chase Those Micro-amperes.

PAUL RALSTON'S RADIO STATION.

With the exception of the pair of Brandes' phones, a ½ k.w. Packard transformer and the rotary gap motor, this set is all of my own construction.



Paul Ralston, of Conneaut Lake, Pa., Is an Ardent Student of the Art of Wireless Telegraphy.

The normal sending range is 50 miles. Altho I have not a license, I receive stations as far as Key West (1,200 miles distant). My call is 1HR.

I have also increased the efficiency of my station by adding an Oscilaudion bulb, a new rotary gap and an oscillation transformer.

PAUL RALSTON.

Conneaut Lake, Pa.

550 WIRELESS MEN AVAILABLE IN PHILADELPHIA.

A trained body of 300 expert wireless operators now working on ships at sea or at commercial or naval stations along the coast, and 250 amateurs capable of completing their radio studies within a few months, is Philadelphia's contribution to the nation in the important branch of wireless communication in event of war. In addition, forty students are now enrolled in the Philadelphia School of Wireless Operating.

This school was the first to be established in America. It was started with a few pupils back in 1911, and since that time has turned out more than 300 trained men, nearly all of whom are holding commercial licenses to-day.

All licenses for wireless operating are issued by the federal authorities, so that the records at Washington constitute an index of the operating force of the country. In this respect Philadelphia is said to lead every other city with its 250 amateurs.

Altho the operation of wireless stations is kept under government regulation, no order has been issued since the breaking off of relations with Germany to make regulations more drastic, and none is expected. In some respects the large number of amateur stations means better protection for the city, for there is hardly one hour out of the twenty-four when some stations are not operating or listening.

In addition to this force, Philadelphia is guarded by three powerful stations, Wanamaker's, League Island and Cape May. Most of the commercial business of the city is handled over the plant on the roof of the Wanamaker store. This is rated at 100 miles, but its messages have been picked up as far south as Florida. The plant is generally closed now at night, but should the need arise it could be kept in constant operation and could pick up messages from a considerable distance out in the Atlantic.

GIVE COLLEGE RADIO OUTFIT.

St. Ignatius's college of Cleveland, O., was presented with a new wireless outfit at an alumni smoker in the college gymnasium on February twentieth. The outfit was the gift of the alumni of the institution. Dr. Charles S. Howe, president of Case School of Applied Science, delivered an address.

HARRY WALLE'S AMATEUR RADIO STATION.

I present herewith a photograph of my wireless station, to be entered in your "Amateur Radio Station Contest." My set employs a 4 wire aerial 60 feet long. The receiving apparatus comprises a loose coupler, variometer, variable condenser, fixt condenser and a 50 tap tuning coil, which are all mounted complete in an oak-finished cabinet. The receivers are Trans-Atlantic 2,800 ohm type. The sending outfit includes a 1-inch spark coil, helix, spark gap and a key. I hear 8 U E, 8 R Y and 8 G L very clearly.



Harry Walle Finds Keen Enjoyment in His Small But Efficient Radio Station.

HARRY VANDE WALLE.

Cincinnati, Ohio.

Amateur News

The Waco, Texas, High School Radio Club.

In September, 1914, the Waco High School Radio Club was organized with a charter membership of four.

To-day the club has an active membership of thirty, a first-class one kilowatt transmitting set, two receiving sets (one an ordinary 4,000 meter Audion set and the other a 2,500 meter regenerative set), hot wire ammeter, wave meter, motor-generator set, Multi-Audifone set, Omnigraph and various other experimental apparatus.

The Radio call is 5 YG. The club meetings are held every Friday evening. The club would welcome all communications sent to Willis F. McCracken, care of Waco High School Radio Club, Waco High School, Waco, Texas.

Ypsilanti Radio Amateur News.

The Ypsilanti Radio Amateurs have elected the following officers for the coming year:—President, Donald Knight; Secretary, Allen Rust; Treasurer, James Orr; Sergeant-at-Arms, Louis Roberts.

The club participated in a local exhibit during America's Electrical Week.

School Forms Radio Club at Arlington, Mass.

A wireless club was formed by the pupils of the Russell Grammar School of Arlington, Mass., during the month of November.

The following officers were elected:—President, Ernest A. Snow, Jr.; Vice-President, Richard Noyes; Secretary-Treasurer, Borden Billings.

The club has a set installed and meets Tuesdays and Thursdays in the afternoon to study the code.

Dansville Wireless Association of Dansville, N. Y.

On December 28, 1916, a number of "live wire" radio amateurs organized the Dansville Wireless Association.

The Club has twelve members and the station is located within the school building and would like to get in touch with other active clubs and amateurs.

The officers of the club are James Welch, President; Nobert Smith, Secretary and Conway J. Sheerin, Chief Operator.

Uper Sandusky, Ohio, Wireless Club.

The amateurs of Upper Sandusky, Ohio, have organized a club and have located in the business section of the town. The society consists of seventeen members. We are installing a 1 K. W. transformer and expect to install an Audion set in the near future.

The following officers were elected on December 1, 1916: Ralph Casey, President; Robert Maskey, Vice-president; Russel Selligman, Secretary and Hillis Berkey, Treasurer.

Radio Amateur League.

The Radio-Amateur League of Grand Prairie and Dalworth Park, Texas, was organized March 5, and the following officers were elected: Frank M. Stubbs, President; Arthur Bradshaw, Vice-president; Ivan Ferguson, Secretary and Treasurer; Joe Ward Edwards, Chief Radio-Engineer and Press Reporter.

The "League" intends to construct most of its own instruments. We wish to communicate with other clubs and learn of their ideas. We have several ideas on the "Erection of Aerials" and the construction of other instruments which we will communicate to any clubs desiring this idea.

All communications may be address to the secretary at Dalworth Park, and to the President, or Radio-Engineer, at Grand Prairie, Texas.

Fifth District Radio Club Elects New Officers.

In compliance with the by-laws of the club, Mr. R. B. Godbold was re-elected President; Karl Frueb-ing, Secretary-Treasurer and George Deiler, Librarian, who will serve the club until July, 1917.

RADIO CLUBS ATTENTION!

We are always pleased to hear from young Edisons and Radio Clubs. Send a write-up of your Club with photos of members and apparatus to-day to: Editor "Amateur News" Section, The Electrical Experimenter, 233 Fulton St., New York City.

The headquarters of the Club are in the rooms of the Y. M. C. A. Radio School. The club owns a moderate library and has the use of a fine receiving station, also a storage battery charging plant.

Invitations are extended to all interested in the Radio Art. Meetings are held every Saturday night. Photographs of the club's set will be mailed upon request. We would also like some pictures from other clubs. Address all communications to Karl Fruebing, 1232 Magazine Street, New Orleans, La.

Eureka, Illinois, Radio Amateur News.

On the evening of March 7, the Eureka Radio Club was formed and ten members admitted. The following officers were elected: Alvin Spencer, President; Glenn Dorward, Vice-president and Henry Klaus, Secretary-Treasurer.

All communications should be addrest to the Secretary-Treasurer.

Y. M. C. A. Radio Club of Springfield, Ohio.

Under the leadership of Mr. E. Hineline, the amateurs of Springfield, Ohio, recently organized a radio club, which promises to be one of the most successful organizations of that locality. Widespread publicity was given in the local newspapers and it is reported that there are a large number of men and boys who are taking interest in wireless telegraphy. They have erected aerials and provided instruments, but so far have been working at cross-purposes with few people to talk to and no organization to further the work, so there is a need for a progressive club of amateurs.

The members of the club have planned a sending set, capable of sending two hundred miles, and a long-distance receiving set to receive all high-powered stations in this country and Europe. In organizing the club, Springfield becomes a center of activity for amateur wireless. One of the principal objects of the Club will be to teach its members the use of the Continental Code and Mr. Hineline hopes to interest the Y. M. C. A. in the new club and in this way induce a large number of boys to participate. The temporary organization which was effected at the second meeting placed the following officers—Harold Steadman, President; J. W. Fenton, Vice-president; E. J. Grieb, Secretary; Mr. Baldridge, Treasurer and J. W. Wright, Assistant Treasurer.

Address all communications to the Secretary, 121 Rose St., Springfield, Ohio.

EXPERIMENTAL PHYSICS.

(*Continued from page 25*)

a pointer which moves around and points to a circular scale which has been calibrated to read the same as the ordinary mercury barometer.

EXPERIMENT 23—

A thin bottle (preferably a Florence flask) is tightly *corked* with a rubber stopper, thru which a thin glass tube is connected. If this is inverted into a glass containing water to which a few drops of red ink have been added and the bottle is now heated, gently the air in the bottle will expand and some will pass into the water (see Fig. 19). If now the bottle is allowed to cool, some of the liquid will rise in the tube. If the colored water rises above half way up the tube some of it can be let out by raising the tube above the level of the water in the glass. This apparatus can now be used as a crude thermometer for obviously if heat is applied to the bottle, the air in the bottle will expand and push the water in the tube back towards the glass; if a colder temperature is applied the reverse will happen and the water will rise in the tube. The *hotter* the temperature the *lower* the level in the tube and the *colder* the temperature the *higher* the level in the tube. This experiment was first performed by the great Galileo and was the first method of measuring temperatures.

EXPERIMENT 24—

If a little ice is gradually added to some water in a highly polished vessel (a piece of the family silverware just answers the purpose) while the water is being stirred and a thermometer is kept in it, a temperature will be reached when the polished surface *fogs, i.e.,* (moisture forms on it). This temperature varies according to conditions of the atmosphere and is called the *dewpoint.* This moisture does not leak thru the vessel as is commonly supposed but *condenses from the atmosphere.* We are all familiar with this phenomenon, having observed it every summer whenever ice water is served. The explanation is as follows—moisture is continually evaporating into the atmosphere and when the atmosphere contains *as much moisture as it can hold,* it is said to be *saturated.* The same amount of air can hold more and more moisture as the temperature is increased and *vice versa.* Hence if the atmosphere is saturated and the temperature is decreased, some of the moisture will have to condense as the atmosphere cannot hold more moisture than *as much as it can hold.* Likewise if the atmosphere is not saturated *cooling it will saturate it* and further cooling will cause moisture to condense.

The cooling of the grass, trees, stones, etc., at night more rapidly than the atmosphere itself cools, causes the *formation of dew* (a condensation from the atmosphere). If the air near the earth also cools, the condensation also takes place on the dust particles near the earth and this condensation is called a *fog.* If this *fog* forms at some distance above the surface of the earth, it is called a *cloud.* If a considerable amount of moisture condenses in the cloud the drops become large and because of their weight fall as *rain.* Rain passing thru cold regions freezes into *hail.* If the temperature of condensation is below freezing the moisture condenses into crystals called *snowflakes.*

(*To be continued*)

A ONE-MAN ELECTRIC SUBMARINE.

(*Continued from page 6*)

on) to make several short, quick trial maneuvers, until he bumps into the hull of the enemy vessel. Also he can see a distance of 25 to 50 feet or more under water by means of the powerful electric searchlight, and once against the hull of the enemy Submarine or Dreadnought, it is but the work of a moment to excite the electromagnets in the war-head which instantly grip the steel plates of the enemy vessel with a powerful hold, and to release the war-head by means of the electro-magnetic clutches previously mentioned. The operator then scurries away at a mile-a-minute speed, and if he is but one quarter of even one-eighth of a mile away when the war-head explodes, he will be safe. In the event that the comprest air and gasoline engine driving machines should both fail on his return trip, he can send out distress rockets thru the rocket shute attacht to the periscope column, and thus be rescued by a boat from the mother-ship or by patrol boats sent out from shore.

Amateur Radio Stations Licensed by the Bureau of Navigation During the Month of September, 1916 (Concluded)

Call Signal	Owner of station	Location of station	Power kilowatt
	FIRST DISTRICT		
8DE	Frost, Norbert	552 Glenwood Ave., Buffalo, N. Y.	.5.5
8OF	Hewitt, C. Tefft	7942 Westmoreland Ave., Swissvale, Pa.	
8KE	Houk, Robert J.	73 Douglas St., Tiffin, Ohio	.5
8AMX	Moyer, Edward A.	640 N. Sandusky St., Bellevue, Ohio	.5
8BG	Peacock, Howard	Barker, N. Y.	.5
8OC	Simons, Harold C.	617 May St., Lansing, Mich.	.5
8RF	Slape, Frank	106 Eureka St., Pittsburgh, Pa.	.5
8PH	Thomas, William K.	400 Minton St., Pittsburgh, Pa.	.5
8HX	Towsley, Paul W.	1019 Bement St., Lansing, Mich.	.5
8AMC	Warden, William F., Jr.	R. F. D. No. 11, Cuyahoga Falls, O.	1
	NINTH DISTRICT		
9AJW	Baer, Elwynn W.	1710 4th St., Madison, Ill.	1
9AIL	Becker, Alby	3146 32d St., Catlettsburg, Ky.	.5
9GH	Branom, Albert L.	208 Giddings Ave., Jerseyville, Ill.	.5
9AKB	Davis, Laurence O.	Hazard, Ky.	.5
9AJT	Dubuque College	Dubuque, Iowa	1
9AJR	Fox, Harry	3116 N. 24th St., Omaha, Neb.	1
9AKF	Gitchoff, Anton A.	500 5th St., Madison, Ill.	1
9AKG	Hamlett, Robert T.	Fulton, Ky.	.5
9AKJ	Hammond, George R.	219 S. 5th Ave., Selwein, Iowa	1
9AJO	Hardy, Reginald	441 49th Ave., West Allis, Wis.	.5
9AJS	Herr, Carl E.	540 9th St., Red Wing, Minn.	1
9VD	Herron, Carson L.	1712 Court St., Le Mars, Iowa	.5
9AKA	Holmberg, Harry E.	Bottineau, N. D.	.5
9AKE	Keller, Warren H.	101 Lincolnway, La Porte, Ind.	1
9AKH	McBride, Kenneth	101 Bowen Ave., Independence, Mo.	1
9AKD	Markley, Max	416 W. Central Ave., Bluffton, Ind.	.5
9HG	Nelson, Earl P.	1320 Commercial St., Waterloo, Ia.	.5
9AKC	Niessen, Leonard P.	430 Layton Blvd., Milwaukee, Wis.	.5
9VQ	Poser, Stanley F.	730 1st St., Milwaukee, Wis.	1
9AJU	Robinson, Roy E.	3257 Alcott St., Denver, Colo.	1
9AKK	Eyder, Earl	806 S. College St., Springfield, Ill.	.5
9AKI	Tuhtar, Eugene W.	503 6th St., Milwaukee, Wis.	.5
9AKL	Werlein, Edwin	4060 Lincoln Ave., Chicago, Ill.	1

MAGNETIC INDICATOR FOR CRITICAL TEMPERATURES.

The fact that steel loses its magnetic properties on attaining the critical temperature forms the basis on which has been designed an instrument which infallibly indicates the instant when a mass of steel has attained the decalescent or hardening point. The instrument consists of a contact box containing magnet and coils, mounted on one end of a rod provided with handles and heat shield. The other end of the rod carries a fluxmeter, the needle of which indicates the gradual approach of the steel to the non-magnetic or critical point.

THE THERAPY OF LIGHT AND THE NEW "R-RAY."

(*Continued from page 15*)

radiation is somewhat similar to the Ultra-violet ray, inasmuch as an arc is used; but two different arc electrodes are employed in this work. The arc is produced between an electrode composed of quartz and mercury with a second electrode of ordinary arc carbon. Fig. 1 shows one of the complete arc lamps used in these experiments.

Viewed as a spectrogram the R-ray occupies one side of the Ultra-violet region, and grades uniformly from the first octave to out and beyond the visible portion. Also here we find radiations that cause air and matter to have such affinity that they are instantly absorbed, and investigation of their characteristics can only be conducted in a vacuum.

As resultant deductions of therapeutic interest in considering the properties of the R-ray, we find the following:

(1) They are readily controllable and give penetrative therapeutic light of uninterrupted intensity.

(2) They are rich in Ultra-violet rays of shorter wave lengths than the emissions from any other known arc.

(3) They differ materially from X-rays in that they may be deflected and focussed on any given area, so as to combine their inherent heat-ray value with their visible and invisible light radiations.

(4) They are more readily absorbed by matter than any present known arc ray, and as such secure vibratory reactions in deep-seated cellular organisms.

In order to show the position of the unmapt region wherein the R-ray lies, and as compared with the vibrations of other sources of radiation, the chart, Fig. 2 was made. It will be found very interesting to those who are pursuing the study of different sources of radiations.

The chart indicates the wave lengths of radiations ranging from the visible part of the spectrum to X-rays and the Gamma rays of radium.

To fully understand this chart, the following notation is used: the numbers across the top give their respective wave lengths in Angstrom units (one Angstrom unit is equal to 1/10 of a meter and this unit is abbreviated as A.U.). Thus the wave lengths are given in *tenths of a meter,* using here the language of the scientist. The Angstrom unit is equivalent *actually* to 10^{-10} meter, one meter being equal to 39.37 inches. The numbers below represent the number of octaves which these rays range over.

The region of about six octaves, beginning at 4 and ending at 10, represents the unmapt portion. This separates the extreme ultra-violet from the commencement of the very soft X-rays. The most easily absorbed X-rays, whose wave length has been determined, are the characteristic rays of burning aluminum with a wave length of 8.4 A.U. Passing up thru several octaves of X-rays, the limit indicated by the line "N" is reached; these represent the hardest i.e., the most penetrating X-rays, which have so far been produced. The line "M" represents the *medium* penetrating ray. It will be noticed that some of the gamma rays as produced by the disintegration of the radium atom, are of longer wave lengths than some of the shorter X-rays.

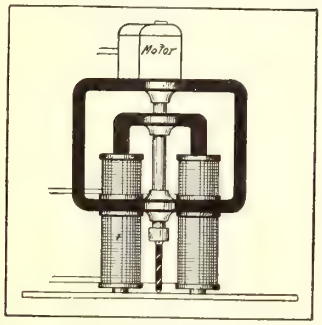
The region ranging between octaves 4 and 10 are vibrations which are easily absorbed by matter. They vary in wave length from approximately 900 to 9 A.U. The region between wave lengths 3,800 to 1,900 is the portion of radiation which is of therapeutic interest.

LATEST PATENTS

Magnetic Drilling Attachment

(No. 1,219,190; issued to Henry Symes.)

The inventor here provides an electro-magnetic means of feeding a machine drill against its work.

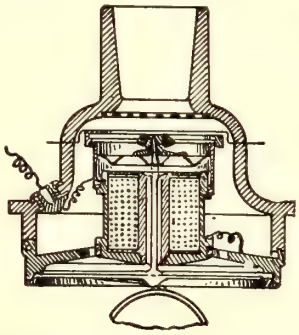


An iron frame supports the drill spindle, which is driven by an electric motor. The spindle carries a suitable iron yoke and pole-pieces which are acted upon attractively by powerful solenoid electro-magnets, tending to pull the iron pole-pieces within in the coils. The current supplied the magnet coils can be varied to give various degrees of pull on the drill frame. For long vertical action two or more sets of solenoids, one above the other, can be utilized as shown.

Electric Phonograph Recorder and Reproducer

(No. 1,218,799; issued to Herman G. Pape.)

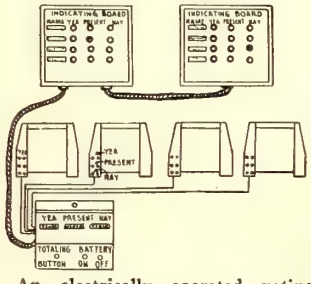
A device for making phonograph



records and combining in its make-up a suitable electro-magnet, a diafram, and a means for causing the diafram to vibrate in response to electrical impulses in the electro-magnet—as from a microphone. Acoustic vibrations or sounds can operate the diafram as usual thru an open grid above it, a stylus being connected to the diafram to vibrate with it.

Electric Voting Machine

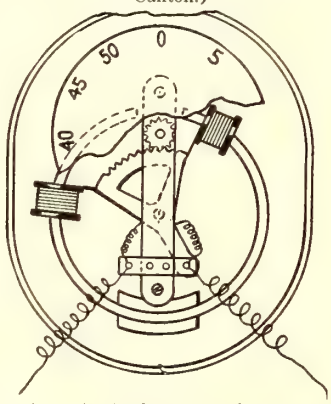
(No. 1,219,053; issued to Marshall F. Thompson and Arthur L. Townsend.)



An electrically operated voting board which includes provision for totaling and recording all of the votes cast and flashing them up on an indicator board. The primary circuit includes a voter's circuit closer, a visual lamp signal and a relay magnet. The latter closes a secondary circuit including the visual signal and a vote recording mechanism. Also there is provided a special circuit breaking attachment out of control of the voter, for the purpose of breaking the primary or voter's circuit. The idea is particularly applicable to government and society meeting chambers, making it possible to record and announce the vote of members present in the minimum of time.

Magnetic Speedometer

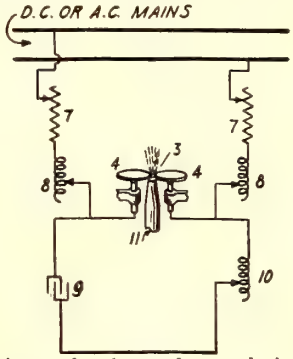
(No. 1,219,245; issued to Allen A. Canton.)



A radical departure in speedometer design, involving the use of a permanent steel magnet of ring form, over which are placed two movable magnet windings, one of which is supplied with a constant electric current and means for intermittently supplying electric current to the second solenoid coil. The magnetic reaction occurring with such an arrangement causes the coils to move. In so doing they rotate a geared sector, as shown, the sector teeth meshing with a small gear pinion fixt rigidly to the dial shaft, thus causing the numbered dial to move under an observation slot or window.

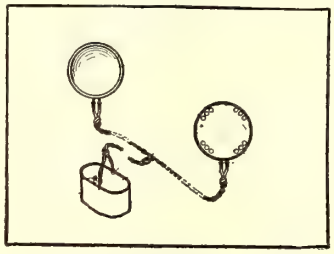
High Frequency Oscillation Apparatus

(No. 1,216,646; issued to James C. Armor.)



A novel scheme for producing high frequency oscillations for radio-telegraphy, radio-telephony and similar arts. Using alternating or direct current as a source, the inventor provides choke coils 8 and resistances 7, across which is shunted the special spark gap 4-4. This gap is shunted by an oscillatory circuit comprising suitable condenser 9 and inductance 10. The first discharge wave of the condenser across the gap is quenched by blowing a high velocity (5,000 ft. per second) jet of gas or fluid between the rapidly rotating spark discs 4, 4. Higher efficiency is claimed and the production of extremely high frequency, dead-beat unidirectional discharges.

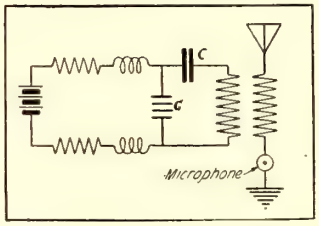
Hearing Device



(No. 1,219,411; issued to Charles E. Williams.)

A specially sensitive electric telephone device to aid partially deaf people to hear better. Operating on the dictograph principle it comprises a super-sensitive microphone which is connected with a suitable telephone receiver and a high voltage battery. The battery comprises a plurality of cells and means for reducing the high potential by having an extra resistance wire between a terminal on one cell and a pole of another, with flexible connections between the external terminals to the receiver and microphone.

Radio Transmitting System



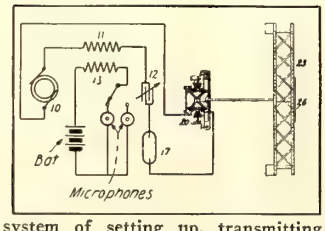
(No. 1,216,615; issued to George Seibt.)

A radio transmitter operating on direct current, which is supplied to a quenched gap, thru suitable choke impedances and resistances. A suitable coupling is provided to enable the cutting off of oscillations in the closed primary oscillating circuit after the first beat of the oscillations. The spark gap is designed to be short, and a rapid heat dissipater, thus quenching the spark and giving rise to powerful, slowly damped free oscillations in the secondary or aerial-ground oscillating circuit and, it is claimed, that the two-coupled oscillations practically disappear. This system is adapted to radio-telephony, using a microphone in the ground lead.

Submarine. Subterranean and Aerial Telephony

(No. 1,212,202; issued to Reginald A. Fessenden.)

A new phase of the Fessenden

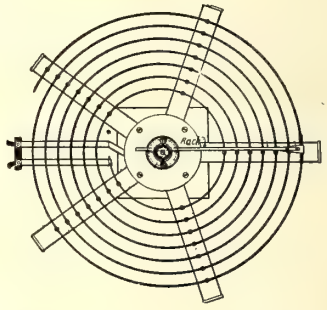


system of setting up, transmitting and receiving powerful sound waves in the form of telegraphic and telephonic signals thru water, land or air. Prof. Fessenden here invokes the use of the Alexanderson magnetic amplifier 11-13, with which to control by microphones, the output of say a 100 K.W. radio frequency alternator. This R F. current is past (also modulated by secondary 11) thru a rectifier 17, thence into a non-inductive oscillator 20. This is linked up with a metallic beam girder 23, supported at two points, as shown, and carrying a large metal diafram 26, say 50 feet square.

Precision Variable Inductance

(No. 1,217,348; issued to O. F. Rothen.)

The smallest part of a turn of the

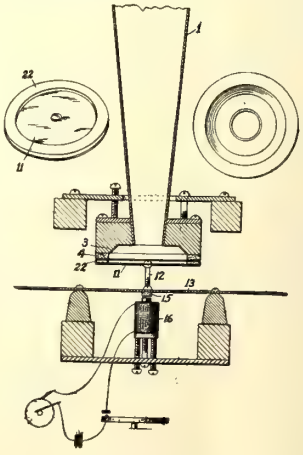


spiral may be accurately tuned in or out of the circuit by simply turning the central knob or handle. Spiral inductances of this type invariably have the defect that the slider will not follow the turns. Here the inventor provides a toothed rack on the slider arm which co-acts on a fixt central gear stud, so that as the handle is turned the slider arm is moved in or out accordingly and in a spiral path the complement of the helix. The pitch circumference of the stationary pinion is selected equal to the radial pitch of the spiral.

Electric Musical Instruments

(No. 1,216,829; issued to Harry S. Martin.)

When an interrupted current of the frequency corresponding to any certain musical note is fed into



electro-magnet 16, it causes pulsating magnetic forces to act on the tuned reed 13. This in turn sets the diafram 11 vibrating at a corresponding periodicity, which vibrations are communicated to the column of air in horn 1, thru the annular mouth 3. Diafram 11 carries a felt ring 22, which may be dispensed with for certain effects. By this means it is claimed that extremely powerful and unusual sonorous vibrations are set up.

COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c EACH

PHONEY PATENT OFFIZZ

No. √ Q.R.T. / Q.R.M. / Q.S.B. } Q.S.C.

AUTOMATTICK BRAT HUSHER
C. U. SPIDOR OF PERAMBLATOR, CA.

Species Fikation of Patent Lettors **Patent Buscated**

To Whom It Should Worry:

Let it be knowed to all fathers, fatheads, mothers, parents, and elders thruout the land and the seven seas and lakes, that I, Constantine Ulysses Spidor of the City of Peramblator, in the state of prolonged coma, have imagined, conceived, designed and executed, at the risk of my imperfect sanity, an apparatus which will revolutionize the baby industry and do away forever with "the hand that rocks the cradle."

It is a greatly to be lamented fact that our national baby industry has suffered greatly during the past decade, primarily for the reason that babies, infants, brats and other similar nuisances tend to keep their elders at home and away from tango parlors and the "movies." Not that the parents cherish the idea of staying in, no, not that. They *hafto.* For, if the nurse or hired girl take their daily spin in the family "Tin-lizzie," who would feed the brat to still his or her war-whooping?

The sad result of the upshot is, that the annual total production of babies and brats has almost reached the vanishing point. It is also to be noted with significant significance, that altho everything else imaginable has gone up during the war, only the output of babies and brats has gone down! And this despite of the constant uproarous roar of Teddy from Oyster Bay.

Happily, such disgraceful conditions need prevail no longer, due principally and solely to my marvelous Automattick Brat Husher. By using this inexpensive apparatus, parents may now tango or "movie" all night, if so desired, without in the least retarding the natural growth of their offspring. Also and most important of all, "Pah-pah" need no longer invent new forms of sudden strokes, cramps, colds, fevers, chills, etc., which make it impossible for him "just then" to leave a comfortable, warm bed, in order to perform the twice-nightly Marathon with an obstreperous brat, clutched tightly in his arms.

Having thus explained my invention in non-technical terms, I now refer to the patent drawing for further elucidation:

1, is a sensitive (but happily unfeeling) microfone. The first brat-yell jars its sensibility to such an extent that current begins to flow thru it at a terrific rate, which in turn operates electromagnet 2. This actuates pawl 3 permitting Thermos-bottle 4, containing the best imported *Extract de Cow* to con-descent downward into the brat's fists. Instinctly the Brat stuffs the nipple in its empty void and the land becomes quiet once more. But this is not the end of a perfect day. Simultaneously with the descent of bottle 4, a contact is made and electromagnet 5 attracts switch 6, usually held off by spring 7, which now actuates instinctanously motor 8. Gear 9 takes up the Q.S.T. (General Call) and Perambulator 10 now begins to perambuscate viciously back and forward, being thus induced by arm 11.

Neither does this end the story. Brats as a rule, due to the cunning of nature are not satisfied with cow-juice and perambulating joy rides only. They wish to be talked to and sung to. Bearing this requirement in mind, when bottle 4 is empty and has ascended once more, thanks to coil-spring 13, electromagnet 12 releases victrola which begins to talk and sing lullaby to brat. This so bores the latter that he, she or it, falls to sleep at once.

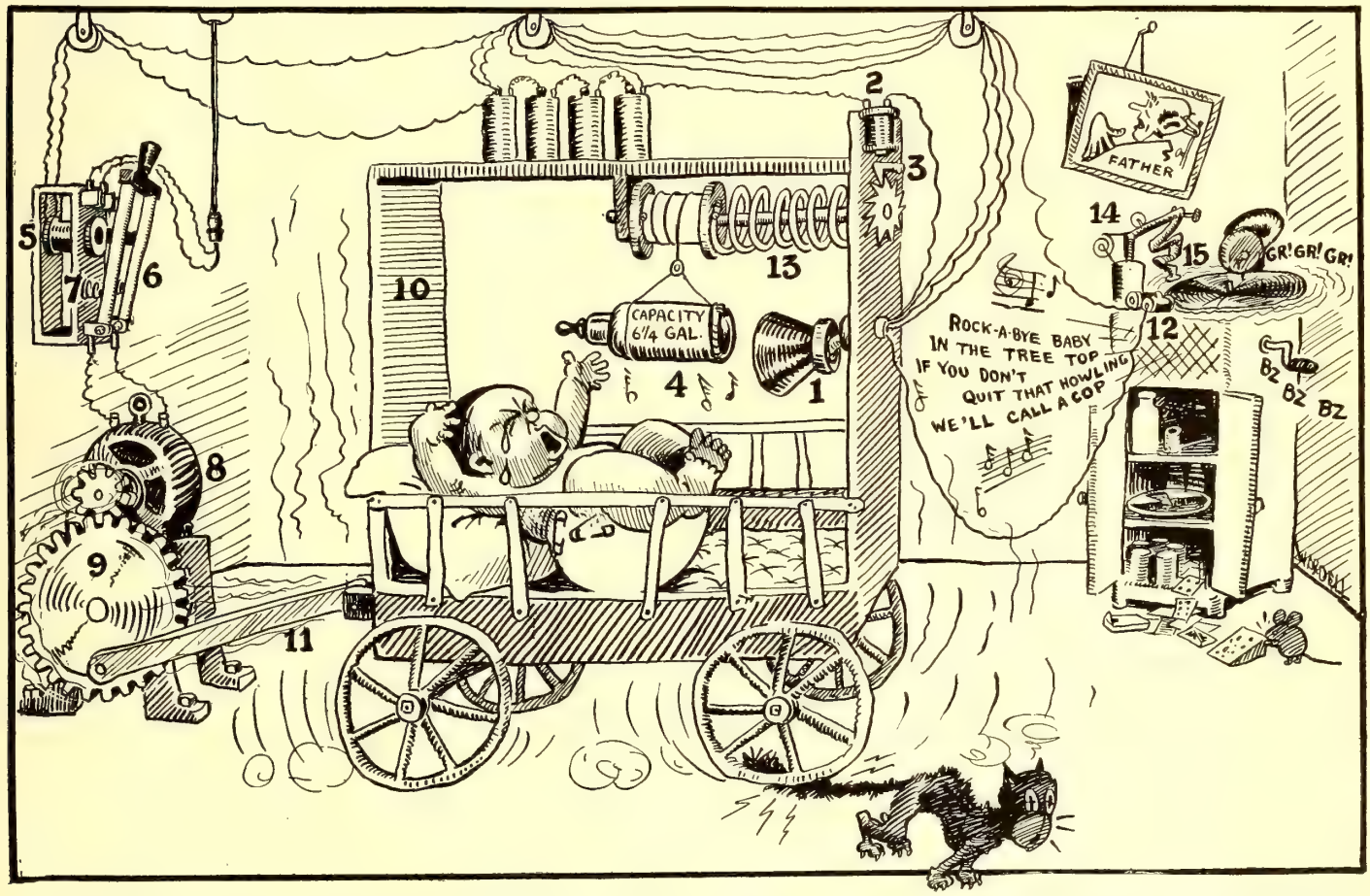
If, perchance, the Brat should wake up once more and yell, 10 gets busy once more and perambuscates at once. Spring 14 has reset reproducer 15 in the meanwhile, when mother's original selection issues forth anew. This so disgusts the Brat that he, she or it, falls to sleep instanter.

What I claim is:

1° A self-contained automattick Brathusher.

2° A Brathusher making attending parents and nurses unnecessary.

3° A Brathusher supplying feed, lullabys and rocking simultaneously.



Let it Be Knowed to All Fathers, Fatheads, Mothers, Parents, and Elders thruout the Land and the Seven Seas and Lakes, that I Constantine Ulysses Spidor of the City of Peramblator, in the State of Prolonged Coma, Have Imagined, Conceived, Designed and Excuted, at the Risk of my Imperfect Sanity, an Apparatus Known Hereinafter as an "Automattick Brat Husher" Which Will Revolutionize the Baby Industry and Do Away Forever with "the Hand That Rocks the Cradle."

In subscribing to the above facts, I have therefore implanted my own facsimile otograf hereunder and forever on this 27th day of Monday in the 53rd year after the advent of the safety-pin.

C. U. SPIDOR.

By his Attorney
A. Bruce Brown,
Norwich, Conn.

Witnoses:
S. H. Utup
Wade U. Givenus
Fore F. Lusher



This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions address to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of **25 cents** is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

RADIO QUERIES.

(760.) Harold Janeway, Edmonds, Wash., asks:

Q. 1. Could I hear amateur stations with a loose coupler, galena detector, fixt condenser, and an Electro "Government" 'phone in connection with an aerial fifty feet high and thirty feet long? If not what other instruments would I need?

A. 1. There is no reason why you should not receive amateur stations with the instruments you mention. A variable condenser shunted across the secondary of your loose coupler will increase the selectivity very much.

Q. 2. How can I drill holes in a marble slab so that I can mount a ground switch upon it?

A. 2. An ordinary steel twist drill should be employed which should be constantly kept wet by applying water to its boring surface.

Q. 3. Would I be violating the rules of the Fire Underwriters if I put a box over my outside ground switch and covered the ground wire with lath?

A. 3. Yes. The ground wire should be kept free from any surrounding objects.

POWER FROM PRIVATE PLANT.

(760-A.) W. C. Guibb, Grabill, Ind., wishes to know:

Q. 1. What is the best way to use the output of a private lighting system in a radio sending set? The generator has an output of 30 to 45 volts and 13.3 amperes, and charges a storage battery of 16 cells.

A. 1. The best way to utilize the electric power generated by your private plant is to employ a spark coil outfit; the size of the coil will depend upon the distance which you desire to cover.

Q. 2. Can I use it in connection with an open or closed core transformer, or is the spark coil the only way?

A. 2. Yes, providing that a mechanical vibrator is used in conjunction with it when using an open core transformer. This can either be directly operated by the transformer core or else you may employ an independent vibrator. We would advise that you employ a spark coil, say about a 4-inch coil, and you will find that it will give better service than if an open core transformer is used.

Q. 3. Could I not use the combined voltage of the generator and battery and have sufficient voltage?

A. 3. Yes; but the voltage will not be sufficient or of the correct character to operate a transformer without a mechanical interrupter.

UNDAMPED WAVE RECEPTION.

(761.) Walter B. Clifford, Worcester, Mass., writes:

Q. 1. Is it possible to employ a mineral detector in place of an Audion detector for receiving undamped signals? If so, what connection of instruments should be used?

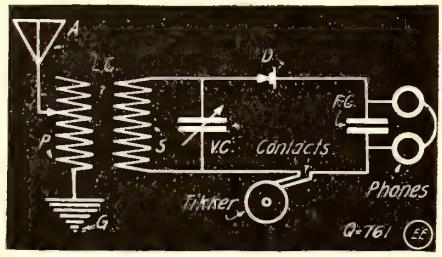
A. 1. It is possible to receive undamped waves by employing a crystal detector providing a *tikker* of some kind is employed in the detector circuit. The diagram of connections is given herewith and shows a circuit breaker or tikker being used.

Q. 2. Will you please publish a diagram of the connection of the instruments used in a simple inductive wireless telephone circuit?

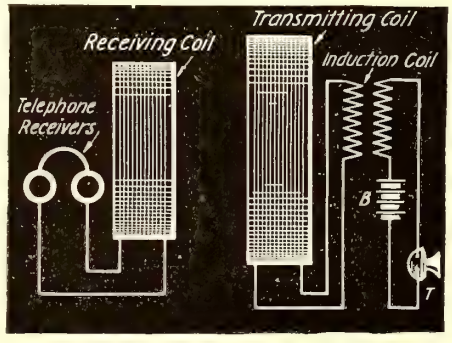
A. 2. Our diagram gives the connection of a simple radio telephone employing the induction principle. The transmitting coil should be five feet in diameter while the receiving coil is four feet. Each coil is wound with one hundred turns of annunciator wire.

Q. 3. Is it advisable to employ a helix with a one inch spark coil?

A. 3. If you desire to bring your transmitting wave length to some definite value, you should employ a helix.



Proper Connection for "Tikker" Type of Radio Receiving Circuit for Undamped Wave Signals.



Hook-up for Inductive Wireless 'Phone.

SELENIUM.

(762.) E. W. Donaldson, Fairmont, W. Va., wishes to know:

Q. 1. In what quantities is the element selenium available?

A. 1. This element can be supplied to you in any quantities desired, and it may be procured from The Electro Importing Co., New York, N.Y., or Electro-Set Co., of Cleveland, Ohio.

Q. 2. Does it remain constant in its conductivity under periods of use, say three or four seconds several times a day or longer?

A. 2. The conductivity of selenium crystals under the influence of light is not constant but variable. The variation of conductivity of lenium depends upon many factors, such as the applied voltage, source and intensity of illumination and chemical purity of the selenium crystal.

MOTOR STARTING QUERY.

(763.) J. Adler, New York, N.Y., asks:

Q. 1. How should a shunt motor be started?

A. 1. First, the field current is applied at full line voltage; then the armature current is thrown on at much less than line voltage, the voltage being held down or controlled by resistance in a starting box; as the motor comes up to normal speed, resistance is cut out step by step until full line voltage is imprest on the armature. This is all accomplished by one motion of the handle of a well-designed rheostat or starting box. Most starting boxes are so arranged with a magnetic release or otherwise, that the motor is automatically cut out of the circuit in case the line voltage should, thru any accident, be shut off.

Q. 2. What is an accumulatively wound compound motor?

A. 2. It is a motor whose series and shunt field windings are in the same direction and therefore as the load comes on the series field assists the shunt field and a stronger magnetization and increased torque, with slightly reduced speed, results.

STORAGE BATTERIES.

(764.) Harry Blumenthal, Harrison, N.J., wants to know:

Q. 1. To what use is the storage battery sometimes put in electric lighting or power stations?

A. 1. To carry the *peak* of the load, *i.e.*, that excessive portion of the load which, for instance, in electric lighting stations has to be carried only for two or three hours a day. They carry the entire load at minimum hours; to act as equalizers or reservoir.

Q. 2. How do Faure plates compare with those of the Plante type?

A. 2. They are usually lighter and have a higher capacity, but have a tendency to shed the material from the grid, thus making the battery useless.

Q. 3. At what density is the resistance of dilute sulfuric acid at a minimum?

A. 3. At 1.260 Baume.

MOTOR ACTION.

(765.) L. Askel, Detroit, Mich., asks:

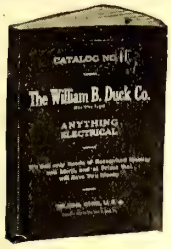
Q. 1. Why does the speed of a shunt motor increase when the position of the brushes is off neutral?

A. 1. When the brushes are shifted from the neutral plane, the reverse voltage between the brushes is decreased, the speed remaining unchanged. Accordingly, the pressure in the supply mains forces an increased current thru the armature, thus producing an increased armature pull, which causes the speed to increase until the reverse voltage reaches a value sufficiently large to reduce the current to the value required to supply the necessary driving torque.

Q. 2. Can you tell me the existing mutual relations of motor torque and speed?

A. 2. The character of the work to be done not only determines the condition of the motor torque and speed required, but also the suitability of a particular type of

(*Continued on page 52*)



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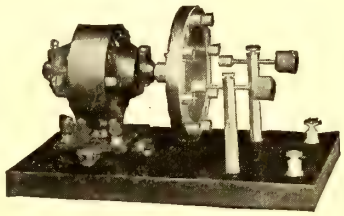
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Every worth while feature is incorporated in this Regenerative Set. Initial tests in our laboratory and at the local Scott High School brought in with remarkable clearness amateur stations in Texas, Louisiana, Wisconsin, and all eastern states. Amplification and selectivity surpassed several other sets tested in conjunction with it. We have no hesitancy in claiming for this instrument no superior, and in fact we thus far know of none that equals it. It is designed for wave lengths from 180 to 475 meters. Case $6\frac{1}{4}$" x $11\frac{3}{4}$" x $6\frac{1}{4}$", nand rubbed mahogany finish. Panel, polished Formica. Set has variable coupling. This is essential for selectivity and the elimination of static, thereby insuring greatest possible range. Primary circuit adjustable by single turns. Grid inductance adjustable by 12 point switch. Special variable condenser included in circuit for close tuning.



$24.75 Prepaid.

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All electrodes are of ½" round copper. Revolving electrodes ⅜" long. Stationary electrodes ⅝" inch long. The use of copper for the electrodes and their unusual size makes this gap much more efficient than any other gap of its type on the market. The copper conducts the heat away from the sparking surfaces. All advanced radio engineers concede that copper is unsurpassed for electrodes. Gap equipped with Universal motor. For use on stations up to 3 K. W.

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Hear the Arc stations in Germany and elsewhere.

No. 528 for secondary loading coil and for tuning the wing circuit, $7.75

No. 1526 for primary loading coil, $7.75

Two No. 528 and one No. 1526, $22.00

None on the market equals these undamped loaders at $10.00 each. No. 22 & 28 Silk Covered Wire is used on primary and secondary, respectively. Variation of inductance is by means of 20 point instrument type switch mounted on ¼" Bakelite. With an ordinarily loose coupler wave length 15,000 meters.



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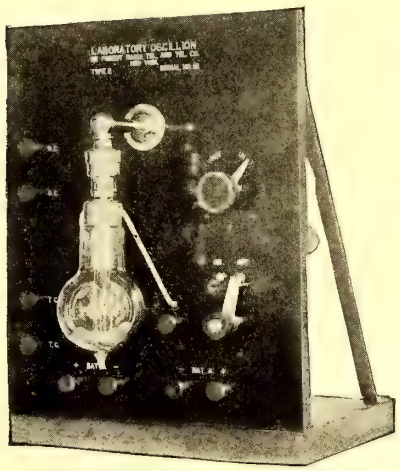
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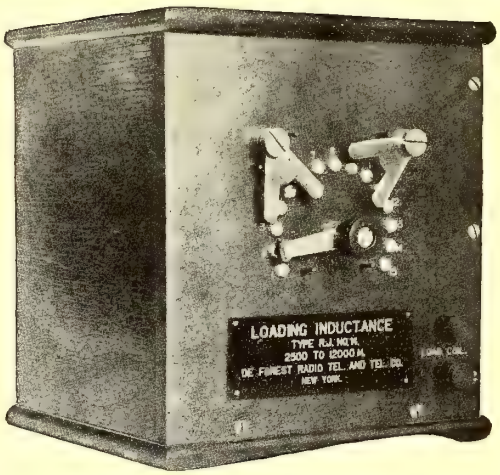


TYPE "S"—$60.00

DeForest "Oscillion"

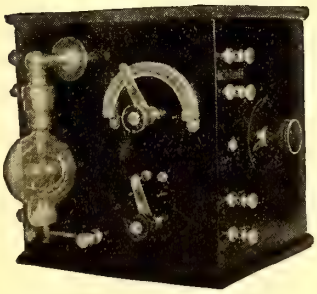
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It is not a Detector in any form.

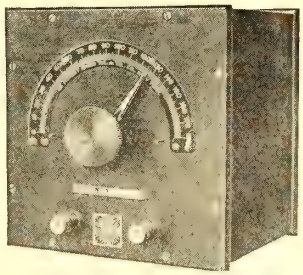
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EXPERIMENTAL CHEMISTRY.

(*Continued from page 43*)

EXPERIMENT NO. 52

Wash the test tubes, add fresh acid, and drop a piece of Calcium carbonat (marble) into each tube successively. Proceed in the same manner as with the metals in the foregoing experiment, only in this case the gas must be tested not only with a burning match, but as follows: Dip a clean glass rod into lime-water, and hold it in the escaping gas. (The escaping gas is Carbon dioxid).

The results of these experiments are characteristic of all acids, and substances acting thus are said to be *Acid,* or to have *Acid properties,* or to have an *Acid reaction.*

The test with litmus paper is true only for litmus, but it is a striking, simple test for acids, and should be remembered, that acids turn blue litmus red.

BASES—

Bases in chemistry, includes those Hydroxids of metals which neutralize acids by partly or entirely replacing their hydrogen, thereby yielding compounds called salts.

Bases are in a few cases soluble, in most cases insoluble. When soluble in water they turn red litmus blue, and possess caustic properties.

Bases usually have an acrid or bitter taste.

Since every base contains Hydrogen and Oxygen they are sometimes called Hydroxids. Hydrat is sometimes used as a synonym of Hydroxid, while the term Alkali, emphasizes general properties rather than suggests specific composition. Hydroxids are distinguished from each other by placing the name of the metal before the word Hydroxid, as, Sodium Hydroxid, Potassium Hydroxid.

Not all bases contain the same number of hydroxyl groups. Therefore, bases, like acids, may form one or more salts. This power is called *Acidity.* Bases are called, Monacid, Diacid, Triacid bases, etc., according to the number of replaceable hydroxyl groups present in the molecule. Calcium hydroxid ($Ca[OH]_2$) is a diacid base, and Aluminum hydroxid ($Al[OH]_3$) is a triacid base.

A base contains a metallic element, as, Potassium (K), Sodium (Na), Copper (Cu), Calcium (Ca), Iron (Fe), Zinc (Zn), together with Hydrogen and Oxygen.

Below are bases:

Potassium Hydroxid	KOH
Sodium Hydroxid	$Na[OH]$
Calcium Hydroxid	$Ca[OH]_2$
Ferric Hydroxid	$Fe[OH]_3$
Copper Hydroxid	$Cu[OH]_2$
Zinc Hydroxid	$Zn[OH]_2$
Ammonium Hydroxid	NH_4OH
Aluminum Hydroxid	$Al[OH]_3$

When a salt is formed from an acid and base, the metal of the base enters into the acid in place of the hydrogen, and the hydrogen combines with the Hydrogen and Oxygen of the base to form water (H_2O).

HNO_3 + KOH = KNO_3 + H_2O
Nitric acid — Potassium Hydroxid — Potassium Nitrat — Water

(Acid) + (Base) = (Salt) + (Water)

The same is true of the following:

H_2SO_4 + 2NaOH = Na_2SO_4 + $2H_2O$
Sulfuric acid — Sodium Hydroxid — Sodium Sulphat — Water

EXPERIMENT NO. 53

Pour 5 cc. of Ammonium Hydroxid (NH_4OH), 5 cc. of Sodium Hydroxid (NaOH), 5 cc. of Potassium Hydroxid (KOH), into separate test tubes and place in a test tube rack. Add about 5 cc. of water to each, and shake the contents.

Place a piece of both red and blue litmus paper (or litmus solution may be used, a drop being sufficient) into each tube and note the result.

It will be noticed upon the introduction of the litmus, that the blue paper (or solution) is unaffected, while the red paper (or solution) has turned blue. This is a characteristic of all bases, and is employed as a test for them.

After testing as above pour the contents out and rinse the tubes.

If we arrange the symbols of the above bases we have:

NH_4OH
NaOH

and

KOH

It will be noticed that the OH or hydroxyl is contained in all three. It will also be noted that the remaining portion, namely, NH_4, Na, and K, are metallic. That the bases turn red litmus blue.

SALTS

A salt is a substance composed of a metal or positive radical united with a nonmetal or negative radical. These compounds in some respects resemble common salt, that are formed by the replacement of the hydrogen of acids by metallic radicals, both simple and complex. They may be classified as Normal, Acid, and Basic salts, according to whether the hydrogen of the acid is completely or only partially replaced in the first two cases, or whether the Oxygen or hydroxyl groups of a base are only partially neutralized by an acid in the last.

A salt generally has an acrid taste.

Some salts are soluble, some insoluble.

Salts may be prepared by one of the following types.

1. Action of a metal on an acid. This, besides forming the salt, usually sets free hydrogen or some decomposition product of the acid produced by its action. For example, Zinc sulphat and copper nitrat are produced by the reactions;

Zn + H_2SO_4 = $ZnSO_4$ + H_2
Zinc — Sulfuric Acid — Zinc Sulphat — Hydrogen

and,

3Cu + $8HNO_3$ = $3Cu(NO_3)_2$ + $8NO_3$ + $4H_2O$
Copper — Nitric Acid — Copper Nitrogen — Nitrogen Monoxide — Water

2. Neutralization of an acid by a base, the latter being an oxid, hydroxid, ammonia, or similar substance. Thus lead chlorid, sodium acetat, and ammonium nitrat are produced by the reactions:

PbO + 2HC1 = PbC1$_2$ + H_2O
Lead Oxid — Hydrochloric Acid — Lead Chlorid — Water

NaOH + CH_3COOH = H_2O + CH_3 COONa
Sodium Hydroxid — Acetic Acid — Water — Sodium Acetat

NH_3 + HNO_3 = NH_4NO_3
Ammonia — Nitric Acid — Ammonium Nitrat

3. By the double exchange between two salts or an acid and salt, as in the preparation of Barium sulphat and Sodium hydrogen sulphat by the reactions:

Ba C1$_2$ + Na_2SO_4 = $BaSO_5$ + 2NaC1
Barium Chlorid — Sodium Sulphat — Barium Sulphat — Sodium Chlorid

NaC1 + H_2SO_4 = $NaHSO_4$ + HC1
Sodium Chlorid — Sulfuric Acid — Sodium Hydrogen Sulphat — Hydrochloric Acid

Other reactions forming salts are:—

Na_2O + H_2SO_4 = Na_2SO_4 + H_2O
Sodium Oxid — Sulfuric Acid — Sodium Sulphat — Water

Zn + H_2SO_4 = $ZnSO_4$ + H_2
Zinc — Sulfuric Acid — Zinc Sulphat — Hydrogen

$CaCO_3$ + 2HC1 = CaC1$_2$ + CO_2 + H_2O
Calcium Carbonat — Hydrochloric Acid — Calcium Chlorid — Carbon Dioxid — Water

When a salt is formed from an acid and

(*Continued on page 78*)

QUESTION BOX.

(*Continued from page 50*)

motor for a given service. There are three general classes of work performed by motors and these require the following conditions of torque and speed: (a) Constant torque at variable speed; (b) variable torque at constant speed, and (c) variable torque at variable speed.

Q. 3. What is the object of the commutating field produced by the interpoles of a motor?

A. 3. Its object is to assist commutation, that is to help reverse the current in each coil while short-circuited by the brush, and thus reduce sparking.

WIRING QUERIES.

(766.) W. Holsen, Buffalo, N.Y., desires to know:

Q. 1. What are the disadvantages of open wiring?

A. 1. The wiring is not sufficiently protected from moisture and the effects of fire which will destroy the insulation of the wires; it is also liable to mechanical injury.

Q. 2. How far apart should the wires be placed if open wiring is used?

A. 2. When installed in dry places and for pressures below 300 volts, the insulators should separate the wires 2½ inches from each other and ½ inch from the surface over which they pass. For voltages from 300 to 500 volts the wires should be separated four inches from each other and one inch from the surface along which they pass. When wiring in damp places or over metal ceilings the wires should be at least one inch from the surface.

Q. 3. How should wires be protected when run vertically on walls?

A. 3. They should be boxed in or run in a pipe. The covering should extend six feet above the floor.

RADIO-TELEPHONY.

(767.) Marion L. Brown, Oroille, inquires:

Q. 1. Please advise me as to whether the hook-up which I send you will work on 110 volts, alternating current, using an ordinary telephone transmitter. If this hook-up will not work, please send me a simple hook-up that will work on 110 volts A.C., using telephone transmitter and one that is inexpensive to make.

A. 1. The diagram of connections which you submit will not work satisfactorily and wish to inform you that in order to make a radiophone operate on A.C. that you connect the transmitter in series with the primary of the oscillation transformer. An ordinary microphone as employed in telephone practise will handle not more than one-half ampere, so that it will be necessary for you to confine your power below ½ K.W. If more power is to be controlled, then several microphone transmitters will be required in parallel and their mouthpieces brought to a single mouthpiece.

WAVE LENGTH PROBLEM.

(768.) Wm. H. Mansfield, Jr., Putnam, Conn., desires:

Q. 1. What is the wave length of an aerial 144 feet long, 50 feet high and a 70 foot lead-in? It is a three-wire aerial.

A. 1. The wave length of your aerial is 320 meters.

Q. 2. What is the wave length of an aerial 6 wires 30 feet high and 35 feet long?

A. 2. The wave length of this antenna is 110 meters.

Q. 3. What is the smallest sized spark coil an Oscillation Transformer can be used on efficiently?

A. 3. This will depend upon the antenna system and the wave length which you desire to tune. It may be said in general that two turns will be the least number that the coil will require. The primary winding has less turns than those of the secondary.

(*Continued on page 54*)

TRADE-MARK
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LENZITE CRYSTAL DETECTOR

Patented May 2nd, 1916

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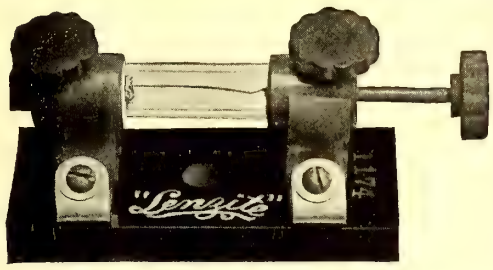
Why Is Our Detector Near Perfection?

If you want to have a perfect receiving detector, try ours. If not satisfactory, return same within thirty days and we shall be pleased to refund you the price.

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I found that the reception of signals with Lenzite as a detector quite beyond any hopes that I may have had.

Inasmuch as the mineral in question (Lenzite) seems to be "sensitive" nearly all over its surface on all sides, which is a very great advantage as it makes it almost as easy to keep in adjustment as an audion, and brings in the signals, when proper attunement is accomplished, in a very loud and positive manner, and I must add I was greatly surprised as it, without any question, has given me far greater results than any other sort of mineral detector I have tried, and I have tried to get all that I have been able to hear of.



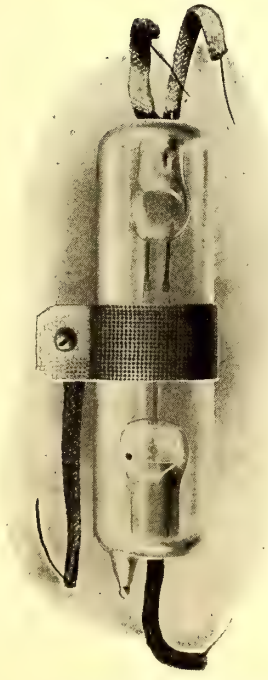
Its clear, loud, readable demonstrations should make it very desirable to operators whether or not they use audions, which consume power which Lenzite does not, and it is quite as good for long distance work as well. I shall be glad to tell others of it.

Very truly,
HERBERT W. BRISCOE.
(6 IH U. S. License.)

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This detector does not employ or incorporate an evacuated vessel containing three electrodes, namely, a filament, a plate, and a grid disposed between the filament and plate.

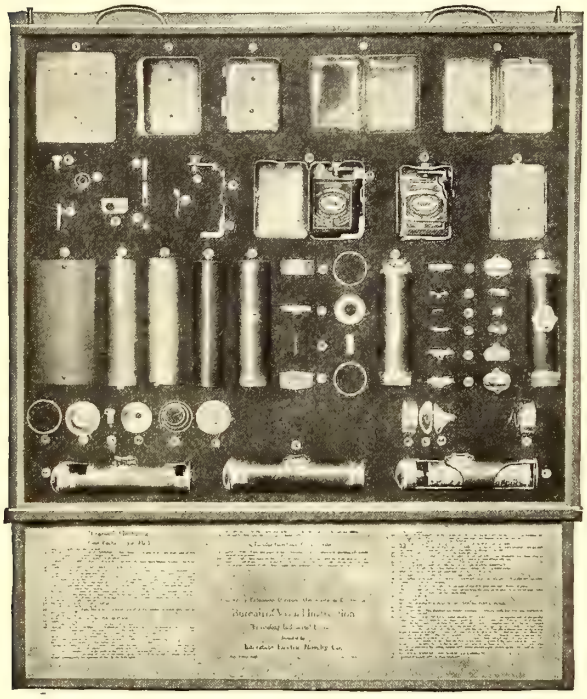
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THE STORY OF FLASHLIGHT MAKING.

All of us have undoubtedly found the electric flashlight extremely useful at some time or other, but very few people are privileged to know just how the flashlight is made. One of the leading manufacturers of these useful devices recently constructed a display board containing the essential parts constituting a complete flashlight, the appearance of which may be judged from the accompanying illustration. It was used by the bureau of visual instruction of the University of California as a traveling industrial exhibit. The upper two rows represent the various stages of manufacture thru which a coat pocket style flashlight passes. The lower three rows show the progressive steps in the making of a tubular flashlight. A similar visual exhibit prepared by the same concern showed in a striking and educational manner, the various stages of flashlight battery make-up; from the zinc plate to the assembled battery, consisting of two or more cells nestling comfortably in its paper carton.



Interesting Exhibit Which Tells the Story of Flashlight Making Grafically. Every Important Stage of Manufacture Is Clearly Shown.

The Detroit Edison Company has made a number of tests with different methods of electrically heating cars stored in unheated garages. Various means of heating insulated and uninsulated garages have been tried and experiments made with nearly all of the heaters sold for heating the engine itself. The results of these tests are now being worked up, and they will probably be presented in a paper at one of the conventions during the summer.

ELECTRIFYING THE AEROPLANE.

(*Continued from page 7*)

ward the exact amount which is likewise shown in degrees. The scale is coated with Radium paint so that it is visible at night by its own light.

One of the greatest problems of aeronautical engineering is that of making the aeroplane as safe as possible. Thousands and even hundreds of thousands of dollars have been spent in this direction and the nearest conclusion to this problem is the adoption of some automatic pilot, which will control the machine automatically in case the pilot is unable to get positive control of the machine.

The only real solution so far to this problem involves the use of the *gyroscope* and the work done by Mr. Elmer Sperry in this line gives much light to the solution. Fig. 5 illustrates the Sperry automatic pilot which relieves the pilot of the labor and drudgery in operating the controls of his machine. In the military aeroplane it renders it possible for the pilot to fulfill the duties of both pilot and observer. When dropping bombs it enables the pilot to bring the aeroplane laterally over the target, makes a reference plane of the aeroplane, which greatly increases the accuracy of bomb dropping, and creates a steady platform from which to fire and drop bombs.

The equipment consists principally of three units—the generator, servo motor and gyro unit —which may be likened respectively to the heart, muscles and brain of the human pilot.

The gyro unit which is placed in a metal case and shown in the background utilizes the gyroscopic effect of the four rotating gyros which it contains, in maintaining a horizontal reference plane. Any departure of the aeroplane for its set relation to this gyroscopic reference plane causes an electrical contact to be made which completes a circuit to one of the magnetic clutches in the servo motor. The case is equipt with a glass window to enable the operator to note the joperation of the four gyros. The power generated in the servo motor air turbine is now transmitted thru the engaged clutch to one of the drums over which the control wire passes.

The generator which is seen in the foreground of the photograph supplies alternating current for driving the gyros and direct current for the servo motor clutches. It consists of a double armature, one winding of which is tilized for the generation of the alternating current and the other for direct current. It is driven by means of an aluminum propeller driven by the air current. The four leads are run from the rear to the generator.

By means of a special set of clutches on the gyro unit, the operator can set the aeroplane to any position relative to the horizontal which he may desire, by simply pressing a button located conveniently on the manual control and moving his controls as tho no automatic pilot were installed on the machine. When the aeroplane reaches the desired altitude, the button is released and control is again given over to the automatic pilot, which will hold the machine in that altitude until altered by the operator.

Complete and unhampered control may be instantly resumed at any time by pressing on the push button on the controls.

WAR CONFERENCE WITH TELEGRAPH AND TELEPHONE OFFICIALS.

Messrs. Theo. N. Vail, president of the American Telephone and Telegraph Company; Newcomb Carlton, president of the Western Union Telegraph Company; Charles P. Bruch, vice-president of the Postal Telegraph-Cable Company; F. B. McKinnon, vice-president of the United States Independent Telephone Association, and N. C. Kingsbury, vice-president of the American Telephone and Telegraph Company, were in conference with war department officials at Washington on March 19 to perfect plans to insure the government rapid and efficient wire communication.

QUESTION BOX.

(*Continued from page 52*)

WAVE MOTORS.

(769.) G. H. G., Detroit, Mich., inquires as to the efficiency and practicability of wave motors:

A. 1. We do not know just now of any successful installation of such wave power plants as described in the February issue of this journal and while the initial cost of installing such a plant is not so prohibitive, there has always been more or less prejudice against them, owing to the fact that the power developed is so irregular.

There have been a number of attempts made by inventors to overcome this difficulty, but the fact of the matter remains that we have yet to see a practical installation of a wave motor on any large scale. The proposition to our mind seems to possess many practical and economic features, and it seems very likely that in later years a future generation may see the adaptation of wave motors to a very large extent.

You may obtain copies of the patents issued on this interesting subject by communicating with the U. S. Patent Office, Washington, D.C., and with these before you, you will be in a better position to see just what has been done and what has been proposed in solving this problem.

CONDENSER IN AERIAL CIRCUIT.

(770.) Anthony S. Detrees, Hartford, Mich., asks:

Q. 1. Can a series condenser be used successfully in connection with a transmitter, to reduce the natural wave length of an aerial from 325 to 160 meters?

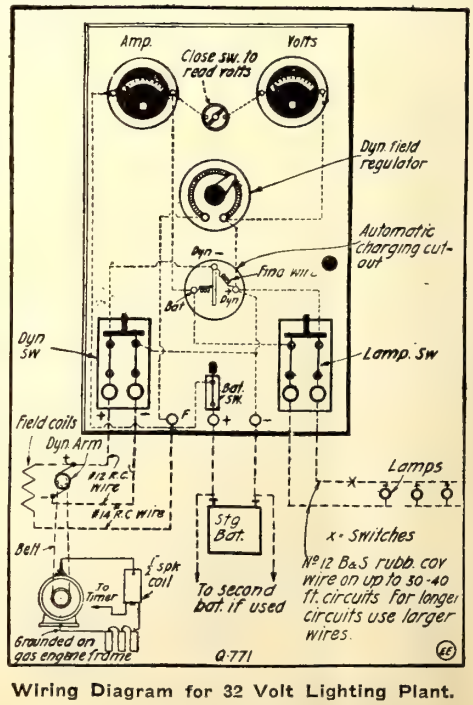
A. 1. Yes.

Q. 2. Would such an arrangement result in low efficiency in transmitting?

A. 2. The addition of a condenser in series with the antenna circuit increases considerably the amount of losses and at the same time increases the decrement due to an increase in antenna resistance by the series condenser.

32 VOLT LIGHTING PLANT.

(771.) U. J. Grant, Apple Creek, Ohio, writes:



Wiring Diagram for 32 Volt Lighting Plant.

Q. 1. I would like to have a wiring diagram for a 32 volt isolated lighting plant with the following apparatus: ¾ K.W. generator, 32 volt 60 ampere-hour storage battery, switchboard with voltmeter, zero-center ammeter showing charge and discharge, circuit-breaker, regulating rheostat for generator and proper fuses and switches.

A. 1. The accompanying wiring diagram gives the connections of a complete 32 volt lighting plant.

Q. 2. What is the wave length of my inverted "L" type aerial, composed of one wire 400 feet long, 70 feet high at one end and 40 feet at the other, with 30 feet lead-in and 20 feet ground (No. 4 copper wire)?

A. 2. The wave length of your antenna is 617 meters.

DYNAMO QUERIES.

(772.) George Ledly, Cleveland, Ohio, desires to know:

Q. 1. Can a 12 volt, 9 ampere dynamo, such as the "Electro" Hercules charge successfully two 6 volt, 100 ampere-hour storage batteries in series?

A. 1. Yes. They should be connected in parallel, however.

Q. 2. Can a 25 volt, 4 ampere dynamo be run in series with four 6 volt 100 ampere storage batteries to produce 50 volts?

A. 2. Yes, providing that the batteries are fully charged. It would be advisable to employ an underload circuit breaker in the storage battery side so that they will be disconnected when they are in a discharged condition, thus preventing the charging of the battery by the dynamo in an opposite direction, in this way preventing the plates from being ruined.

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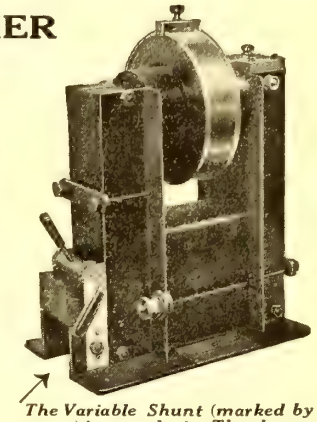
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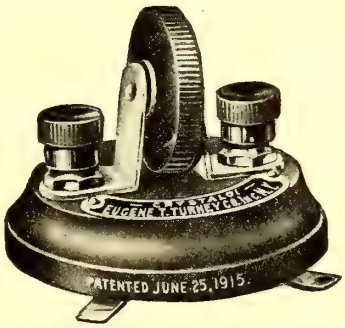
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INDIRECT LIGHTING.

(773.) J. Andrews, San Francisco, Cal., inquires:

Q. 1. What is meant by indirect lighting and what are its characteristics?

A. 1. Indirect lighting as the name signifies is illumination in which the light comes to the working plane indirectly. The light of the lamp is directed at the ceiling by suitable reflector appliances, and from there is diffusely reflected into the room, making the ceiling a secondary light source.

The enlarged low brilliancy source of light, the ceiling, produces a highly uniform and diffuse illumination, free from glare. Shadows are softened and merge very gradually into the brighter areas. There is practically no glare or reflection from glossy surfaces. Recent tests apparently confirm the general belief that indirect lighting requires minimum intensity of illumination for comfortable vision and causes very low fatigue of the eye as a result of several hours' work.

Q. 2. What are the chief considerations in planning an adequate lighting installation?

A. 2. Planning a lighting installation is a complex problem, requiring due consideration of a number of factors. The intensity of illumination must be ample for clear comfortable vision; the distribution must be nearly uniform over the working plane. The color of the light must be suitable for the class of service, and the taste of the individual and the diffusion must be satisfactory for the class of service. The sources of light must be placed well above the range of vision and the intrinsic brilliancy reduced by the use of diffusing glassware or indirect reflector equipment; shadows on the working plane must be softened and toned down so as not to be too abrupt and for drafting rooms, operating rooms, etc., practically eliminated; objects capable of high specular reflection (glossy objects) should be removed from the range of vision.

POWER HOUSE PROPOSITION.

(774.) Paul Wheadon, New Brunswick, Ga., wants:

Q. 1. What types of power houses are used by large factories as we desire to equip our plant with an electric equipment?

A. 1. There are several types in common use. Some factories use 125 volts direct current. However, 220 volts direct current is popular among steel mills. The larger ones sometimes use 500 volts. Alternating current is largely used, induction motors being employed to drive machines or line shafting. Cranes are mostly operated by direct current, altho alternating current may be used for this purpose.

Q. 2. What arrangement of excitation is customary?

A. 2. Direct current generators are usually self-excited. Alternators usually require separate excitation which is had from a relatively small direct current generator. It is preferable that the exciters should have a separate prime mover if space economy is possible, tho many exciters are driven by the same engine that drives the main generator.

Q. 3. What considerations determine the voltage of a transmission line?

A. 3. The voltage of a transmission line is found by a careful study of the advantages of very high voltages in permitting the transmission of a large amount of power on a small conductor; the advantages of lower voltages because of the greater ease of insulating, the distance to be covered and the nature of the country thru which the line is to be run. Due consideration is also given to the first cost of power. If it is obtained from water power or from very cheap coal, it may be best to design for relatively high line losses. If coal is transported a long distance, it is therefore expensive, and the line must be designed for low losses. Each case requires special study by experts.

INDOOR AERIAL.

(775.) Mr. Shane, Grand Rapids, Mich., says:

Q. 1. Kindly let me know what an indoor aerial is made up of and the distance one can hear with the same.

A. 1. An indoor aerial is nothing more than an ordinary antenna which is erected indoors. The distance which one can receive with such an antenna depends entirely upon the sensitivity of the instruments used with this type of aerial.

Q. 2. Kindly let me know where I can get full set of rules in reference to size and power receiving and sending set the Government will allow one to have and what is necessary to pass examination to allow a large set to be erected?

A. 2. We advise you to communicate with the Radio Inspector of your district who will give you all the information you desire.

Q. 3. Kindly let me know if it is always necessary to have a wire run all the way down to the earth to make a ground and if one is in a hotel on the ninth floor or higher up, how he can make a ground without having to let a wire down to the street at the same time wanting it to be safe from all danger to property or in case of lightning and if the apparatus will be just as efficient in receiving.

A. 3. It is not necessary to run a wire down to the ground if a water or gas or even a radiator pipe is located near the station. However, in erecting a lightning ground it is necessary for you to wire from the lightning switch to the outside ground, which must connect from the ninth floor as in your case. The sensitiveness of the receiving outfit will not be lowered by this ground.

RECEIVING RADIUS.

(776.) Harry Cate, Chattanooga, Tenn., inquires:

Q. 1. Can a loose-coupler, a tuning-coil and a loading-coil all be used together successfully?

A. 1. Yes; providing they are properly connected.

Q. 2. What would be the range of the following set with an aerial 45 feet long and 40 feet high if question (1) is correct; a small tuning coil (E., I. Co.'s "Electro" tuning coil), a small loose coupler (E. I. Co.'s "Electro" loose coupler); loading coil with wave-length 5,000 meters, galena detector, 2 fixt condensers and 3,000 ohm head set.

A. 2. The approximate receiving range of your apparatus is 1,500 miles.

SERIES CONDENSER.

(777.) John Huether, Sharon, Pa., inquires:

Q. 1. Is it necessary to use a series condenser with a transmitting set on an aerial 75 ft. long and 55 ft. high?

A. 1. A series condenser in the transmitting circuit is not necessary if the set is tuned to its natural period of 200 meters as permitted by the Government. With the aerial you possess it will not require a condenser in series.

Q. 2. Are you allowed to have an input of over 9.1 amperes on a 1 K. W. transformer to comply with Radio Regulations, or can you have whatever input the transformer will draw? (Operated from 110 volts A. C.)

A. 2. 9.1 amperes of current at 110 volts A.C. is just permissible. However, we would advise that the transformer should be operated on 9 amperes so as to be on the safe side.

HYDROGEN GENERATION.

(778.) W. H. Allum, Quebec, Canada, asks:

Q. 1. Would it be practical to make a small apparatus to generate hydrogen gas by the decomposition of water by direct current if so, kindly send me a rough sketch of apparatus mentioned.

A. 1. The most practical and inexpensive method of generating hydrogen gas is by the decomposition of water by a direct current. In this work, it is essential not to employ too great a voltage, but a large current. There has been a large number of different types of hydrogen generators developed but the one described on page 547 in February, 1916, issue of this journal will be found most suitable for the making of a small machine. Not only will you be able to obtain hydrogen gas but at the same time and with the same current and water you will obtain oxygen gas.

Q. 2. Would hydrogen gas generated in this manner burn by itself, the flame to be used for the purpose of lead burning in connection with the repair of storage batteries and lead containers for the same? I have access to 125 volt D.C. up to 60 amperes.

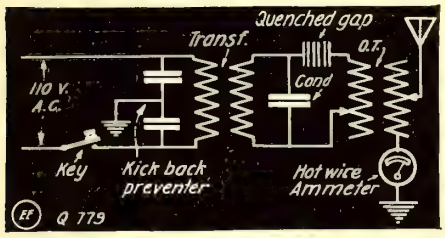
A. 2. The hydrogen gas generated by this electrical method will be required to be combined with oxygen making the so-called oxy-hydrogen blow pipe. This oxygen will be obtained from the same generator. The gas produced will be required to be collected in some reservoir chamber equipt with proper safety valves.

Q. 3. Has this gas any injurious effect on metals; if so what metals are suitable for the construction of such apparatus.

A. 3. Hydrogen gas has no injurious effects upon metals, but when combined with oxygen and ignited they will be molten as it produces terrific heat, the value of which is next to that of the electric arc.

TRANSMITTING SET.

(779.) F. Gibbons, Toronto, Ont., asks:



Correct Hook-Up for Quenched Spark Radio Transmitting System.

Q. 1. What instruments are required to make a transmitting set efficient? How do you connect them?

A. 1. The following instruments will be required and operated on 110 volts alternating current: ½ K.W. 10,000 volt transformer, kick-back preventer shunted across the primary of the transformer, heavy key, high tension condenser having a capacity of .015 microfarad, 5 section quenched spark gap, oscillation transformer and hot wire ammeter used for indicating the amount of radiation in the antenna system. The connections of the instruments are given here. With the above mentioned instruments and an aerial composed of 6 wires 50 feet long and 60 feet high, you should have no trouble in covering a distance of 80 to 100 miles.



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RADIO WIRING DIAGRAM.

(780.) EXPERIMENTER Reader, Pleasant Plains, Ill., desires:

Q. 1. Please give me a diagram of the following instruments for both damped and undamped wave reception: Loose coupler, loading coil, Audiotron bulb, galena detector, buzzer and push button, two variable condensers, 'phones and a large loose coupler for undamped waves. Please give necessary switches for changing from damped to undamped for either detector, and for using the variables on either the damped or undamped set. Also the necessary loading inductances in the undamped circuit if there has to be any.

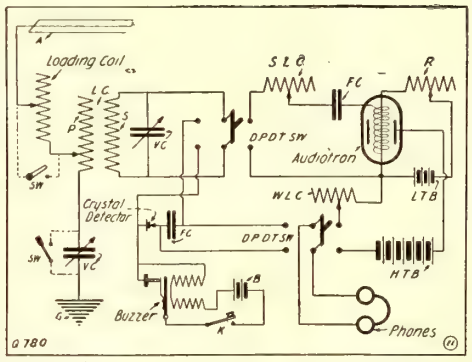
A. 1. We give herewith a complete wiring diagram of a damped and undamped receiver, showing the necessary switches.

Q. 2. Could this set receive music on the undamped wave? If not, please tell me how?

A. 2. Yes, providing the Audiotron tube is set oscillating.

Q. 3. The probabilities of Congress putting a stop to, or shutting down the Amateur stations of the United States?

A. 3. The 1912 radio law provides that the President has authority to close all radio stations in case of war.



Hook-up for Audion and Crystal Detectors to Be Used in Receiving Damped and Undamped Radio Signals.

AUTOMOBILE SPARK COIL.

(781.) Leo Peterson, Thorsby, Ala., wants:

Q. 1. Would an automobile coil with three binding posts giving a spark ¼ inch long work all right for wireless?

A. 1. It will work satisfactorily for transmitting a short distance.

AEROPLANE RADIO GROUND.

(782.) George Sloan, St. Louis, Mo., writes:

Q. 1. I would like to know the address of Dr. Nikola Tesla.

A. 1. The address of Dr. Nikola Tesla is 8 West 40th St., New York.

Q. 2. How do aeroplanes get a ground for their wires.

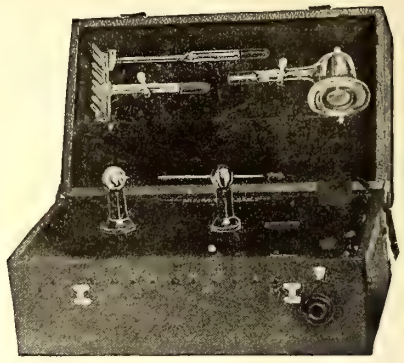
A. 2. By suspending a wire from the aeroplane which trails behind the machine.

RADIO ARC TRANSMITTER.

(783.) Mr. ———, Pittsburgh, Pa., asks several questions regarding an article on an Arc Type Radio Transmitter by Mr. Gordon C. Farmer, which appeared in the February issue:

A. 1. It is possible to obtain a fairly high note with such an arc transmitter, especially if the arc is shunted with a suitable tone circuit after the method of Von Lepel. You might use a 43 plate Murdock variable condenser or the equivalent, providing the plates are immersed in oil. The size of the plates in the arc would remain the same for mica instead of paper; paper has been found best for this

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PRICE LIST—Smooth Wound Wireless Tubes

Outside Diam.	Lgth.	Price	Par. Post
3	x 7½	.12	.18
3½	x 7½	.12	.18
4	x 7½	.15	.22
4½	x 7½	.20	.27
5	x 7½	.25	.31
5½	x 7½	.25	.33
6	x 7½	.30	.37

GENERAL INFORMATION
These prices include PARCEL POST CHARGES; and are shipped at once on receipt of order and remittance.
We CANNOT furnish these tubes in longer lengths than 7½" unless ordered in quantities of 100 of a size.
We CAN furnish SPIRAL WOUND TUBES in any length up to 45 inches at .02 per inch in the following inside diameters, 3½-4-4½-5-6.

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purpose after exhaustive experimentation. The paper is pierced with a pin-hole at the center when assembling the arc gap, and also it is extremely important as to just what kind of paper is employed—one of the best papers for the purpose having been found to be a certain kind of water line bond. The editor of this column does not recollect just now as to who made this paper, but you can obtain the name of the concern supplying this particular writing paper by communicating with the Institute of Radio Engineers, New York City.

An arc may be started with 500 volts using a small gap of 1/100 inch or so, especially where the circuit is made and broken by a quick break switch. The transformer described by Mr. Farmer would be rated at about one-half kilowatt.

FORMULA AND RECIPE BOOK.

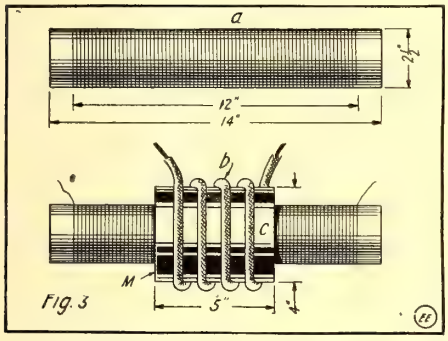
(784.) Tom Otis, Cedar Rapids, Iowa. writes for information on a book containing formulas and recipes:

A. 1. You will find books containing several hundred different formulas listed in our Book Catalog, which we shall be pleased to forward you on request. We shall also continue to publish a number of these formulas monthly in THE ELECTRICAL EXPERIMENTER.

ELECTRICITY AND LIFE.

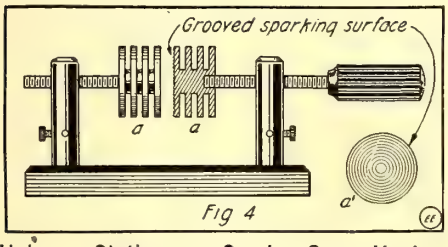
(*Continued from page 24*)

like discharge three feet in diameter (Fig. 1), and gives a heavy arc over two feet in



How Small Size Tesla Coil for Medical Treatment Is Built; "b" Is the Primary, "a" the Secondary.

length. (Fig. 2.) This shows remarkable efficiency when it is considered that the resonator is excited by a "Type E" transformer drawing only 1 K.W. and a con-



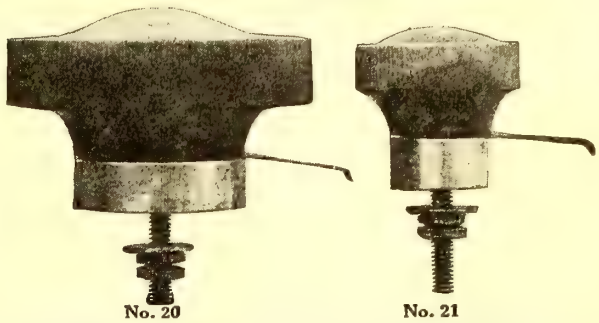
Unique Stationary Spark Gap Having Grooved Faces, as Devised by Dr. Strong.

denser of but .01 m.f. capacity. A small rotary spark gap is used such as is supplied by the E. I. Co. This result is made possible by the use of the separate inductance in series with the resonator primary (exactly the same as that described in connection with the therapeutic apparatus) (d Fig. 8). The writer believes his resonator gives the most spectacular discharge ever obtained from 1 kilowatt of energy.

Ordinary plate condensers are used, made from 8 x 10 inch negative glass, coated on both sides with tin-foil 6 x 8 inches (a Fig. 7). Six pairs of plates assembled into a

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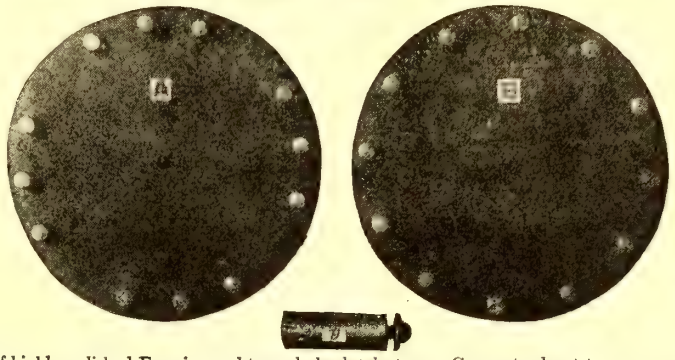
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" 21 " " - - "	36.00	x 1-4 tapped 6-32 - per 100	$1.75
" 1 Knob only - - - - - "	30.00	" 14 Brass contacts 5-16 in.	
" 2 " " - - - - - - "	15.00	x 5-16 tapped 6-32 - "	2.50

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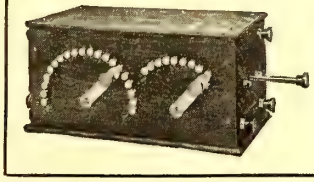
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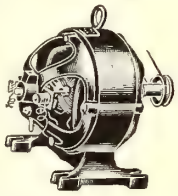
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The gap is enclosed in a circular iron housing 8 inches in diameter and 2½ inches thick, with removable cover (for inspection). The adjustment can be as close as desired between sparking points.

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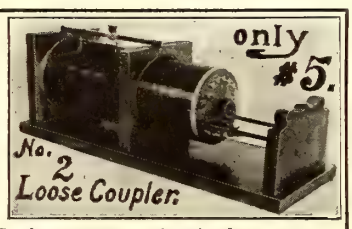
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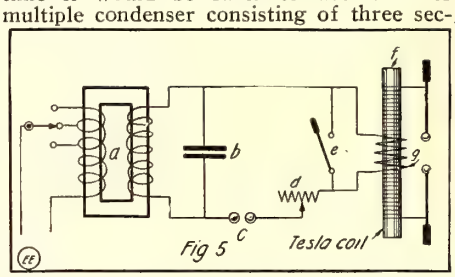
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unit and boiled in wax give a capacity of .01 m.f. For safety it is better to employ four of these sections connected in pairs of .02 m.f. each (b Fig. 7). To run this resonator at full power for long periods of time it would be safer to use a series multiple condenser consisting of three sec-

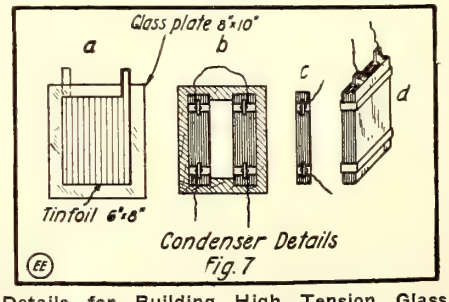


Connection Scheme for Tesla Coil "f—g," Shorting Switch "e," Tuning Inductance "d," Spark Gap "c," Condenser "b" and Step-up Exciting Transformer "a."

tions of .03 m.f. each in series. Such a condenser would contain 108—8 x 10 inch plates, and would be expensive, bulky and very heavy. For this reason the writer has found it much more convenient to use a single 12 plat (.01 m.f.) condenser across the transformer secondary and to replace it when it punctures. The large resonator was operated for six months in lecture and experimental work before a condenser section broke down.

The cone for the secondary of the large resonator is of hea paperboard and was built for the author by Bicknell and Fuller of Boston. Its dimensions (see Fig. 6) were suggested by Mr. Earle L. Ovington, the cone being similar in shape to those used by Mr. Ovington in the New York Electrical show several years ago. Any amateur can make a cone of this kind by superimposing strips of heavy paper, soaked in paste, over a wooden framework. The secondary winding consists of 400 turns of No. 27 D.C.C. copper magnet wire. Two parallel strands of wire are wound onto the cone, the adjacent turns in contact; after winding, one strand of wire is removed, leaving a space equal to the diameter of the wire between each of the 400 turns. The cone and winding is then treated with several coats of *"Armalac"* (ordinary shellac will not answer).

The primary consists of five turns of thin copper ribbon 1 inch wide, ⅛ inch paperboard strips being placed between the turns. The diameter of the coil is 24". When completed it is taped and rotated in a pan of melted wax until thoroly impregnated. The terminal shown in the photographs is made from a large brass oilcan, the stem being removed and replaced by a 3" brass "bed-ball." The terminal is not attached to the cone but simply rests on its upper surface in contact with the end of the secondary wire. The primary and secondary are separately supported by



Details for Building High Tension Glass Plate Condenser to Be Connected in Tesla Coil Circuit.

quare wooden blocks; the coupling is rather loose, the bottom of the resonator being at least two inches above the primary. The lower end of the secondary coil is attached to the inner primary terminal and grounded.



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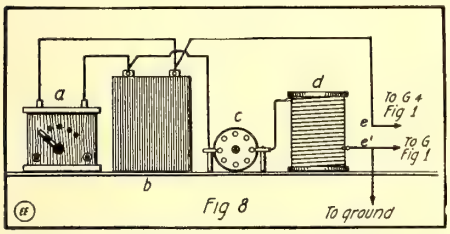


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The author is greatly indebted to Mr. O. K. Luscolm, for advice and assistance which made possible the successful construction of the large resonator.



Method of Connecting Transformer, H. T. Condenser, Rotary Spark Gap and Tuning Inductance "d" to Large Oudin Coil.

At a recent lecture before the Belfast Association of Engineers Mr. A. W. Brown suggested the transmission of power generated from the tidal rise and fall of the water at Strangford Lough and Lough Neagh to Belfast. Thus, at Strangford Lough there are twenty square miles of water available, the spring tides have a rise of 14½ feet and the neap tides a rise of 11½ feet, with a range of 7½ feet. About 20,000 horsepower could be developed for a period of two and one-half

THE WASHINGTON'S BIRTHDAY RELAY PRIZE WINNERS.

(*Continued from page 23*)

live in a state that has as much real earth in it as is blown into the air in some of our larger states during every wind storm!

These few think they are very important and if you don't do as they say, why the Government will close you up. They say "The Danger Signal is up." Did you ever hear of a good, red-blooded American Kid who could be bluffed? No! It is not in your make-up. The Government is only too anxious for you to perfect yourself in the art, and help it out by joining the "Radio Reserves."

PRIZES.

This is a stunner for one who would like to give everybody that helped a prize, but it can't be done, so I am going to ask the boys who acted as sending stations to consider that they are one of the family and help me by agreeing that the prizes should go to the boys who made the best records in receiving and delivery. The rest of the amateurs will be rewarded by having their names printed in this magazine, so that when you grow older and have a little one on each knee in front of the old log fire, some cold night, you may read to them about Daddy and what he did when he was a mere boy.

Before you all get busy reading about the prize winners, I want to call your attention to several hard workers who turned in the most complete reports, or "logs," of the relay, that the writer has ever had the privilege of reading.

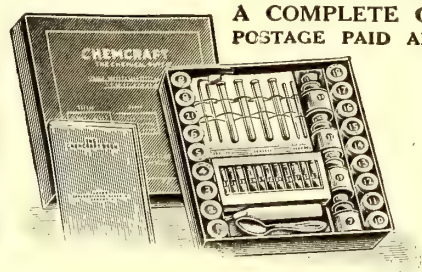
Hoyt, of Hayward, California, 6 SI, who is also a prize winner, turned in the most complete report ever seen.

Stewart of St. Davids, Pennsylvania, 3 ZS, whom you all know as one of the hard hours, the power available varying from maximum to minimum every six hours. workers of the Radio Association of Pennsylvania, turned in a truly wonderful report, but he stayed up till nearly 6 a.m. the next morning, boys, and from the looks of his "log," he went to sleep with the pen in his hand. It really only took me about *two hours* to digest this report.

Emerson of Dallas, Texas, 5 DU, as ex-man-o-warsman, turned in a regular Navy Report, brim full of interest and curt reports. He, too, along about the dog watch, evidently slept on duty. Bet

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he is glad he wasn't aboard the good ship "Hardship," as they shoot men in wartime for sleeping on duty. He was right on deck tho, all the time, and the writer could clearly read his calls to 9 ZF and answers to the boys east.

The boys of the San Francisco Radio Club also made splendid reports, as did also our College Professors, who are always with us.

A perfectly legal report was also received from a staid old lawyer in Jacksonville, Fla., who prefaced his letter with the remark that he was not trying for a prize, but being a "Radio-Bug," he just could not keep still.

A well known D. D. S. in Elmira, also sent in a very complete report and called it a great night's work.

I just compared two interesting letters from one amateur.

1916. He was diligently stabbing a piece of galena and complaining about his vibrator sticking on his one inch coil. Said he did not get M.S.G. but thought he would report anyway.

1917. He sent me a list of stations he hears, as long as your arm, and he is now sporting a one K.W. and working as a star relay station, 1,000 miles being as nothing to him. I heard him from my station—clear, quick sending; prompt business-like signatures, and abbreviations that went clear over my head. "The world do move!"

PRIZE WINNERS.

Mr. E. B. Duvall and Mr. A. P. Smith are awarded the prize of the Electro Importing Company—their *"Nauen POZ" Radio Receiving Set!* These young men operate jointly the Radio Station, 3 AK, in Baltimore, Md. This prize is awarded for the quickest delivery of both messages, and particularly in being on the job for the return M.S.G. No one but the sending stations east of 9 ZF knew when the east bound M.S.G. was coming thru. If this had been a real emergency call for Government help on 200 meters, these same fellows would have landed the message just the same. Congratulations to them.

SECOND PRIZE.

Mr. W. B. Pope, 4 AA, of Athens, Georgia, is awarded the *Professional Wave Meter,* donated by the Electro Importing Company of New York. It was awarded for long distance reception, prompt business-like delivery, and for perfect indexing, timing and marking both east and westbound messages, received in approved commercial style. From a study of the Q.R.M. map, he was seriously handicapped on both messages, and is heartily congratulated by the writer and all good radio "sports."

THIRD PRIZE.

Kenneth Briggs of Rochester, N.Y., 8 MG, whom you all remember as almost catching up with C. E. Hughes, the presidential candidate, with a copy of the Relay Message on October 27th, 1916, is awarded the *One K.W. Thordarson Transformer,* donated again by the Thordarson Transformer Company of Chicago, thru their Mr. Connors. Mr. Briggs is congratulated on his persistency, good receiving, prompt delivery and true American spirit, as he showed not the least jealousy toward several who were working against him. The Q.R.M. map showed marked interference, particularly on westbound messages, and he can thank the Q.R.T. of W. C. Ballard, Jr., at Cornell College, 8 XU, for giving him the chance to win this prize. I hope he will perfect his sending apparatus, and line up with the Q.R.M. League.

FOURTH PRIZE.

Scott High School of Toledo, Ohio, is awarded the William B. Duck's celebrated *Arlington Tuner;* for long distance reception with moderate apparatus; diligent and persistent listening for the return message and very complete business-like report.

FIFTH PRIZE.

Leander L. Hoyt of Hayward, Cal., 6 SI, is awarded the *Chambers No. 749* tuner for the reception of arc and spark signals. This prize is awarded for the long distance work and incessant effort to line the boys up in that neighborhood to a realization that, for once, California would be put on the Relay Map. Mr. Hoyt, besides, turned in one of the most wonderful and complete reports on everything of importance that happened, from the moment the westbound M.S.G. left New York, until the eastbound message arrived in the same city. The absence of jealousy shows he is a real man—an American—and one from whom we will hear more later on. To satisfy you all, we will publish this report in this magazine, if Mr. Hoyt's permission to do so may be obtained later. We most earnestly hope Mr. Hoyt will not find as much real cause for worry when listening in on the wave lengths from 6,000 meters up as he heard during the relay from 600 meters *down.* California is surely lined up now for good work with such fellows as 6 EA for sending L.D. and 6 SI for detail work. Mr. Hoyt will make a valuable addition to the Q.R.M. League.

SIXTH PRIZE.

Mr. and Mrs. C. Candler—8 NH, whom you all know and have heard, are located in St. Mary's, Ohio, but their "Sigs." do not stay at home. During the Presidential Relay, this station received six hard-earned credits and later stated that their transformer was not working right. They surely proved this during the last relay, as their "Sigs." were everywhere, and if it had not been for this station, lots of stations south and west would never have received the Westbound M.S.G. at all. Some who did not know 8 NH was supposed to help on relay, reported him as Q.R.M. When you all get your stations arranged so that you can Q.R.M. boys 1,000 miles away, you are sure on the trail of efficient long distance work.

This station is awarded the prize of the

"Geyser" Electric Water Heater



INSTANTLY
The Hot Bath is Ready

Continuous Flow of Water as Desired. Always Ready.

You only pay for electricity as used. All water that passes through the "Geyser" is thoroughly sterilized. The "Geyser" is perfectly insulated and is absolutely safe, no danger of short circuiting or electric shock.

Cold to Hot Water by Merely Turning Handle.

Both the water and the current act together and both controlled by the *movement of the faucet handle.* To secure hot water turn handle to the left, for cold water turn to the right, at the center both the water and current are shut off.

The Supreme Court has decided that we control the absolute right to the manufacturing of "Geyser" Electric Water Heater. Others take warning, as we will prosecute any infringing on same. Write us today to send you full information

FELDMAN MFG. CO., Inc. **1514 Times Building, New York**

Perfection Radio Laboratory of Clinton, Iowa. *One Short Wave Amplifying Tuner.* The writer used a tuner of this make during the last relay and could hear the "Sigs." of 4 CL and 2 PM, very Q.S.A. It is a very small and compact affair and am sure 8 NH will find it a most valuable addition to their station. The owner or maker of this apparatus calls it a "Cow Sucker." It is the most sensitive and reliable receiver the writer has ever used.

SEVENTH PRIZE.

O. R. Terry, Stoughton, Wis., is awarded the prize of the Manhattan Electric Supply Company of Chicago. This is a pair of *3,000 Ohm Mesco phones.* They are dandies, and the writer has been using a pair for the last year. Mr. Terry made a creditable report and great record for receiving thru Q.R.M. of the worst kind.

EIGHTH PRIZE.

The Phoenix Radio Club of Phoenix, Ariz., is awarded the donation of Mr. Philip E. Edelman of St. Paul, Minn. This is his latest book, *"Experimental Wireless Stations,"* and it is a wonder how so much useful information has been crowded into such a compact space. This book will put Arizona on the wireless map forever, and the prize is awarded for long distance reception, cooperation in the relay, and real genuine American patriotism in keeping quiet when necessary.

INSTRUCTIONS.

The prize winners may obtain these prizes by writing to the above Donees and giving your name and address, and referring to this issue of THE ELECTRICAL EXPERIMENTER.

Q.R.M.

There is not enough space in this magazine to report all Q.R.M., but some of it was intentional, and the writer does not care to stir up any ill feeling by publishing it. If you are interested in knowing, however, who deliberately Q.R.M.'d the stations in Connecticut and Massachusetts at 10:35 p.m., the night of February 24, 1917, write to 1 IZ—R. T. St. James, Great Barrington, Mass.

PERFECT SCORES.

Below you will find the names of the boys and stations that made "perfect scores."

ARKANSAS.

John M. Clayton, 5 BV, Little Rock

ARIZONA.

R. A. of Arizona, 6 FD, Phoenix
L. E. Glenn, 6 IT, Alhambra
J. Giraud, 6 EO, Phoenix
R. Higgy, 6 DM, Phoenix

COLORADO.

E. F. Doig, 9 ZF, Denver
W. H. Smith, 9 ZF, Denver

CALIFORNIA.

Seefred Bros., 6 EA, Los Angeles
L. Lynde, 6 UG, Long Beach
C. H. Hirst, Stanford University
F. Terman, 6 FT, Stanford University
L. L. Hoyt, 6 SI Hayward

CONNECTICUT.

H. Haugh, HH, Derby

DAKOTAS.

M. Tuve, MT, Canton, S.D.
P. C. Green, PG, Aberdeen, S.D.
D. Cottam, DCL, La Moure, N.D.
E. Worthington, 9 APG, Aberdeen, S.D.
E. R. Issak, 9 TZ, Eureka, S.D.
A. Shaw, AS, Parkston, S.D.

FLORIDA.

J. C. Cooper, Jr., Esq., 4 EI, Jacksonville
C. M. West, U.S.N., St. Augustine

GEORGIA.

D. L. Gaston, CWW, Commerce
A. F. Hood, CWW, Commerce

Super-Sensitive Microphone Only $6

This instrument is offered at an extremely low price. It is excellent for building your own radio amplifier. Can also be used in many experiments where a sensitive microphone is required.



DETECTAGRAPH, $12

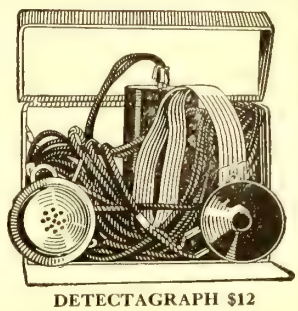
This detecting instrument of marvelous sensitivity can be used for detecting secret conversations. Outfit consists of Sensitive Transmitter, 25-ft. Black Cord, Receiver, Headband, Case and Battery.

Send for One Today and Convince Yourself

MICROPHO-DETECTOR COMPANY

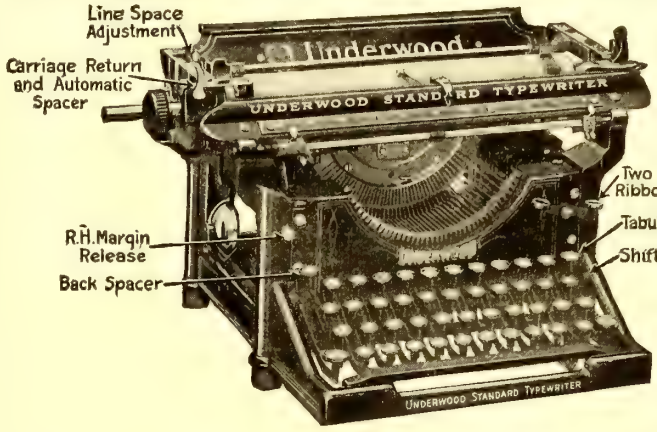
GASTON BOISSONNAULT, - President

119 NASSAU STREET, NEW YORK



DETECTAGRAPH $12

Makers of Super-Sensitive Microphone Apparatus



I want, through this advertisement, to establish as friendly business relations with you as I possibly can. I want you to realize also, that it is my earnest effort and intention to give you full, honest value for every dollar that you spend with me. This is the only way I can ucceed. My advertisement has appeared in this magazine continuously for more than four years.

I am building up my business on the foundation of good value and square dealings. I am saving thousands of satisfied customers thousands of dollars by supplying perfect —late style—visible writing—typewriters, at remarkably low prices.

All my transactions are handled throughout by personal correspondence. I assure you every courtesy and consideration in your dealings with me. Your order will have my prompt, careful, personal attention. I will be glad to do business with you.

Harry A Smith

ALL LATEST IMPROVEMENTS

TYPEWRITER SENSATION

Free TRIAL—Use as You Pay

Send me only $3.00 a month until the low total price of $49.15 is paid, and the machine is yours

This is absolutely the most generous typewriter offer ever made. Do not rent a machine when you can pay $3.00 a month and own one. Think of it—Buying a $100.00 machine for $49.15. Cash price $46.45. Never before has anything like this been attempted.

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Perfect machines, Standard Size, Keyboard of Standard Universal Arrangement, writing the full 84 characters—universally used in teaching the touch system. **The entire line of writing completely visible at all times,** has the inbuilt tabulator, with billing devices, the two-color ribbon—with automatic reverse and key controlled shift, automatic flexible paper feed—automatic paper fingers the back spacer—roller bearing carriage action —in fact every late style feature and modern operating convenience. Comes to you with everything complete, tools, cover, operating book and instructions, ribbon, practice paper —nothing extra to buy. **You cannot imagine the perfection of this beautiful reconstructed typewriter until you have seen it.** I have sold several thousand perfect latest style machines at my bargain price and everyone of these thousands of satisfied customers had the beautiful, strictly up-to-date machine on 5 days' free trial before deciding to buy it. I will send it to you F.O.B. Chicago for five days' free trial. It will sell itself, but if you are not satisfied that this is the greatest typewriter you ever saw, you can return it at my expense. You won't want to return it after you try it—**you cannot equal this wonderful value anywhere.**

You Take No Risk—Put in Your Order *Now*

When the typewriter arrives deposit with the express agent $7.15 and take the machine for five days' trial. If you are convinced that it is the best typewriter you ever saw, keep it and send me $3.00 a month until my bargain price of $49.15 is paid. If you don't want it, return it to the express agent, receive your $7.15 and return the machine to me. I will pay the return express charges. **This machine is guaranteed just as if you paid $100.00 for it.** It is standard. Over one hundred thousand people own and use these typewriters and think them the best ever manufactured. **The supply at this price is very limited, the price will probably be raised when my next advertisement appears, so don't delay. Fill in the coupon today—mail to me—the typewriter will be shipped promptly.** There is no red tape. I employ no solicitors —no collectors—no chattel mortgage. It is simply understood that I retain title to the machine until the full $49.15 is paid. **You cannot lose. It is the greatest typewriter opportunity you will ever have. Do not send me one cent. Get the coupon in the mails today—sure.**

HARRY A. SMITH

738–231 N. Fifth Avenue Chicago

H. A. SMITH
Room 738
231 N. Fifth Ave.
CHICAGO, ILL.

Ship me the UNDERWOOD F.O.B. Chicago, as described in this advertisement. I will pay you the $42.00 balance of the SPECIAL $49.15 purchase price at the rate of $3.00 per month. The title to remain in you until fully paid for. It is understood that I have five days in which to examine and try the typewriter. If I choose not to keep it, I will carefully repack it and return it to the express agent. It is understood that you give the standard guarantee for one year.

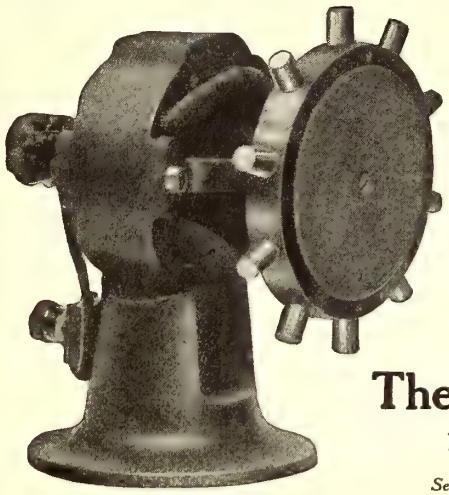
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A Motor and a Rotor for $5.25

We have built 5000 of these outfits, consisting of a motor that will operate on a. c. or d. c., 5000 to 6000 r. p. m., 100 to 130 volts.



One-half actual size

An aluminum rotor, perfectly balanced, machined and insulated.

Regular price of these outfits, $8.50

$4.00 *Motor only*

Introductory offer as above, while they last. Act quick.

$1.50 *Rotor only*

When ordering rotors give size of shaft

The Fosco Corporation

1355 N. Western Ave., Chicago, Ill.

Send postage for catalogue of motors and supplies

STORAGE Marko BATTERY

The Mark-o'-Quality

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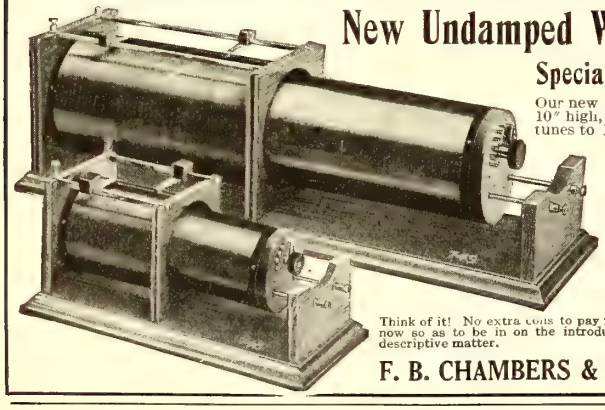
to secure a GOOD storage battery at a moderately LOW cost. The ONE article you cannot afford to experiment with is a storage battery.

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MARKO storage batteries are especially adapted for operation of all kinds of spark coils, insuring a heavy and powerful spark. There is nothing superior FOR AUDION USE

Type	Volts	Amp. H.R Capacity	List Price	Special price to wireless engineers
4C2	4	40	$ 7.00	$4.90
6C2	6	40	10.00	7.00
6C4	6	60	12.00	8.40
6C6	6	80	16.00	11.20

PAUL M. MARKO & CO., Inc., 1191 Bedford Ave., Brooklyn, N.Y. N. Y. Depot—974 8th Ave., N.Y. City



New Undamped Wave Coupler No. 749

Special Introductory Price, $18.00

Our new coupler No. 749 is 32" long, 9" wide, and 10" high, over all, and on an average-sized Antenna tunes to 15,000 meters. This coupler, used with the new CHAMBERS' SYSTEM or CIRCUIT, will bring in signals from domestic and foreign Arc Stations surprisingly loud and clear. Note the difference in size of our No. 748 and No. 749.

We claim to be the original inventors of a SYSTEM or CIRCUIT for the reception of the undamped waves without the use of Loading Coils or Oscillating Coils, as they are sometimes called; as with our SYSTEM or CIRCUIT only two Inductively Coupled Coils are necessary. Circuit supplied with each coupler.

This CHAMBERS' CIRCUIT saves you money. Think of it! No extra coils to pay for, and price of coupler only $18.00. Place order now so as to be in on the introductory price. Orders filled in rotation. Send for descriptive matter.

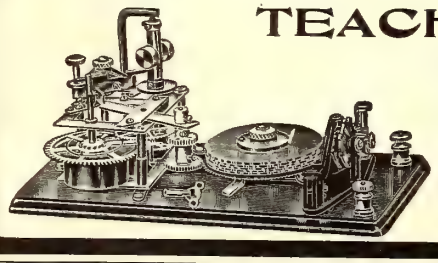
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MONTANA.

A. C. Campbell, 7 ZC, Lewiston

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Genesee Radio Station, 8 OZ, Rochester
Dr. H. E. Fitch, 8 ZE, Elmira
O. W. Saxton, 8 FY, Buffalo
A. C. Young, 8 ARB, Buffalo
H. Blower, 2 HB, Brooklyn
Kenneth Briggs, 8 MG, Rochester
J. Weiss, 2 FH, Port Washington
G. M. Benas, 8 CC, Utica
W. J. Vickery, 8 SE, Gloversville
J. K. Hewitt, 2 AGJ, Albany

NORTH CAROLINA.

W. S. Rothrock, 4 DI, Winston Salem
J. T. Moorehead, JM, Greensboro

OHIO.

Fred Travis, Defiance
R. Hoffman, Defiance
D. Israel, 8 ANC, Cincinnati
G. D. Howsare, 8 ASG, Eaton

(The balance will be publisht in the June issue.)

Are You An American?

Are you with the country or against it? If you own a radio outfit it behooves you as a patriotic American to offer your Wireless Station to your country. You do not obligate yourself in any way by signing the blank printed below, except that you give the Government permission to operate your station at any time its officials may see fit to use it.

Thousands of Amateurs have thus pledged their stations, WHY NOT YOU? Sign the blank to-day, and it will be promptly forwarded to Washington. (See also page 3, this issue.) Join the *Radio League of America;* no fees, no dues to be paid. By joining you get a free membership certificate printed in green and gold. Send stamp for large eight page information booklet. Radio League of America, 233 Fulton Street, New York City.

Application for Membership in the Radio League of America

I, THE UNDERSIGNED, a Radio Amateur, am the owner of a Wireless Station described in full on the face of this application. My station has been in use since....., and I herewith desire to apply for membership in the RADIO LEAGUE OF AMERICA. I have read all the rules of the LEAGUE, and I hereby give my word of honor to abide by all the rules, and I particularly pledge my station to the United States Government in the event of war, if such occasion should arise.

I understand that this blank with my signature will be sent to the United States Government officials at Washington, who will make a record of my station.

Witnesses to signature: Name.....

..... City.....

State.....

..... Date.....191

Describe the apparatus of your station on the blank below.

In the event of national peril, you will volunteer your services as a radio operator in the interest of the U. S. Government?.....

This last question need not be answered unless you so desire it.

Description of My Station and Apparatus

Sending .....

.....

.....

.....

.....

Receiving .....

.....

.....

.....

.....

(5-17)

CUT OUT, FILL IN, AND RETURN AT ONCE

DISTRIBUTED CAPACITY AND ITS EFFECT.

(*Continued from page 33*)

of the June 1916 issue of this journal. For those who have not seen this copy, the accompanying reproduction is made, Fig. 5. The construction is very simple and the drawing is self-explanatory.

The effect of distributed capacity and dead-end effect is more pronounced in long coils and it is advisable to wind such coils in sections as shown in Fig. 6. It has been found that a considerable amount of distributed capacity is eliminated by such a method of winding and it should be done in every case where it is possible, especially on secondaries of loose couplers. The reason for reducing the distributed capacity is self-apparent, as the capacity varies inversely as the thickness of the dielectric between the conducting mediums. Thus the capacity is reduced by increasing the distance between sections. It will be an ideal inductance if each turn of the coil is separated from its neighboring turn, say, one-thirty-second of an inch each. The distributed capacity of such a coil would be very small as compared to a coil with the wires close together.



"You Get The Job"

"We've been watching you, young man. We know you're made of the stuff that wins. The man that cares enough about his future to study an I. C. S. course in his spare time is the kind we want in this firm's responsible positions. You're getting your promotion on what you *know*, and I wish we had more like you."

The boss can't take chances. When he has a responsible job to fill, he picks a man *trained to hold it.* He's watching ***you*** now, hoping you'll be ready when the opportunity comes.

The thing for you to do is to start today and train yourself to do some one thing better than others. You can do it in spare time through the International Correspondence Schools. Over 5000 men reported advancement last year as a result of their I. C. S. training.

The first step these men took was to mark and mail this coupon. Make *your* start the same way—and make it right now.

I. C. S., Box 5346, Scranton, Pa.

TEAR OUT HERE

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 5346, SCRANTON, PA.

Explain, without obligating me, how I can qualify for the position, or in the subject, before which I mark X.

☐ ELECTRICAL ENGINEER	☐ SALESMANSHIP
☐ Electric Lighting	☐ ADVERTISING MAN
☐ Electric Car Running	☐ Window Trimmer
☐ Electric Wiring	☐ Show Card Writer
☐ Practical Telephony	☐ Outdoor Sign Painter
☐ Telegraph Expert	☐ RAILROADER
☐ MECHANICAL ENGINEER	☐ ILLUSTRATOR
☐ Mechanical Draftsman	☐ DESIGNER
☐ Machine Shop Practice	☐ BOOKKEEPER
☐ Gas Engineer	☐ Stenographer and Typist
☐ CIVIL ENGINEER	☐ Cert. Pub. Accountant
☐ Surveying and Mapping	☐ Railway Accountant
☐ MINE FOREM'N OR ENG'R	☐ Commercial Law
☐ Metallurgist or Prospector	☐ GOOD ENGLISH
☐ STATIONARY ENGINEER	☐ Teacher
☐ Marine Engineer	☐ Common School Subjects
☐ ARCHITECT	☐ CIVIL SERVICE
☐ Contractor and Builder	☐ Railway Mail Clerk
☐ Architectural Draftsman	☐ AGRICULTURE
☐ Concrete Builder	☐ Textile Overseer or Supt.
☐ Structural Engineer	☐ Navigator ☐ Spanish
☐ PLUMBING AND HEATING	☐ Poultry Raising ☐ German
☐ Sheet Metal Worker	☐ AUTOMOBILES ☐ French
☐ CHEMICAL ENGINEER	☐ Auto Repairing ☐ Italian

Name_____

Occupation & Employer_____

Street and No._____

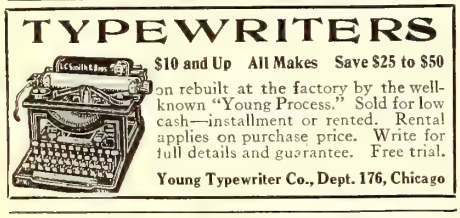
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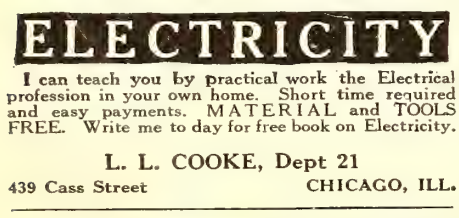
If name of Course you want is not in this list, write it below.













EDDY CURRENTS.

(*Continued from page 21*)

as one of the fleet when the war had broken out. I tried to ask him questions, but he was as clammy as Parker and I could get nothing out of him.

What was behind that locked steel door? Was the means of destroying the enemy's ships concealed there? What was this curious torpedoless means? I wanted to ask Parker, but pride and shame at my own stupidity held me back. So I wondered and pondered and puzzled all that day.

Thought of the affair was dispelled when about sundown the lookout sighted an enemy aeroplane dead ahead and some distance aloft. We immediately sank to the awash condition and then as the plane grew near, we submerged with only our periscope showing. This we drew in as we noted that the aeroplane sighted us and swooped down for a look. We ran submerged for a half hour or so and then cautiously poked up our periscope.

There was a sudden cry of warning from the man at the instrument and we dove again. There had been an enemy torpedo boat destroper near, and even in the dusk it was not safe to come up when any of these craft were about. We had been sighted we knew, for its searchlights made the water dimly translucent above us. But we submerged below the light and ran still east by north.

It was just after this that I noticed that Billy came to the feeler case. I heard him give directions that the small alternator which supplied the coil with current, should be started. Then he worked the two control wheels, and by glancing over his shoulder at the dials I saw that he was sweeping the coil from side to side, and frequently changing its inclination. By this means he was throwing out an arm of magnetic force which would indicate the position of any enemy ship within ten thousand yards.

"Hunting for fish?" I asked.

"Yes, I'm feeling for them," he answered, watching the angle of the horizontal gage, and then turning to me with a twinkle in his eye. "Have you solved it yet?"

"No, I haven't," I admitted.

"You watch tonight then," he said. "We're about due to be in the enemy's fleet and we ought to have some experience at least."

The light on the case before him flashed suddenly red, and the dial needle marking distance jumped up to eight thousand and stopt there. He turned and held the horizontal control wheel stationary a moment.

"We're in them now," he said. "There's the first one."

There followed a most wonderful piece of maneuvering. He turned the coil until he was sure of the position of the enemy, and then changed the course of our boat to correspond to his. Slowly we worked around, the little coil giving us the position of our foe with its unerring magnetic touch.

In half an hour we were making twenty-two knots west by south and running thirty feet under. The enemy was off to starboard according to our indicator.

"He must be a battleship. Twenty-two is too slow for anything else," Billy said.

I agreed and a moment later, with a final assurance that our courses were parallel, Billy turned to a locked case beside the feeler box. I glanced at the dial. The enemy was just 1436 yards away according to our readings.

Billy was opening the case which looked exactly similar to the feeler, but lacked the lamp and distance dial and had only two control wheels. Under it was a small electric pushbutton whose function I could not understand.

He twisted the control wheels for a moment until the dials read the same as those of the feeler. Then he called down the speaking tube.

"Start the alternator."

"Yes, sir," came back Dickenson's reply.

I heard faintly above the other machinery the starting crescendo of a turbine.

"Here goes for a trial," Billy said.

I watched him, and with a final glance to make sure that both dials corresponded, he deprest the button. The machine forward, the alternator, I thought, dipt several notes in its hum and then rallied. The button was down for four or five minutes and then he let it up and gave the command to stop the alternator.

What had he done? Had this deprest button let loose some mysterious new force, some wonderful ray, some hitherto undiscovered etherial vibrations which could travel through water and destroy the enemy ship alongside us? What had he done when he prest that button? I wanted to ask him, but again pride and chagrin stopt me.

Instead I went to my instruments, thinking that I might pick up some of the enemy's talk and hear something worth knowing. To this purpose I juggled my tuner knobs, getting many and rapidly changing combinations with the sliding contacts.

It was while doing this that I heard a sudden loud buzz in the receiver. I held the adjustment there a moment and heard several letters, apparently forming a foreign word. Then I listened while a message in the enemy's tongue was spelled off loudly into my receiver. I wrote it down as it came. When it had stopt and I had translated it, I had before me the following:

"The fire in the forward port compartment, No. 7, is in the oil tanks and is so hot that it has melted out a section of the hull plates. We have a heavy list to port, but are not in immediate danger. Good luck.

"Captain Von Heissburg,
"The Stoltzenfels."

That looked as if there was trouble in one of the enemy's ships. I showed the message to Billy.

He read it over twice and then glanced up with a gratified light in his face.

"Pretty good, but not quite enough," he said. "Have to use more next time I guess," and he turned away to the feeler case.

I could make nothing of this remark and did not try to. I was too busy watching him again.

Once more he was sweeping with the feeler. We were bearing off to the south and running slowly. Again the light flashed and he twisted controls and helm until we ran parallel with the enemy, 43 yards away and off his starboard side. Once again we were thirty feet under and running at twenty-two knots, which seemed to be the speed of the fleet. As before Billy twisted the controls on the other and un-named case until the dials read the same as the feeler. Once again he called the order to start the alternator. The hum of the machine sounded and as before the button was prest. I timed it now and found that it was held down six and a half minutes.

Then we sheered off to the south, slowing up and letting the enemy pass ahead of us.

I watched again in intense but unsatisfied curiosity while Billy twisted and and turned the little wheels and after our boat came parallel to the enemy, prest the

button after having the alternator started.

Fourteen more times it happened that night, while we maneuvered and changed our course to get into position. I did not get a chance to ask him that night. He was busy and the gratified light was too strong in his face, and I knew from all signs that I would only encounter more teasing.

So I stood by and watched and wondered what mysterious force was being loosed when he prest that button. Was it intensified wireless waves? I listened at my receivers once to make sure of this theory, but heard nothing. So I gave it up and watched and waited to let him tell me in his own way at his own time.

The next morning we had cruised for two hours without catching anything in the meshes of our magnetic net and Billy was about to give the order to come to the surface when we picked up something off our port bow. We slowed down to fall in with it, since it seemed to be running slower than we. After a few moments we found that it was stationary. We ran around it three times and then running several hundred yards away from it, Billy gave the order to come up cautiously.

The rising periscope flasht the picture, the scene that was there, spread on the water in the early morning light. I saw it over Billy's shoulder in the mirror.

It was a proud battleship, or had been, now leaning far over to port and surrounded by a bevy of small boats filled to overflowing with men. The great guns were pointing wryly skyward, and gave it a ridiculously helpless air as it lay there, rolling heavily in the swell of the sea.

"Its the Stoltzenfels," Billy said, looking intently into the mirror.

Then I remembered the message from her captain which I had overheard last night. I was about to mention this when I saw that the men in the boats had sighted us and were now pointing to us and signaling to the battleship. One of the great turrets swung about drunkenly and then we dove. We ran under the ship and her boats and then away to the west.

"Let them go. They can't hurt anything with that leaky tub. That's the one we experimented on and didn't give enough to," Billy said.

We ran that morning with our periscope and breather pipes out of water, but ready to sink unseen if necessary. We saw nothing of the enemy, but about nine o'clock while at the receivers I caught this message:

"Captain Rollins, U.S.N. Aviation Corps. Have sighted much wreckage and hundreds of enemy boats filled with men. Also life rafts and other floating objects with men clinging to them. Sighted the Stoltzenfels leaking badly, and with many boats. Caught glimpse of few transports but kept away by destroyers. Send cruisers and detroyers out at once. Battleships seem lost. Lieutenant Fletcher, Aviation Corps No. 7."

This I knew came from the wireless of one of our big scoutplanes which had been sent out to watch the movements of the enemy fleet.

I showed it to Billy Parker. He read it and his face lit with satisfaction in spite of the fatigue of the sleepless night.

"Good," he shouted, "we got them all right, didn't we? We got'em, the country's saved, we got'em!! We got'em!!!"

He capered about in the mess room, in a manner quite unbecoming for an officer and a man of his years.

"But how did you do it?" I begged, following him about in his joyous antics, and daring to broach this subject again in the face of his good humor.

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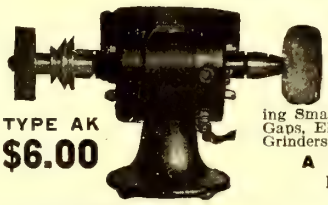
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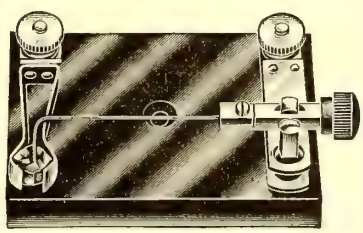
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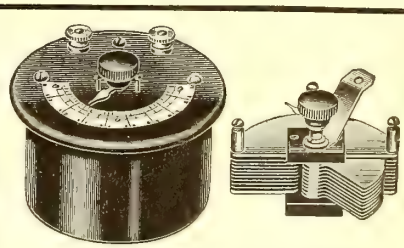
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"You poor stupid blockhead," he laughed, slapping me on the back, "don't you see yet?"

"No, I don't see at all," I admitted.

"Let me tell you so you can wireless the whole thing back to the papers. You understand how that feeler works?"

"Yes, perfectly," I said.

"Well, up on the bow we have a big coil just like that, mounted on a universal joint so it can be raised or lowered or swung around at any angle in the vertical or horizontal, except directly back. That coil takes about two thousand kilowatts of current which is supplied to it by a big alternator put in the old torpedo room forward."

He paused.

"Well?" I demanded.

"Don't you see now?" he asked.

"No, I don't, go on," I commanded.

"Oh, man, you haven't a bit of imagination," he groaned.

"Well, we can swing this coil around and send a current thru it," he went on. "If an enemy ship comes within one hundred yards of us, the same thing will happen that happens in an induction furnace. *We can send enough eddy currents thru his hull to melt out a whole section of the plates.* Now do you understand?"

But I was at the key, pounding out the message.

COMBATING THE TORPEDO.

(*Continued from page 11*)

hand on *Detonator switch* No. 1, he calmly waits. When the hostile torpedo is but ten feet distant from motor torpedo No. 1, he throws the switch. There is a terrific explosion and a huge column of water is thrown up several hundred feet into the air. Motor torpedo No. 1 has vanished, so has the enemy torpedo. The ship for the time being is safe. Instantly the crew has lowered away a new motor torpedo to take the place of the one just destroyed and long before it touches the water it has been electrically connected to the control board. But this would be necessary only for a large ship with a very valuable cargo. A small steamer would have enough torpedoes left to cope with the enemy. By this time, too, enough time has elapsed for the ship to alter its course and run in a zig-zag line, making it very difficult for a submarine commander to hit the fleeing vessel with the next torpedo. But in case of necessity the other motor torpedoes are still "in the ring" to successfully grapple with the enemy. Even where two torpedoes are sent simultaneously against the ship the scheme will work out satisfactorily. In that case the operator at the control-board simply has to work two rheostats and two detonator switches instead of one and given a level head and a good eye for calculating distances and speeds, the task is not such a very difficult one.

There are a number of firing positions and schemes and while as a rule only one motor torpedo would be used to destroy the enemy torpedo, Fig. 1 shows how two motor torpedoes could be brought close together (see dotted lines of No. 1) to intercept the deadly missile. In that case torpedoes No. 1 and No. 2 would be freed simultaneously and leave little chance for the enemy torpedo to escape.

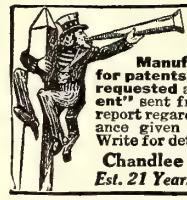
It is, however, not always absolutely necessary to actually destroy the hostile torpedo. Suppose that the submarine fires from a close range, and suppose that the selected motor torpedo cannot be speeded up fast enough—even by overloading its motor 100 per cent by raising its voltage—to come closer to the enemy torpedo than, say, thirty feet. Even in such an extreme case—tho quite possible in rough weather—the control operator fires his tor-

(*Continued on page 70*)

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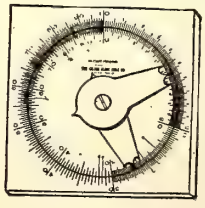
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PATENT ADVICE

Edited by H. GERNSBACK

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

SAFETY-FIRST OIL CAN.

(144.) John Brent Marshall, Cincinnati, Ohio, submits drawing and description of a, what he calls, safety-first oil can, and wants to know if it can be patented.

Ans. The idea as submitted contains nothing new to our mind and we are quite positive that no patent can be obtained on it.

LIGHT DIMMER.

(145.) Arthur Norris, Defiance, Ohio, has submitted a light dimmer which acts on the principle based upon the rotary potentiometer, the idea being to place a high resistance between supply wires and the light.

Ans. This is a very good idea and we are quite certain that the device can be patented. We have never seen anything like it on the market and providing the device can be made cheap enough and incorporated in a lamp socket, there should exist a good demand for same. We would advise our correspondent to get in touch with a patent attorney at once.

SPARK PLUG.

(146.) Clarence Melotz, Florence, Neb., submits what he calls a sootproof spark plug. The arrangement is such that the spark is supposed to keep a small cup from carrying carbon. Our advice is asked.

Ans. There does not seem to be anything new contained in this and at the present time there is a very similar spark plug on the market under the trade name of the "Soot-proof" spark plug.

PROPELLER.

(147.) Alison J. Kurth, Colorado Springs, Col., encloses sketch and description of a propeller for motor-driven boats. Instead of using a propeller, a certain perforated disc is used and our correspondent would like to know if we advise him to have it patented.

Ans. While this propeller no doubt works, it is impossible to determine its efficiency without actually testing it out, in practice. It is very doubtful to our mind, however, if this propeller should be more efficient than the regular one. In the absence of actual tests, we would not like to finally commit ourselves and advise our correspondent to try out the device in practice before applying for patent.

AUTOMATIC VOICE RECORDER.

(148.) Joseph Prochaska, Chicago, Ill., submits to us drawings and specifications of a novel idea, particularly for use by physicians whereby it is possible for a patient to call up the doctor while he is not at home and instead of the doctor answering, the phonograph does this for him, all automatically, telling the patient where the doctor can be located or when he will return.

Ans. The device is well worked out and while there does not exist an urgent demand for this invention, there is no doubt quite a number of people who would be interested in owning such an apparatus. We think a patent might be obtained upon the mechanical features embodied in this device.

"PERPETUAL MOTION."

(149.) Percy Muirhead, Dayton, Wash., submits a scheme of "Perpetual Motion" in which is utilized a Radiometer which as is known, works by light striking it. He wants our opinion of this scheme.

Ans. There is no such thing as "Perpetual Motion" and by using a Radiometer, this rule is no exception, for the simple reason that the Radiometer employs light which is a form of energy, and for this reason the scheme cannot be termed "Perpetual Motion" and no patent could be obtained on the idea.

WINDOW ATTRACTION.

(150.) L. E. Summerton, Maryville, Tenn., has submitted to us a window attraction and he would like to know if it is worth while patenting. Also if there is a ready sale for such a device. The idea consists of an electrical arrangement whereby a small artificial bird acts as a woodpecker, pecking against a piece of wood every few seconds.

Ans. This is a very good idea and by elaborating it a little more, we are quite certain there would be a good market for a thing of this sort. By using a plurality of birds, a very interesting window attraction would be had.

WAVE MOTOR.

(151.) C. Mattison, Oakland, Calif., submits drawing and description of a wave motor to be used in the ocean to utilize the power of the waves. He wants to know what we think of it and whether it is practical.

Ans. There is nothing new contained in the idea, which is not a good way of solving the problem. The first requisite necessary for a good wave motor is that it must automatically adjust itself to the various water levels as the tide rises or falls. Such an idea was shown in our February issue from which it will be readily seen that the device will of necessity have to be somewhat complicated for best results.



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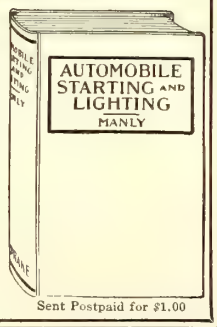
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COMBATING THE TORPEDO.

(*Continued from page 68*)

pedo anyway. The result is such a terrific as well as instant disturbance in the water that the enemy torpedo will be certainly deflected sufficiently from its original course so as to make it ineffective. And after all, this is what we want. For the enemy torpedo once it is spent, sinks automatically, because to leave it roam about the sea would constitute as much danger to its own submarine as to the attackt vessel.

All the technical points have been worked out satisfactorily and while the basic idea can and will be no doubt improved upon, the reader can form his own opinion as to the practicability and effectiveness of the scheme.

The main point in its favor is that each torpedo can be built at a cost of less than $1,000. For ten units this makes a cost of less than $10,000 for a ship of 600 feet. This is pretty cheap insurance, considering that the cargo alone on such a ship nearly always is worth from three-quarters to one million dollars and often considerably more. The ship itself costs as much again. Besides if the vessel is protected adequately, the maritime insurance is reduced largely and no big bonuses need be paid to the crew, as is the case now.

The speed of the ship is not reduced by the motor torpedoes either, as they run independently, nor is the power to operate them very great. For ten torpedoes we require but 100 to 150 horse-power—a trifling amount for a 600-foot steamer developing some 20,000 to 30,000 horse-power.

Nor are the motor torpedoes used during the entire trip. Thus during a cloudy, dark night, during a fog, or in a very heavy sea there is no need for them, as a submarine cannot successfully torpedo a ship in such cases.

During these periods the motor torpedoes are hoisted out of the water by means of their steel covered cables and are lashed fast to the decks till needed.

As the torpedoes are fired by electricity, there is little danger from an accidental explosion, even if they should bump against the side of the ship occasionally, for instance during launching or in a squall. The distance of 50 feet of the motor torpedoes from the mother ship is necessary, for if they are exploded at a closer range than 30 feet they will damage the ship.

That the submarine commander sees the brightly colored torpedoes does not matter in the least. For he will soon learn that firing torpedoes at a ship thus protected is a waste of time and material. And then until something better is found, submarine warfare, to a large extent, will sink into a stalemate. And this is what we all desire.

A ship equipt with guns (to prevent the submarine from using its own guns) and equipt with motor-torpedoes as well stands little chance of being sunk.

It should be noted that our cover design is not strictly correct. First, the motor-torpedoes in practise run almost entirely submerged, leaving only part of the mast exposed. Secondly, the submarine is shown very much too close to the ship. These slight technically incorrect points were necessary to bring out the idea from an artistic standpoint.

GLADSTONE AND THE TELEPHONE.

The mental fatigue which would follow the introduction of the telephone was foreseen by the late Mr. Gladstone, England's grand old man. When he was asked by Mr. Edison's representative whether he would like to have a telephone apparatus set up in his house, he wrote on a postcard: "Sir, my means of communication from without inwards are already equal to my needs and in excess of my desires."

MAGNETISM PRODUCES REMARKABLE PHOTOGRAPHS.

(*Continued from page 14*)

like a line of latitude, no mere arrangement of the molecules of a magnet, can account for the result. There must be motion—*currents of ether,* for there is only ether under the receiver.

A detailed examination of the articles will strenghten this proof. The articles are lettered somewhat in the order in which the impression is made on the plate. Note that at A, but little, if any, impression is made on the plate—the currents could not penetrate—while J and K hardly show at all because the currents past thru them and affected the plate; and to pass thru or to penetrate there must be motion—currents. From A to K, it will be noted that the effect on the plate grows gradually stronger, showing that some are more penetratable than others and this degree of penetration implies motion. Note that D, E and F are penetrated less than G, and that G is penetrated irregularly, plainly showing the location of the acid pits on the surface of the zinc. None of these effects could be produced by light. Again, B and C are iron weights with cavities in the bottoms and openings thru the sides of these cavities. The weights were placed on the plates so that the cavities were downward. Yet these cavities show plainly in the plate. Light could not produce this effect, for in any event it would produce a shadow and enough light could not enter the small opening to effect the plate practically as much as the exterior. But currents of ether following the lines of the iron, as is the well known effect of iron in a magnetic field, could and did produce this result. Moreover, careful measurements show that the cavities are a little larger and the circumferences of the weights as shown in the plates are a little less, than in the weights themselves, conforming to the well known deflection or bending of lines in a magnetic field by the presence of iron. But the crowning proof is in H. Here is a wooden button showing the grain of the wood. The wood was penetrated more in some parts than in others. Light could not produce this effect for it could not penetrate the wood and if it were supposedly possible to bring to bear light strong enough to penetrate the button, it would penetrate all parts equally. The cracks and seams in J and K are shown in the same manner but in a less degree. Here then is unquestionably penetration, and penetration can not possibly take place without motion. Who would now question the existence of currents about the magnet?

Furthermore, here is incontestable proof that the *lines of force, lines of tension, mere lines of direction* do not "emerge from" (without motion) the North pole of the magnet, nor "pass to or enter" (again without motion), the South pole. The effect, the penetration, the currents are equal over both poles. These currents pass into both poles alike. They do not pass out from the poles for the plate is above the poles, both poles, with the sensitive side upward, and the objects are on the sensitive side of the plate above the poles. If the currents were passing upward from either pole, there would be no impression on the plate over that pole, for the current would pass thru the sensitive film before reaching the objects. Instead, it shows plainly that the currents past poleward equally over both poles, penetrated more or less the objects on the plate, affected the sensitive plate more or less according to

the amount of penetration, and then past on to the magnet. What then becomes of them will be shown later.

Still there are doubters. Could the result be due to stray light? Could it be due to phosphorescence? To radio-activity? Could the same result be obtained without the magnet? To answer these I placed a plate over a wooden "U" under the receiver, with the objects placed upon it exactly as before and used exactly the same precautions as in the first instance. At the same time and in the same room, far enough away not to effect the plate under the receiver, I placed a plate over the magnet with several objects upon it, but without a receiver, placed a light-tight box over this, and covered the whole with heavy folds of black cloth. In this instance the room was not opened for twenty-two days. At the end of that time both plates were developed with equal care under the same conditions as in the first case. The plate over the wooden support under the receiver was a *perfect blank!* There was no impression on it. The result with the plate over the magnet in the air is shown in Fig. 4. In this A is a key, B and C are pearl buttons, and D, E and F are wooden buttons. The grain of the wooden buttons can be seen as in Fig. 3 showing that the penetration is the same here but the whole plate demonstrating that the result is somewhat less clear, as might be expected, in the air than under a vacuum. The difference in the penetration at D and at E and F is accounted for by the fact that E and F were almost directly over the poles of the magnet while D was at one side and the penetration was much greater at E and F—again proof of the currents and of the effect of the magnet.

I have also produced Magneto-graphs, as I have chosen to call them, over an electro-magnet and over a straight wire bearing a current, but I have not as yet secured clear results, owing to the difficulty of maintaining a steady current for sufficient length of time.

SOURCES OF ELECTRICITY.

(*Continued from page 12*)

As might be suspected, the voltage produced by heating a single metallic couple, such as the above, is very small, and where a greater potential is desired a large number of similar couples are mounted in as compact a manner as possible, and all of the junctions are heated simultaneously by gas or coal as shown in Fig. 6. The difference of potential for a bismuth-antimony couple is about 117 microvolts for each degree Centigrade, when the junction is heated above the rest of the circuit. The total current produced by the massive compound circular thermopile shown in Fig. 6 is 80 volts and 3 ampres, which is sufficient to light a number of incandescent lamps.

Dynamic Electricity: The most successful and practical source of electrical energy as we know it today is the *Dynamo*. One of these machines, which depends upon the cutting of magnetic lines of force by a rotating wire or *inductor* as it is called, is shown in Fig. 7. It was Faraday, who early in the 19th century discovered that if a circular copper disc be rotated between the poles of a strong steel magnet or an electro-magnet, that there would be a current produced, or rather *induced* in the moving copper disc, due to the cutting of magnetic lines of force. The current was found to flow from the shaft supporting the disc to the rim, or vice versa, according to the direction of rotation. This current was conducted away by wires, having sliding brush contacts, one of which was made to bear against the shaft, while the other made contact with the edge of the disc.

It was not long before the simple copper disc gave way to the more modern *armature*, which contains a large number of insulated copper wires and all of which coils, in consequence, are caused to rotate rapidly in the powerful field of an electro-magnet. These rotating coils are properly connected to a series of metal bars, assembled in ring form and known as a *commutator*, against which contact brushes bear, leading the current from the armature to the electric apparatus, such as lamps, motors, etc. The dynamo is always to be driven by some external prime mover, such as a steam engine, water wheel, etc. In the dynamo we have the conversion of mechanical energy into electrical energy.

ELECTRICITY FROM COAL: One of the most successful forms of apparatus for producing electricity direct from coal is shown in Fig. 8. This particular type of coal-electric cell is due to W. W. Jacques. Here we have a carbon cylinder immersed in a fused caustic soda bath; this is placed in an iron vessel which also serves as the other electrode of the cell. An air pump is employed to blow a stream of air thru the caustic soda by means of a perforated drum under the carbon rod. By means of the coal furnace the whole cell is maintained at a temperature of 400°C. The air stream has the effect of causing the carbon to ox-

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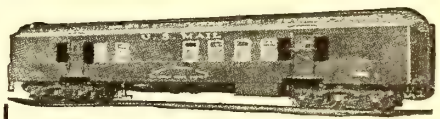
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idize to CO_2, which mostly bubbles up thru the caustic soda solution and escapes. This cell gives about 1 volt E.M.F. The action occurring in the production of electrical energy is believed to be partly voltaic and thermo-electric. The cell has an efficiency of about 8 per cent—compared to 12 to 15 per cent for modern steam boiler and engine plants, and the cost of raw materials to replenish it is said to be at least 34 times that for a good steam engine, while the residue or ash from such a battery would possibly weigh 12 times that from a corresponding steam plant.

PLANT ELECTRICITY: It is not generally known that certain plants exhibit pronounced electrical activity, but such is the case. Perhaps the strongest, that is in the sense of electrical vibrations, is the sensitive plant (*Mimosa pudica*), shown in the illustration (Fig. 9). Others, such as iris, nicotiana, nasturtiums and practically all the meat-eating plants, such as the "Venus fly-trap" and the "sundew," afford splendid examples for experimentation. If any of these be placed "in connection with a galvanometer by means of electrodes attacht to leaves on different sides, and one side of the plant be exposed to sunlight while the other side is kept shaded, then within from three to ten seconds after exposure to sunlight there will be a flow of electricity from the lighted to the shaded parts amounting to .005 to .02 volt. This continues for about five minutes, when the magnet begins to swing back and shows an opposite current of considerable magnitude. The manifestations are similar to those of "teranized nerve."

A better understanding of the electrical qualities of plants will, no doubt, explain many of the hitherto mysterious habits of meat-eating plants. Especially will this be true of such terrible and uncanny plant monsters as the "devil's snare" of South America and the mammoth Utricularia, or fishing plant, which lures minnows and small animals into its voracious mouth, and suddenly, as if an electric button were secretly prest, closes in upon its helpless prey. In other words, it fishes with a net electrically wired! Strange as it may sound this plant safeguarded itself by means of its electrical currents ages before we used the electric burglar alarm and door bell. Were it not for this protection, the plant could not live and hold its own in such an aurial-infested region as it needs for its fishing ground.

ANIMAL ELECTRICITY: Altho not so commonly known, there are in the world several varieties of electric fishes and eels which possess quite remarkable power. Several species of these creatures inhabiting the waters of certain parts of the earth possess the power of producing more or less powerful electric discharges. Physiologically, the principal creatures of this class are the *Torpedo*, the *Gymnotus* and the *Silurus*. One of the most powerful electric fishes is the *Raia Torpedo* or Electric Ray, of which there are three species inhabiting the Mediterranean and Atlantic. This particular specimen is provided with an electric organ on the back of its head. The organ consists of laminae composed of polygonal cells to the number of eight hundred or one thousand, or even more, which is supplied with four large bundle of nerve fibers. The under surface of this fish is *negative;* while the upper surface is *positive.* With the Gymnotus or Surinam eel, the electric organ extends the whole length of the body from tail to head. It has been recorded by Humboldt that a lively combat ensued between a number of electric eels and a herd of wild horses, which were driven by the natives unconsciously into the swamps inhabited by the Gymnotus. This particular specimen of electric fish is said to be able



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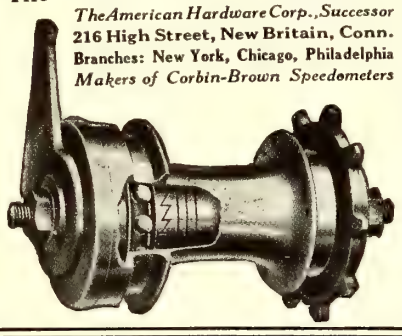
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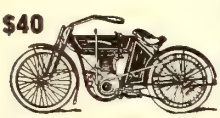
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to give a most terrible shock, and proves a most formidable antagonist when it has grown to its full length of five to six feet. In the Silurus shown in our Fig. 10, the electric current flows from head to tail.

It has been shown by several scientists that nerve excitations and muscular contractions of human beings are the seat of slight electrical currents. For one thing it has been shown that the beating of the heart really creates rhythmical electro-motive force.

PHOTO-ELECTRICITY: One of the most interesting sources of electrical energy and also one of the most direct methods of production of electro-motive forces is found in the *photo-electric cell.* Simply explained this remarkable device comprises nothing more than two copper plates, one of which is perforated and blackened by oxidizing in a gas flame, while the rear or second plate is polished, and both of which plates are placed in a suitable tank containing a salt-water solution. One side of the tank which contains the copper plates is fitted with a glass window and when sunlight, or any other source of light, is allowed to strike the cell, there is a difference of electric potential set up between the front and rear copper plates. This particular cell as developed by Mr. Theodore W. Case, was described extensively in an article which appeared in the September, 1916, number of this journal. It was found possible with some of these photo-electric cells to obtain a voltage of one-tenth and an amperage of two-tenths; the cell delivering a steady current as long as the light shown on it. It is of course possible to connect a large number of cells in series or parallel to obtain any voltage or current desired.

RADIUM ELECTRICITY: It is generally conceded in scientific circles that the activity possest by radium is fundamentally electrical in nature. Radium gives off three kinds of *rays* known as the *alpha, beta* and *gamma* rays. It is possible to influence two of these rays (alpha and beta rays) by means of a magnet or an electro-magnetic field, which indicates that they are undoubtedly electrical in their fundamental structure. Another experiment, which any schoolboy can readily perform with a piece of radio-active mineral, is as follows: First, an electric charge is produced on a sensitive gold leaf electroscope, so that the leaves diverge; then grasp a piece of the radio-active mineral (some may be so fortunate as to possess a tube containing a small quantity of radium bromid) and bring this into proximity with the metal ball or disc at the top of a charged electroscope. It will be noted that the latter loses its charge on the gold leaves almost instantly; the electronic activity of the radium bromid or other radio-active substance used creating a change in the electrical field about the electroscope, apparently making it more conductive, so that the bound electric charge on the gold leaves can escape. Those interested in the subject of "Radium" and the many electrical and other effects created by the greatest mystery of the scientific world to-day will do well to read the extensive article on this subject, which appeared in the September, 1916, number of THE ELECTRICAL EXPERIMENTER..

RADIO ENGINEERS DINE.

The Washington section of the Institute of Radio Engineers gave a dinner, March third, at the Commercial Club, Washington, D.C., complimentary to Brigadier-general George O. Squier, chairman of the Washington section. The following named gentlemen from New York participated: R. A. Weagant, chief engineer, and David Sarnoff, commercial manager, of the Marconi Wireless Telegraph Co., of America; Major J. Andrew White and W. J. Hernan, of the Wireless Press.

THE IONIC RADIO SYSTEM AND THEORY OF IONIC TUNING.

(Continued from page 31)

detector and Weston relay are here connected in multiple, the connections from the local side of the Weston relay being the same as above described.

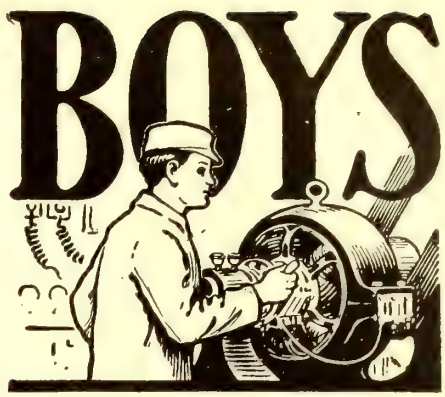
The preferred type of my detector used in this system is shown in Fig. 5, and comprises large nickel-plated binding posts 16 and 17 mounted about two inches apart, center to center, on any suitable material so as to support the electrodes 19 and 20. To 19 a brass rod one eighth of an inch in thickness, is fitted a crystal of silicon 21, cut in the form of a truncated cone. Its base is glued to the rod, the electrical connection being made by wrapping the joint between the brass rod and the silicon with tinfoil. The electrode 20 comprises three inches of flexible cord, scraped of its insulation, then bent double and tightly twisted, the loose ends being cut off evently. If the end of the silicon can be ground smooth without destroying its sensitivity a polished brass rod may be used.

This makes a detector costing about 35 cents to construct. It will have a highly finished appearance, exceptional reliability, unusual sensitivity and require very little adjustment, as the parts are fixed permanently in place. Those trying this form of detector resembling the early "E. I. Co." Auto-coherer I am sure will be well satisfied. After eleven years of experimenting with all forms of commercial detectors I have found this one the only type constant enough for quantitative measurements.

Having described one set of apparatus adapted to be operated according to my new method of tuning I will now briefly describe the characteristics of crystal detectors and the theory of operation of both *thermo-electric* and *ionic detectors,* in order more clearly to disclose the exact nature of my new method.

A Thermo Detector consists of a very fine point or "cat-whisker" resting upon a thermo crystal with a comparatively light contact. When an alternating current passes to and from the crystal, heat is generated in minute quantities at this point. This heat causes a "thermo-pile action" and generates a thermo-electro-motive force. Impulses of alternating current coming into the detector in such direction that their direction is the same as that of the thermo e.m.f. are allowed to continue and pass on thru the circuit. Those passing in the opposite direction are opposed by the thermo e.m.f. and are suppresst or *wiped out.* The impulses which reach our 'phones then are always in the same direction as the thermo e.m.f. Thus is accomplished the rectification by thermo crystal detectors. These crystals always require a metallic point and to this class of thermo crystals belong the following: copper pyrites, tellurium, manganese dioxid, chalco-pyrites, galena, iron pyrites, etc.

Ionic detectors are also rectifiers but perform their function in a different manner, these metal points not being necessary and the form of contact being of relatively small importance. These detectors have no useful thermo e.m.f. A large polished plate of the crystal may be placed between two highly polished electrodes and it will work equally well, if not better, than with a point. I have taken a piece of molybdenite one-half inch in length and tacked it to a board with a tack at each end. It worked very well as a detector and required no adjustment. It was not especially sensitive but its operation was perfectly constant. On the contrary an *ionic* detector rectifies by the polarization of its contained ions, an ion being a combination of a number of positively charged molecules, with one negatively charged electron.



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Let the pyramids in Fig. 4 represent the ions in an ionic crystal, the bases representing the molecules and the vertices or points the electrons. The electrons or points being negatively charged, seek what is to be the positive pole of the detector for the rectified current. The molecules being positively charged seek what is going to be the negative pole of the detector. When an alternating current enters the crystal these ions are polarized, somewhat as the molecules of iron in an iron bar are polarized in magnetic hysteresis. This makes the crystals better conductors in one direction than in the other, or in other words they become rectifiers. The impulses passing thru the crystal in the direction of the points (Fig. 4) meet a very low resistance and are allowed to continue. The impulses coming in the opposite direction, or against the points, meet a very high resistance and are converted into heat, being to all practical purposes thus suppressed or *wiped out.* To this class of ionic crystals belong the crystals of silicon, molybdenite, perikon (copper pyrites and zincite), carborundum and titanium dioxid, titanium (T_1O_2) occurring in two forms, viz., as the minerals brookite and anataste.

Thus while both the thermo and ionic detectors convert alternating current into direct current, the former work by a thermo e.m.f. in one direction, while the polarized ions of the latter cause these crystals to conduct better in one direction than in the other.

My unique method of ionic tuning depends upon the following discovery, which I have made, viz.: *The ions of each chemical element or compound have a definite rate of vibration, the ionic groups of no two elements or compounds having the same rate of vibration.* Thus each chemical element or compound is sharply distinguished from every other element or compound by its characteristic ionic vibration rate.

My novel method of *ionic tuning* is based on this newly discovered principle and I make use of the principle in the following simple manner—namely, by employing the same chemical element or compound in receiving the radio impulses as in generating them. For example, silicon may be employed both in the spark gap at the sending station and in the detector at the receiving station; or, when employing a zincite detector at the receiving station, a zinc spark gap may be used at the sending station, and I have found that not only can excellent selectivity be obtained in this manner, but the detector is far more sensitive to a sender employing the same material, thus permitting transmission over much greater distances.

This phenomenon I believe to be due to the fact that the vibration of the ions in the detector is vastly more easily affected by disturbances of the same basic character produced in the ether by a sender of the same material. On the contrary, when dissimilar elements are used in the sender and receiver respectively, as has heretofore been done universally, the *ionic vibration* at each end is not in unison but is in dissonance.

In further experimentation along this line I intend more fully to study the effects of combining two or more elements in both the sender and transmitter in order to determine whether or not any material loss of efficiency or other disadvantage results from such combination, and I suggest this as one of the many fruitful fields of research opened for future endeavor by my discoveries herein publicly disclosed for the first time.

It is stated that one result of the war in Germany has been the greatly extended use of aluminum for many purposes. Its use is one of the outstanding features of captured German motor construction, being used for crank cases, gear boxes and even cylinder heads, jackets and shafts. The Germans are said to be able to produce aluminum very cheaply, largely owing to the mining of coal in occupied French territory by forced labor. The cheap production of electricity has also stimulated the development of electric motor vehicles, which are now being run with nickel-iron batteries, owing to the shortage of lead.

AN ELECTRIC PARADOX OR SELECTIVE LAMP CONTROLLER.

(*Continued from page 37*)

mechanism. Adjust N so that the travel of the armature shaft is such that every time it travels from the down to the up position, a tooth of the ratchet will have moved the distance between two teeth (1/12 revolution).

The three lights to be operated and also the knife switch may be mounted on a suitable lamp board as shown in the photograph. The mechanism just described and also the rheostat may be hidden, and only the wires coming to the lamp board exposed.

It will no doubt afford the reader considerable amusement when he shows the device to some of his friends who think they are *wiring sharks* and that nothing electrical can fool them.

A STUDY OF THE LAW OF RESPONSE OF THE SILICON DETECTOR.

(*Continued from page 34*)

ponents of the transmitted waves, loops were made with the lengths of the vertical and horizontal portions of the wire in varying ratios. Curves showing extreme variations were obtained. The conclusion to be drawn from these curves is that the horizontal portions of the loop give a maximum response at 0 deg. and 180 deg., the vertical portions at 45 deg. and 135 deg. The receiver responds both to the horizontal and vertical components of the waves received, and the position of the maxima will vary with the particular form.

Receiver in Horizontal Plane.

Since for the study of the law of the detector it was desirable to eliminate as far as possible all response to the vertical component, the entire receiver was placed in the horizontal plane and suspended as before by rubber bands. To reduce still further the response without the resonator the short loop which had given the minimum effect was used. The screen was rotated thru 360 deg. and readings were taken every 20 deg. with and without the resonator as before. The curves obtained showed the effect without the resonator to be a much smaller fraction of the entire response than under the best conditions with the receiver vertical. As a further precaution, oscillator, receiver and rotating screen were carefully centered. Curves obtained under these conditions both with and without the resonator had their maxima at 0 deg. and 180 deg., and their minima at 90 deg. and 270 deg., and the effect without the resonator was extremely small.

The effect for the 90 deg. position of the rotating screen, the position of no transmission, was still to be considered. This residual effect with the resonator was about 15 per cent. of the maximum, and indicated that with the screens used there were diffraction effects which, as might be expected, were more noticeable with the resonator than without. In order to investigate the diffraction the receiver was placed in a tin box. The response to the waves did not entirely cease until the tin cover was made completely to enclose the receiver; even a small opening in the cover produced a decided deflection of the galvanometer. That

the effect was due to the action of diffracted waves on the receiver was further shown by the fact that with the rotating screen in the position to allow no transmission a wire reflector back of the receiver at varying distances clearly indicated the presence of nodes and loops at distances apart which showed the wave-length to be that of the original wave. The average distance from node to node was found to be slightly more than 50 cm., making the wave-length approximately 100 cm.

Final observations were made with the receiver in the horizontal position at a distance of 225 cm. from the fixt screen, and with the oscillator at distances from the screen ranging from 120 cm. to 230 cm.

The Law of the Silicon Detector

Since for the final curves obtained the receiver was so adjusted as to respond only to the horizontal component of the transmitted wave, it seemed possible to use the data to determine the law of response of the silicon detector with a variation in the intensity of the incident wave. The data already obtained showed the response of the receiver for each position of the rotating screen. Since only the component of the wave at right angles to the wires of the screen could be transmitted, the amplitude of the transmitted wave varied as the cosine of the angle between the wires and the vertical. As the receiver was capable of responding only to horizontal waves, the transmitted component suffered a second resolution at the receiver, which again cut down its amplitude by the cosine of the same angle. Hence the amplitude of the component of the wave to which the receiver responded was proportional to the square of the cosine of the angle between the vertical and the wires of the screen. Presumably the amplitude of the oscillations set up in the receiver for different positions of the screen was proportional to the amplitude of this received component, and hence to the square of the same angle.

In determining the law only those data were considered in which the values of the current obtained without the resonator were small. For each set of readings two curves were plotted, with the galvanometer deflections as abscissae and in one case the second, in the other the fourth powers of the cosines of the angles as ordinates.

From these results it seems safe to conclude that the rectified current is proportional to the fourth power of the cosine of the angle between the vertical and the wires of the rotating screen.

Since the amplitude of the oscillations in the receiver is presumably proportional to the square of the cosine, this result indicates that the rectified current thru the silicon detector is proportional to the square of the oscillating current in the receiver. Austin, in his study of the silicon detector, reached the conclusion that for alternating currents of ordinary frequencies and for oscillating currents of a frequency of 140,000 the rectified currents are approximately proportional to the square of the alternating currents. The results of the investigation of the writers confirm this law for a frequency of approximately 3×10^5.

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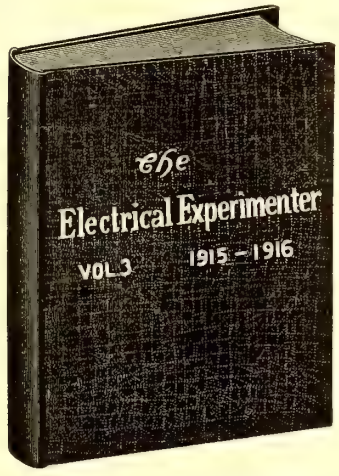
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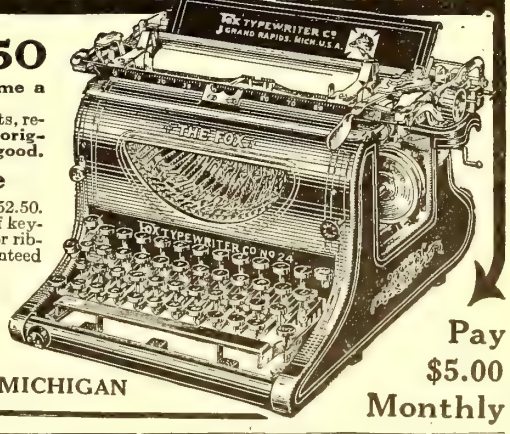
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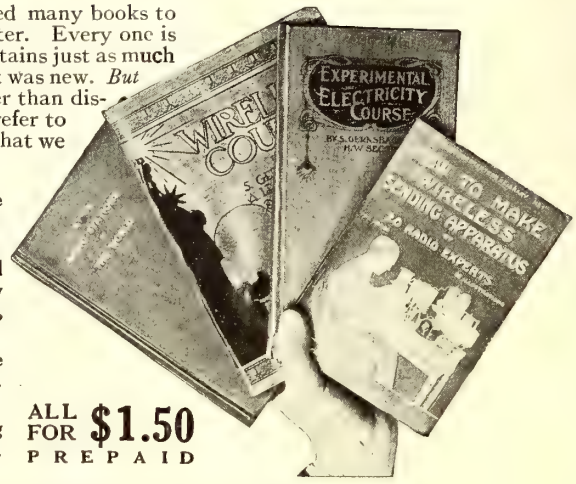
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A SIMPLE ELECTRIC MOTOR ATTACHMENT FOR PHONOGRAPHS.

(*Continued from page 40*)

other two holes mentioned are intended to take the bolts that run through the motor. These bolts are lengthened, by the addition to their ends of ½ inch binding posts, as shown in Fig. 1, upper end of the motor, or are replaced by new bolts long enough to extend through the top board, so as to support the motor. In the writer's case it was a simple matter to find two short binding posts which would screw on to the ends of the motor bolts. With these in place the motor shaft was inserted through the center hole, the binding post slipping into the other two holes, and the thumb bolts which fit the top threads of the binding posts, were fitted with soft rubber washers, inserted in place and screwed up tight to hold the motor in place. The rubber washers mentioned above deaden the hum of the motor considerably, but if their effect is not great enough two thin washers, made from banner felt, can be inserted between the motor top and the talking machine top, being held in place by the motor bolts and bearing as shown in Fig. 1 at b.

The belt should be crossed in order to drive the turntable properly; the electric motor having its field winding terminals reversed if it rotates in the wrong direction.

A simple white string belt, about 1/20 of an inch in diameter, has been used for about two months with excellent results by the author, although at first several materials were tried experimentally, such as leather, rubber, tape and laces. Besides being the simplest to obtain and make up the string belt gave the best service, and is still in use, although the diameter is reduced about 30% by wear. The ends of the belt were simply joined by being tied in an ordinary knot. This belt is readily renewed.

When the driving mechanism has been completely assembled one end of a flexible lamp cord can be attached direct to the motor wires, after first being passed through the hole which formerly contained the crank handle, for winding the motor. The lamp cord may be connected to a lamp socket and the motor controlled by the key switch in the socket, or if so desired a simple push button switch can be connected to the cord near the machine, or else set into the body of the machine itself. The regular stop, with which the phonograph was originally fitted, should be kept in release by means of a small tack or phonograph needle driven into the machine top to hold the lever at starting position.

The records can be readily changed without stopping the machine, provided the turntable is not held back too much by clumsy manipulation of the records. This practice, however, is not to be especially recommended, and is not at all necessary, as the machine with an electric motor attachment attains full speed very quickly upon starting. The speed can of course be regulated in the manner already advised, by the ordinary speed lever.

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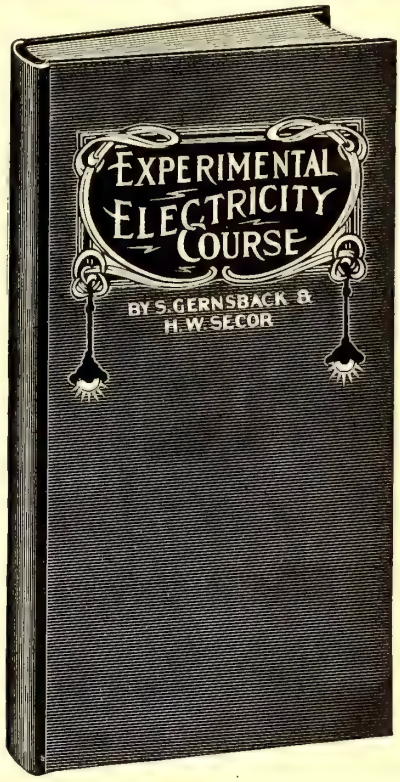
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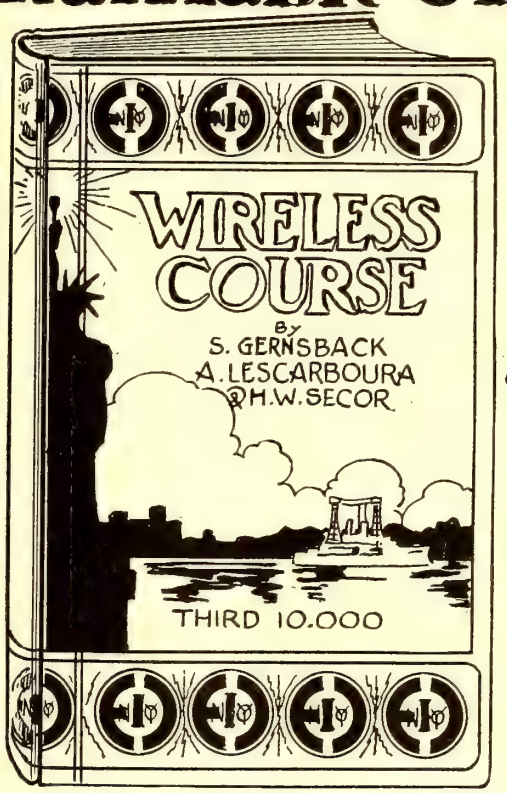
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(*Continued on page 78*)

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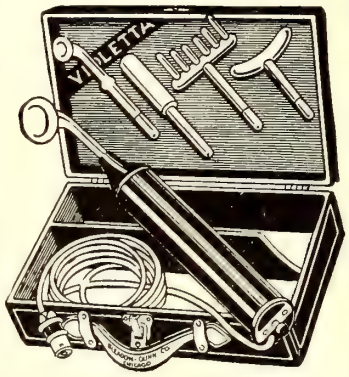


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EXPERIMENTAL CHEMISTRY.

(*Continued from page 52*)

base, the metal of the base enters into the acid in place of the hydrogen and the hydrogen combines with the hydrogen and oxygen of the base to form water.

HNO_3	+	KOH	=	KNO_3	+	H_2O
Nitric Acid		Potassium Hydroxid		Potassium Nitrat		Water

H_2SO_4	+	$2NaOH$	=	Na_2SO_4	+	$2H_2O$
Sulphuric Acid		Sodium Hydroxid		Sodium Sulphat		Water

NOMENCLATURE OF SALTS—

The name of the salts containing oxygen are derived from the name of the corresponding acid. The characteristic suffix of the acid is changed to indicate this relation. Thus, the suffix *ic* becomes *ate*, and the suffix *-ous*, becomes *-ite*.

[Note: The final "e" is usually dropt in simplified spelling as used in this journal.]

Sulfur*ic* acid form Sulf*ats*
Sulfur*ous* acid form Sulf*ites*
Nitr*ic* acid form Nitr*ats*
Nitr*ous* acid form Nitr*its*
Chlor*ic* acid form Chlor*ats*
Hypochlor*ous* acid form Hypochlor*its*
Permangan*ic* acid form Permangan*ats*

The name of the replacing metal is retained, as, Potassium chlorat, sodium sulphat, calcium hypochlorit, potassium permanganat. Notice that the prefixes *Hypo-* and *Per-* are not changed.

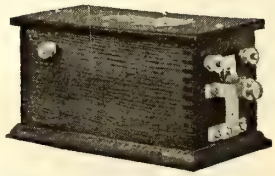
The names of salts containing only two elements, following the general rule for binary compounds, end in *ide*. This suffix is added to a modification of the name of the non-metal, giving the names chlorid, bromid, sulphid, fluorid, etc. The prefix *Hydro-* which is contained in the name of the acid is omitted. Thus, the name of the sodium salt of hydrochloric acid is sodium chlorid; similarly, there are the names potassium chlorid, calcium fluorid, and sodium iodid. Sometimes, the salts of these hydrogen acids are called Halids, to emphasize their relation to common salt, which in Greek is called Hals.



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STYLE C SPECIAL 1" COIL $3.50
Postage extra

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We reserve to ourselves the right to refuse any advertisement which we consider misleading or objectionable. Advertisements for the June issue should reach us not later than April 25.

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FOR SALE—As am not permitted to erect aerial will sell my new cabinet receiving set. Contains large loose coupler, primary and secondary loads, variable and fixt variable condensers, detector, potentiometer, buzzer test anchor gap. All instruments enclosed, with switch and lever control. With Brandes headset $50. Send 5c. stamp for photo. Also spiral helix $2. Spark Coil $1.50, tuner 14 inches long $1. Switches, detector parts, several lbs. fine wire and wireless books. Wanted, for cash, catboat or rifle. Len K. Wright, 518 East 83d St., N.Y. City.

FOR SALE—¼ K.W. Closed-core Transformer, $8.50. Also 200 W. Step-Down Transformer with 6, 12, 18, 24 V. taps, $3. Both in first-class condition. F. K. Billau, 525 N. Delaware, Indianapolis, Ind.

FOR SALE — International Correspondence Schools' course in arithmetic. Also wireless apparatus, cheap. Alex. Serna, Lehigh, Okla.

ATTENTION—Sale or Exchange: Motor, $20; lathe, $35; generator, $6; motor, $6. Stamp for descriptions. H. E. Neefe, La Farge, Wis.

EXCHANGE—Five volume set of Automobile Cyclopaedia, red cloth bound, gold stamped, also six volume set of Modern Shop Practice, flexible leather binding (published by American Technical Society), current editions, for receiving or sending apparatus of standard make. Charles B. Hayward, Great Neck Sta., New York.

IF ANY ONE can give me the address of W. B. Dougherty it will be thankfully received. Chas. Dougherty, Louisiana, Mo.

WANTED—Coil rated at 2 inches. Will pay cash. Henry Kienzle, 501 East 84th St., New York.

FOR SALE OR EXCHANGE—15,000 M. Loose Coupler, $10, also small Loose Coupler, $4, or will exchange for Variometer or Audion. Wanted to buy good polarized relay. Write to J. Cingature, 866 Thirteenth Ave., Milwaukee, Wis.

FOR SALE—$5, 22 revolver shot six times, $3; loading coil, $1; automatic telephone, $3; $6.50 moving picture machine, $4. William D. Peteet, Greenwood, Miss.

EXCHANGE—Good mandolin with case, for typewriter. Write if interested. Wm. Bolme, Enloe, N.Dak.

SALE—Telegraph Instruments, Motors, etc. See ad in April EXPERIMENTER. Sydney Young, Jr., Addison, N.Y., R.F.D. No. 4.

FOR SALE—Three-inch coil, $9; relay, $3; medical coil outfit with meter, cost $100, sell for $16. Ford electric starter and generator, $20 Gorham Cottrell, 1628 Jersey, Quincy, Ill.

FOR SALE OR EXCHANGE—Railroad motor car for electrical goods. S. R. Kimball, Diamond Bluff, Wis.

BARGAIN—Rotary gap having Klitzen disc and 110-volt Universal motor, $6. Fred Ancona, 16th St., & Mineral Spring Road, Reading, Pa.

FOR SALE—1,500 meter tuning coil; 1,000 meter tuning coil; detector, 60c. All new, make offer. Francis H. Coleman, 27 Salem St., Springfield, Mass.

4-Step Packard Transformer in paraffine wax and oak case, E. I. Government phones, 5 lbs. No. 22 D.S.C. wire. Cheap. Best offer takes them. F. Allen, Bliss, Takoma, D.C.

FOR SALE—Two brand new DeForest amplifiers with burned out bulbs. Price right. Palmer Southworth, 34 Montowese Street, Hartford, Conn.

FOR SALE—200 watt transformer. Steps 110 to 10, 20, 30 or 40 volts, $10; 40 watt dynamo or 1/12 H.P. motor, $7; Inch spark coil; fine fat spark, $4; Testing magneto, $2.50; 20 ohm sensitive pony relay, $1.50; 20 ohm giant sounder and steel key, $2.50; Portable voltmeter, 1-20 range, $1.50; Filings coherer, $1; 75 ohm wireless receiver with headband, $1.25; 1/12 H.P. water motor, $1.50. C. M. Adams, Milford, Ohio.

SELL—40 lesson Taxidermy Course, $9. Trade 3 yrs. Youth's Companions for A1, 2 slide tuner. William Litwiller, Hopedale, Ill.

FOR SALE—110 volt, 1½ ampere dynamo ($12) used very little. J. T. Greene, Carrs, Ga.

FOR SALE—Hytone Clapp-Eastham ½ kilowatt transformer in original case. No helix, gap, or condenser. Bargain, $15. Perfect condition. Also new rotary gap. Never used. Adams Morgan make, Robbins & Myers 110 V direct current motor speed 3,000. This gap will be just the thing for the Hytone transformer, $8. Both for $21. All letters answered. Ralph B. Austrian, 49 St. Nicholas Terrace, New York City.

EXCHANGE—"Remy" magneto with vibrator and 1 inch coil without vibrator for 3,000 ohm Phones or what have you? Walter Heinrich, 15 Colby St., Lawrence, Mass.

FOR SALE—Extremely sensitive Audio-Tron bulb, $4. Send for list of wireless goods. What have you for sale? Henry Lehmberg, 5116 N. 12th St., Philadelphia.

WANTED—Burnt out De Forest Audion Bulbs. Will pay cash or exchange wireless goods. Joe Singer, Goldfield, Nevada.

FOR SALE—Tigerman Detecto-Amplifier Type C, panel type with two bulbs, $16. Eddie Smith, 688 South 39th St., Louisville, Ky.

FOR SALE—Thor motorcycle, good running order, has up-to-date equipment. Bargain at $35. Also Thor motorcycle complete except for engine at $10. Harvey Adams, Chambersburg, Ill.

WANTED—R.J. 9 Audion and storage battery, 43 plate variable and E.I. or Murdock loader. L. H. Hammond, Box 51, Baden, N.C.

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NEW $18. Multi-Audi-Fone, $12. Mesco, $12. Intensifying Coil, $7.50. $15 Army binoculars in leather case, $9. All perfect. Peter Pinkston, Valdosta, Ga.

FOR SALE—Pocket Wireless Set 3,000 meters, $2.75; Redhead single head set, $1.85. Max Vineski, Troy, Pa.

EXCHANGE for $16—One Smith Premier No. 4 typewriter, excellent condition, used only short time. Fred Fries, 60 E. Bringhurst St., Germantown, Philadelphia, Pa.

FOR SALE OR EXCHANGE—1¾ H.P. Gasoline Engine nearly new, $20. Wanted, ½ H.P. Gasoline engine. Must be in good condition. Glenn Johnson, Missouri Valley, Iowa.

TO EXCHANGE—Chemical laboratory, value $15 for wireless instruments. J. Y. Parsons, 1906 Park St., Kansas City, Mo.

FOR SALE—Cash only, almost new, half K.W. Blitzen transformer mounted in mahogany, worth $24 at $15. Also R.J. 9 Audion new bulb, $12. New Audio-Tron Panel, two filament, $9.50. Also one K.W. transformer, new, at a bargain. All these instruments good as new. Holtzer-Cabot phones, new, $7. Don D. Tullis, 59 N. Second St., Newark, Ohio.

FOR SALE—10 vols. Hawkins' Electrical Guides and one vol. Rogers' Mechanical Drawing. Cost $12, sell for $7.50. M. Jacobson, Parksville, N.Y.

FOR SALE OR EXCHANGE—Crookes Spinthariscope, $8; Thomson A.C. voltmeter, 0-175, $4, A.C. Ammeter, 0-100, $4. Tuning cabinet hard rubber panel, variometer coupling, no variables, neat, compact and efficient, $12. Home-made transformer coil, about 300 watts, $4. Wanted, small lathe, oscilaudion, variables, books or tools. Experimenter, 2808 N. Lawrence St., Philadelphia, Pa.

WANT TO EXCHANGE lenses, camera and electrical measuring instrument, etc., for old coin and stamps. James Christie, 107 Vanderbilt Ave., Brooklyn, N.Y.

FOR SALE—Tubular Sending Condenser; potentiometer; water motor; large tuning coil; box of wire; screws, etc.; one ten plate sliding condenser, etc. All for $5, as I have no more use for same. Write or call evenings, Henry A. Gilman, 156 Jerome St., Brooklyn, N.Y.

FOR SALE OR EXCHANGE—Brandes Navy Phones, $9.25; regenerative coupler, $6; Clapp-Eastham .002mf variable, $5.75; Murdock 43 plate variable, $3.10; Murdock wave meter, $5; Bunnell key, 75c.; Standard gap, $1; Murdock rotary gap in sound proof mahogany case—cost $20 and is brand new, $11.50; 5 K.W. Aerial switch, $5; Amplifying coil, $5; 5 K.W. Oscillation transformer, $10; 2 sections Murdock Moulded Condenser, $3; 600 feet No. 12 copper aerial wire, $4.75; 8 Ball Insulators, $1; two 10½ inch insulators, 75c.; Lightning switch, $1.25; two 15 foot poles, $5; two spreaders, $2; Winchester model 1906 repeating .22, $8; Surgeon's dissecting instruments, $7.50; L. C. Smith typewriter, cost $97.50, $45. H. W. Semmelmeyer, 2629 N. Fairfield Ave., Chicago, Ill.

SACRIFICE—Smith motor wheel, $35. Particulars on request. Best condition. Francis Pray, 102 Heath St., Winter Hill, Mass.

WILL EXCHANGE a Keystone milli-ampere meter excellent for radio measurements, a Government type Perikon detector, finely finished. Want small 110 volt A.C. motor, rotary variable condenser, A.C. voltmeter or ammeter, or what have you? Samuel Cohen, 1936 Pitkin Ave., Brooklyn, N.Y.

POWERFUL Waite-Bartlett Static Machine. 8 rotary, 8 stationary plates. Gives heavy 16-inch condenser charge. Excellent for X-rays and experiment; perfect condition and best workmanship; complete. Cost over $300. $75 or best offer in wireless. Photos and details upon request. T. Earl, Niles, Mich.

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INDIAN TWIN just overhauled, $70; or trade for marine engine, 6-15 H.P. H. Griffin, Hartselle, Ala.

HAVE—Oliver Typewriter, Model 3. Want cash or receiving apparatus. Make offer. All letters answered. Herbert Richter, Collegeville, Minn.

BARGAIN—Complete new Blitzen Receiving set with extra equipment. Holtzer-Cabot Phones. In perfect condition. Write for particulars. Chas. Bayliss, 68 Peterboro St., Detroit, Mich.

FOR SALE—Complete Audio-Tron on panel with all controls and 4-40 storage battery. Panel has 2 D.P.D.T. mineral change-over switches wired on. Used 10 hours. $10. Also "Arlington" 4,000 M. Coupler, cost $9, for $6.60 and $4. Murdock Oscillation for $3. George R. Hammond, Oelwein, Iowa.

WILL EXCHANGE my Twin-Cylinder, 6 H.P. Merkle motorcycle, in perfect condition, for good wireless apparatus. Francis Joannini, 3326 17th St., Washington, D.C.

FOR SALE—Set Cyclopedia of Applied Electricity. Send for description. All letters answered. J. N. Boyington, South Galena Ave., Freeport, Ill.

FOR SALE—Steam engine designed for commercial use. Bore seven-eighths, stroke 2 inches; and Hoyt voltameter, both cheap; $6 cash. A bargain. John N. Lint, Box 171, Meyersdale, Pa.

FOR SALE—Almost new ½ K.W. Blitzen unmounted transformer, record of this transformer is 300 miles. 10 volumes "Hawkins Electrical Guides" good as new. Write, Hansford Pennington, 1505 Wyoming St., San Antonio, Texas.

QUICK—Type S S Motor, $4; 2 slide tuner, loading coil, condenser, 2 detectors, $6. All new, perfect condition. Send stamp or list. All answered. Chester Shurr, Berthold, N.D.

FOR SALE OR EXCHANGE—One 15,000 meter coupler, one receiving set, one 4½ H.P. gasoline engine. Wanted Omnigraph or what have you? F. B. Dadisman, Independenee, W.Va.

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TRADE—¼ h.p. 133 or 125 cycle A.C. Motor for Audion, Audiotron, or Transmitting Apparatus. H. C. Ross, 1087 Schiller St., Columbus, Ohio.

BARGAINS—Crocker-Wheeler 8 V. 1600 R.P.M. motor, $2. Rebuilt 6 V. Storage Battery, $6. Inch Spark Coil, $2.50. Many other bargains. Write for specifications. H. R. Huth, Beaver Dam, Wis.

WANTED—Two kerosene or gasoline engines, one horse-power, second-hand, good order. Branchaud Bros., Rutland, Vt.

½ H.P. GASOLINE ENGINE, 2000 ohm Red Head Phones (new), 500 ft. Aerial Wire, Coils of Variometers, Loose Couplers, etc., Detectors, Condensers, 4 lbs. Wire, Binding Posts, Switches, Knobs, Buzzers, Miniature Lights, Sockets, Pump Gun, etc. First money order for $15 takes all. E. Myers, 499 So. 21st St., Irvington, N.J.

EXCHANGE—New Telephone goods, large Meccano, gun. Want wireless goods, banjo or revolver. Towns, Marlboro St., Keene, N.H.

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FOR SALE OR EXCHANGE—Tungsten steel magnets, lifts 30 lbs., $1; Telephone magnetos, 75c.; Automobile Transformers, $2.50; 6 volt Starter-motor, $15; generators, $15 and $8; Small motor-generator, $1; Battery charging outfit for Fords, $6.50, automobile magnetos, coils and parts, cheap. Want coils, Volt and Ammeters. Albert Onody, 336 Oak Street, Buffalo, N.Y.

BOYS ATTENTION! Owing to demand, we have added a wireless table with cabinet cover to our list of knocked down furniture. Price from $1 up. Send for descriptive circular. Stevenson Mfg. Co., 459 Tehama St., San Francisco, Cal.

YOU MUST send stamped envelope for list of Wireless, Electrical, Mechanical goods. Carroll, Valley City, N.Dak.

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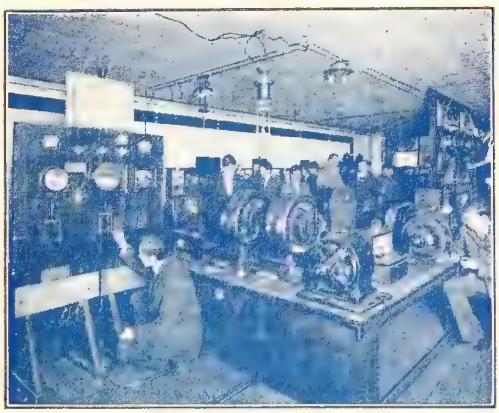
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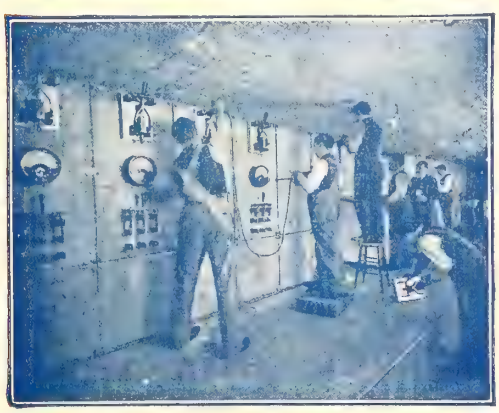
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Silencing America's Wireless

AS all our readers are aware the United States Government, thru the Navy Department, has issued orders thruout the land to cause the immediate dismantling of all radio stations, whether large or small, commercial or amateur, sending or receiving. All aerials have been ordered dismantled and apparatus packed away.

This action came as a great surprise to all patriotic amateurs, who for years past had been encouraged by the Government and who were certain that in time of war they would be allowed to "do their bit" with their outfits for the country.

That the Government should silence all *sending* outfits was eminently proper, and we have as yet to hear the first complaint on that score. But why the *receiving* outfits should be dismantled by the Navy Department is very puzzling indeed.

President Wilson's Executive Order is based upon the Radio Act of 1912, which act however, mentions nothing about closing receiving stations during the time of war. That purely receiving stations were considered harmless by the framers of the law, is best proved by the fact that such stations do not require to be licensed as do all sending stations. Moreover, in President Wilsons's Executive Order of April 6, no mention is made of receiving stations. Indeed, the following passage strikes us as very significant:

"————and furthermore that all Radio Stations not necessary to the Government of the United States for *Naval Communications may* be closed for radio communication."

The italics are ours. Particularly the one word MAY. In the same paragraph the President uses the command SHALL, while the word *may* does not imply that every radio station should be taken over by the Navy Department. Indeed, the longer we study the third paragraph of the President's Executive order, the more we become convinced that the closing of every amateur station, or even commercial stations, was remote from President Wilson's mind when he issued his order.

EXECUTIVE ORDER

WHEREAS the Senate and House of Representatives of the United States of America, in Congress assembled, have declared that a state of war exists between the United States and the Imperial German Government; and

Whereas it is necessary to operate certain radio stations for radio communication by the Government and to close other radio stations not so operated, to insure the proper conduct of the war against the Imperial German Government and the successful termination thereof

Now, therefore, it is ordered by virtue of authority vested in me by the Act to Regulate Radio Communication, approved August 13, 1912, that such radio stations within the jurisdiction of the United States as are required for Naval Communications shall be taken over by the Government of the United States and used and controlled by it, to the exclusion of any other control or use; and, furthermore, that all radio stations not necessary to the Government of the United States for Naval Communications may be closed for radio communication.

The enforcement of this order is hereby delegated to the Secretary of the Navy, who is authorized and directed to take such action in the premises as to him may appear necessary.

This order shall take effect from and after this date.

The White House,
6 April, 1917. (Signed) WOODROW WILSON.

In conformity to the Radio Act of 1912, the President in time of war, may authorize any department of the Government to close all radio stations. But the President's order of April 6, was not to the Department of Commerce, which in the past controlled the nation's radio affairs, *but to the Navy Department.* Why? Because the President, it seems to us, had only the radio communications of the Navy in mind. If, therefore, the Navy Department had caused the closing of all radio stations, particularly sending stations along our sea borders, such action would have seemed perfectly logical. But why the Navy Department should wish to close stations a thousand miles removed from the sea borders, seems to us very puzzling. Furthermore, why all college radio stations, and those belonging to radio apparatus manufacturers as well, should be dismantled seems far fetched. Then there are cases like the one of the Lackawanna Railroad, which is one of the pioneer railroads in the United States to use wireless for train dispatching. Is it wise to dismantle such stations on which the safety of passengers depends?

We certainly have no quarrel with the Navy Department; quite the contrary. We wish to help, but we sincerely do hope that its officials will soon find a way to modify its recent sweeping order.

There are, indeed, encouraging signs already. Certain commercial stations on the Pacific Coast have recently resumed operation, and it is to be hoped that amateurs will be allowed to operate their receiving stations, at a not too distant future. H. GERNSBACK.

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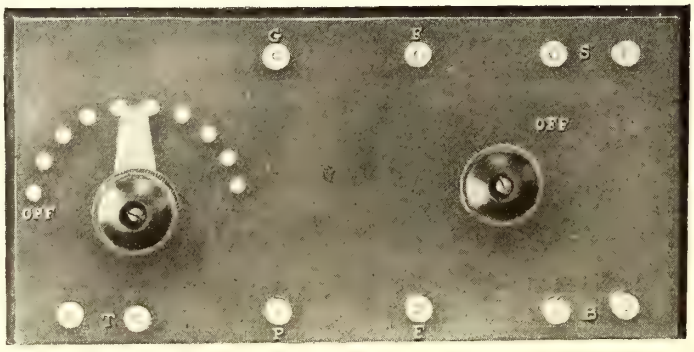
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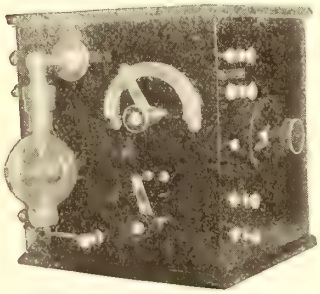
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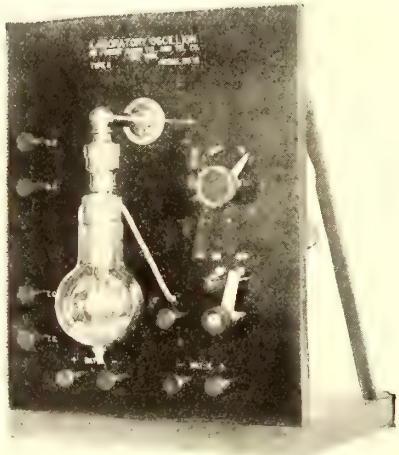
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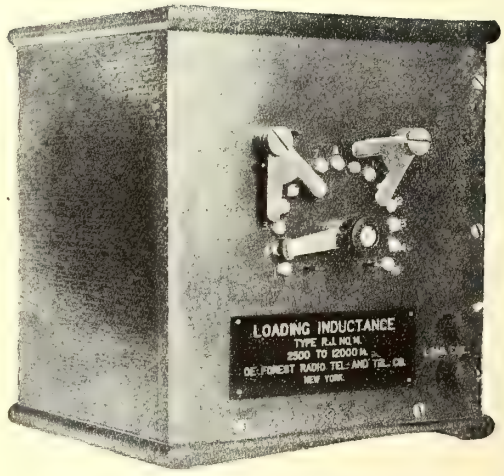
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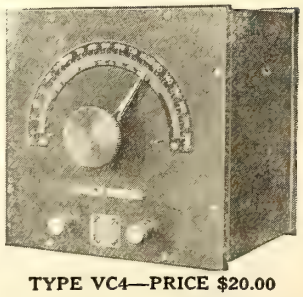


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THE ELECTRICAL EXPERIMENTER

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Electric Crossing Signal Operated by Train's Whistle

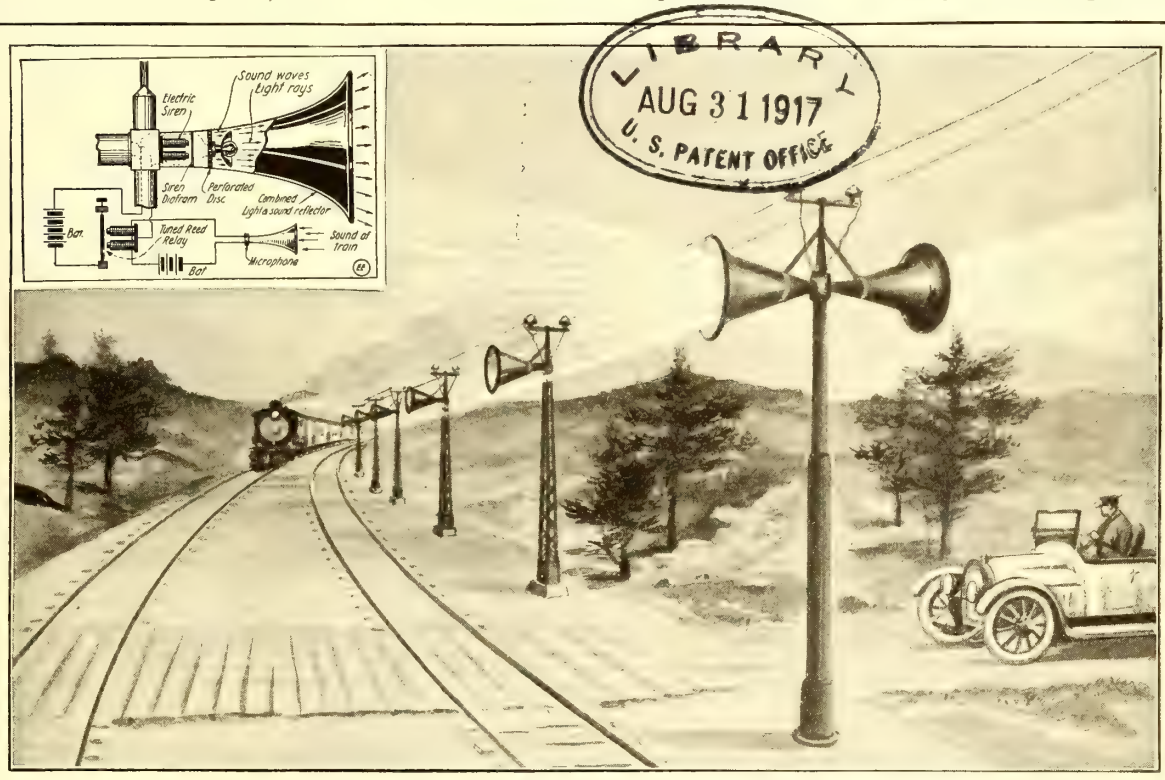
By GEORGE WALL

A NEW YORK genius has developed a clever idea for automatically sounding the alarm at railroad crossings, and whereby the alarm is controlled and actuated by the *whistle* of the approaching train itself. The accompanying illustration shows how the inventor proposes to mount a number of large size horns along the crossing-approaches, each horn being fitted with a super-sensitive electrical microphone, such as used in the well-known *Dictagraph*. When the train whistle sounds for the crossing these microphones, scattered along a distance of several hundred feet on either side of it, pick up the sounds and are caused to control a sensitive relay device operating on the tuned-reed principle. The relay will thus respond with maximum efficiency to a certain whistle tone, as the vibrating reed armature fitted to it is selected to vibrate sympathetically with the dominant note of the locomotive whistle.

When the approaching train's whistle has thus actuated the microphone and in turn the sensitive reed relay, the latter closes the proper circuits to a powerful electric siren installed at the top of the signal tower at the railroad crossing, as shown in the accompanying illustration and diagram of the elemental circuits. For night requirements, the alarm may consist of the electric siren and a powerful beam of light, both of which are projected out of the signal horn. The siren is enabled to project its sound out into the horn past the incandescent lamp, as the latter is mounted on a perforated disc, thus allowing the sound waves to pass by it. The alarm tower may carry two or more of these combined electric siren and lamp signals, and, as becomes evident, the operation of the device is extremely efficient; the alarm ceases as soon as the train has past the crossing.

There are, of course, several details which are not shown in the accompanying view, which would be necessary in carrying out and applying the plan here proposed. For one thing there would have to be some form of time-element device such as a slow-moving dash-pot attached to the sensitive relay, so that the relay could not open the siren and lamp circuits for a period of a minute or so; thus making certain that the signal will sound until the train has past the crossing. The idea is, all in all, quite novel and possesses many other possibilities.

The *microphone* has proven its worth in many difficult rôles in industrial as well as military and naval operations. The soldiers in Europe have found the sensitive microphone of extreme value in listening to enemy sappers as they picked and shoveled a mine below the listeners. Again the French have been enabled to accurately locate and "spot" an enemy submarine off shore by suitably disposing two or more specially tuned microphones along the coast at a known distance apart. Then by a simple triangulation computation on a clever slide rule, the distance at which the submarine happened to be, is readily found, and a fast patrol scout will be waiting for her when she arrives at the surface.



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AUG 31 1917
U. S. PATENT OFFICE

Instead of Having the Gateman Sound the Alarm at Railroad Crossings This Inventor Proposes That Sensitive Microphones be Erected Along the Crossing Approaches, the Sound of the Locomotive's Whistle Causing Them to Actuate a Relay Device Connected to an Automatic Crossing Signal.

Chances for Electricians in the Navy



The U. S. Navy now offers excellent chances to ambitious young men who have a desire to learn a trade and learn it right. The naval electrician has unequaled opportunities for attaining an exceedingly broad and substantial electrical knowledge, covering dynamos and motors, wiring of all kinds, special and standard signaling systems, telephone systems, radio apparatus, and a host of other things with which the average "land-lubber" may never become thoroly familiar. U. S. naval electricians never need to fear that they can not land a job after their service in the navy is finished.

Naval service offers many inducements to ambitious and spirited young men. Not only does it provide opportunities for free travel in many nearby and distant waters with changing scenes, but it furnishes excellent training of high value in civil pursuits at the conclusion of enlistment. It also furnishes steady, healthful work, free board of a wholesome nature, free lodging and clothing, and in addition provides pay, even during the period of training, that can be practically all set aside for saving. The United States Navy pays its enlisted men better than any other national navy and in most lines more than the men could save and in some cases even more than they would receive in similar pursuits in civil life. Above all this it enables the men to render the highest patriotic service open to the citizens of any nation, that of defending the security of their country in the first line of defense.

The many uses of electricity aboard ship and in the naval stations have been steadily increasing. It is used not only for lighting and power service, but also for communication and signaling, and even for cooking and baking. There are a multitude of electric motors in use for ventilating blowers, ammunition hoists and conveyors, gun-pointing equipments, turret-turning machinery, and various other purposes. These motors are supplied thru special control apparatus from turbogenerators, engine-driven dynamos, motor-generators, etc. The lighting equipment includes incandescent and arc lamps, searchlights of the highest powers, special signal lamps, etc. Communication apparatus consists chiefly of telephones and radiotelegraphic sets. Machinery and apparatus in use in the Navy are of the highest types, consequently the training and experience received in their operation and maintenance are of exceptional value to the electrician or radio operator in after life.

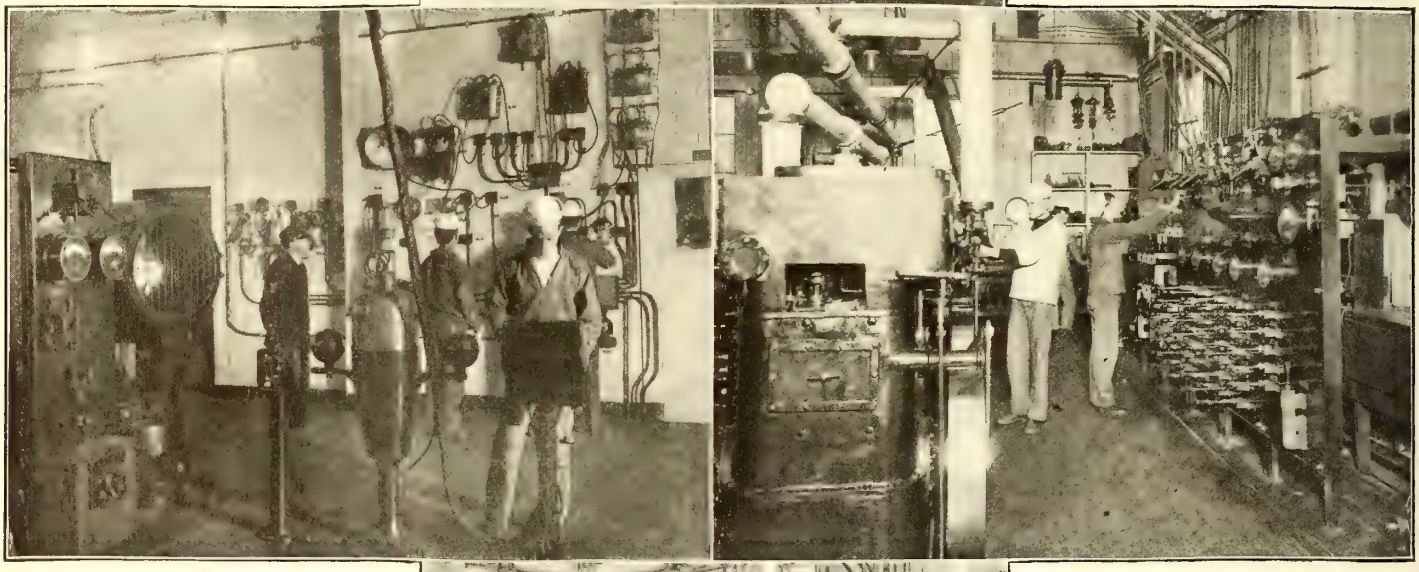
Since the proper operation and care of all the varied electrical apparatus is essential to the efficiency of the Navy, it is the practise to send all new recruits for this branch of the service to either of the two Navy Electrical Schools at the navy yards at Brooklyn, N. Y., and Mare Island (San Francisco), Cal. These schools provide instruction in two classes, general electrical work and radiotelegraphy. The length of the full course for both classes is eight months. Men specially proficient in the work pass thru this period in shorter time, depending on the knowledge and skill they show. All students, either recruits or men from the general service, may enter these schools at any time. In addition to the practical instruction imparted at the electrical and other naval trade schools and training stations, the men receive thruout their service aboard ship and elsewhere both academic and practical training to enable them to demonstrate their ability and to advance in their chosen vocation.

In order that a recruit may enlist for the electrical branch, he must have a knowledge of either general electricity, or be an operator of the Morse telegraph code or have sufficient foundation in radiotelegraphy to be competent to keep up with the class at the school. Electricians (general) must know the names and uses of the various parts of the dynamo and dynamo-driving engines and must be familiar with the ordinary types of switchboards and methods of wiring. Applicants for both classes must be able to write legibly, must understand elementary arithmetic and must be between the ages of 18 and 25. All applicants must be citizens of the United States, either native or fully naturalized.

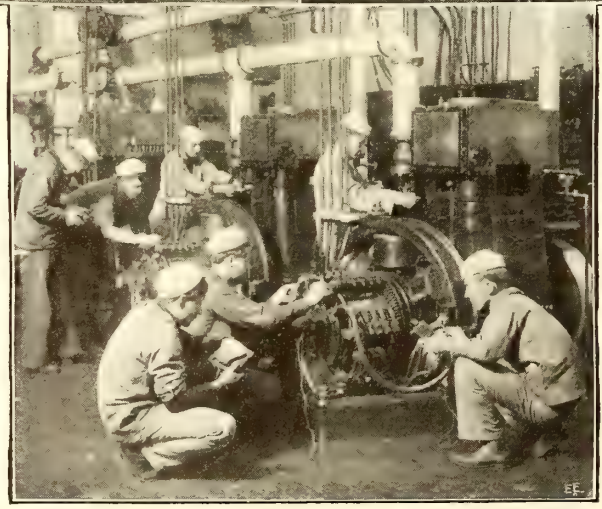
Recruits meeting these requirements are immediately transferred to the electrical school, where the course of instruction comprises machine-shop work,

(*Continued on page* 142)





Another View of the Electrical School at Mare Island, Calif., Class Receiving Instruction in Electrical Appliances, Including Electric Searchlights.



Top:—View in Navy School, New York, Class in Interior Communication and Ship Control Apparatus. Below:—Testing Dynamos and Motors.

Uncle Sam's Naval Men Receiving Training in the Operation of Electric Generators in the Navy School at Mare Island, Calif.

Talking Motion Pictures Via Wireless

MANY of us have no doubt witnessed an exhibition of talking motion pictures, and numerous patents have been taken out on some very elaborate schemes intended to improve the efficiency of the apparatus involved in recording and reproducing the voice, as well as the figures of photoplay productions.

One of the most novel ideas devised toward accomplishing this purpose is outlined in a recent patent awarded to William B. Vansize, of Brooklyn, N. Y. The accompanying illustration by our artist shows how the inventor proposes to utilize and apply the art of radio communication to the recording and reproduction of talking motion pictures. In the first place, the studio stage is fitted with a metal floor, such as one covered with tin or sheet iron. This may be painted so as to give the effect of tile or carpet, and may have a few rugs scattered about to give an artistic stage setting. The small insert illustration shows how the inventor proposes to have each actor actually personify "a walking wireless station." In brief, each actor carries a complete wireless transmitting system on his person. When the actor speaks, the voice waves affect a supersensitive microphone hidden inside the coat or in the bodice, in the case of a woman. This microphone is connected to some form of miniature wireless transmitting apparatus, such as an *Oscillion* or vacuum bulb generator of radio currents. The voice fluctuations are caused to vary the current developed by the Oscillion, and these fluctuating, high frequency oscillations corresponding of course to the voice, are radiated thru a *ground* wire leading to metal plates (and points if necessary) on the heels of the actors, as shown, and also thru a miniature antenna comprising a series of tin-foil leaves which are sewn in the clothing in the manner indicated in the accompanying illustration. The radio apparatus is carried in the clothing, and the weight of each part distributed in the best manner possible. As will be noted the batteries are placed somewhat differently in the case of a lady, as compared to a man.

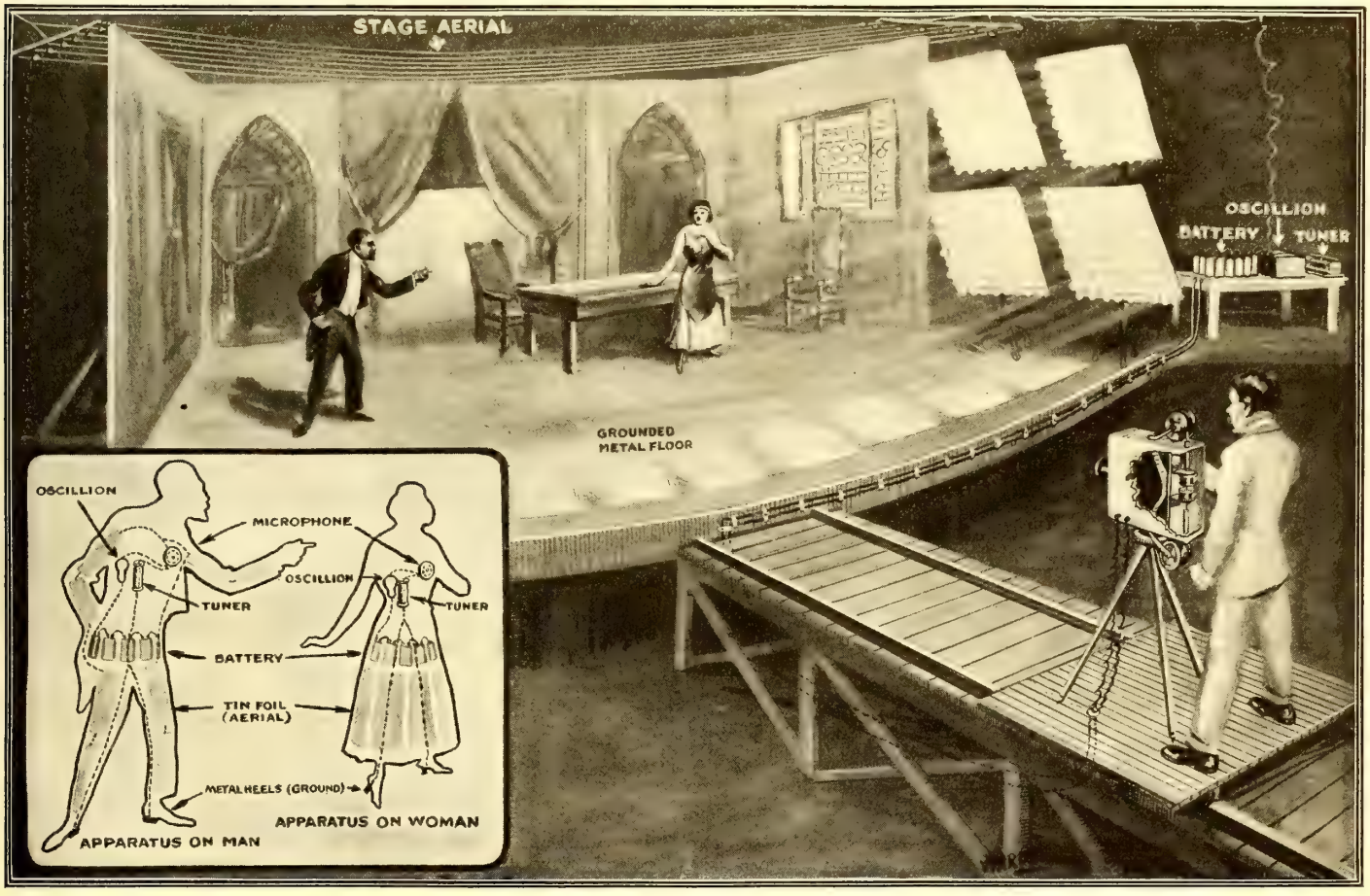
Thus far we see that whenever the actors speak, that they will be radiating wireless telephone currents, and these are intercepted or picked up by a larger radio antenna erected back of or just above the scenic settings of the studio stage in the manner illustrated. The stage antenna is connected up thru suitable tuning coils, with an oscillation or vacuum bulb device, which is used in this case as a detector and amplifier of the received radio-telephonic currents.

Now we have the actor's voice radiated by wireless from his own person, thence propagated thru space by etheric waves, and finally, we have them coming in thru the receiving circuit of the stationary radio detector. The secondary or auditory circuit of the detector and amplifier is connected with the recording electro-magnets of a Poulsen telegraphone, mounted intact on the motion picture camera which is recording the scene photographically. Thus, as the photographer turns the handle on the motion picture camera, he not only records the physical movements of the actors, but simultaneously he also obtains a corresponding record of their voices on the moving steel wire of the telegraphone, which has been explained in detail in previous issues of this journal.

In brief, the telegraphone operates upon the principle that if a moving steel wire is past by the pole of an electro-magnet thru which electrical voice currents are circulating, then there will be *local magnetizations* set up in the steel wire corresponding to the voice fluctuations. If then we afterward pass this steel wire under another electro-magnet, the coil of which is connected to a telephone receiver, we can then hear the voice reproduced.

The great problem confronting all inventors who take up talking motion picture work is to accurately and practically synchronize the motion picture voice with the voice of the actor. This is the most important problem, and by means of this wireless telephonic arrangement, as proposed by Mr. Vansize, it seems that it should become a simple matter to readily accomplish the purpose intended, viz., to record and reproduce faithfully a talking motion picture, and one in which the actors' lips will not be moving about ten seconds after the voice is heard or vice versa.

In practise a number of loud-speaking telephones are scattered about the moving picture theatre, and as the operator cranks his machine, the telegraphone wire is unreeled at exactly the same speed. The impulses from the recorded telegraphone wire now are used to operate the loud talkers about the house, with the result that the audience sees *and hears* the actors in a truly remarkable manner.



The One Great Problem in "Talking" Motion Pictures Lies in the Difficulty of Simultaneously Recording the Voice and the Scene. A New Method of Accomplishing This End Is Illustrated Here. Each Actor Carries a Radio-Telephone Transmitter on His Person. His Wireless Love and Other Speeches Are Intercepted by a Stage Antenna, Connected to a Radio Receiving Set. This Set Is Connected to a Telegraphone Joined Mechanically to the Motion Picture Camera. Thus Synchronism Between Voice and Picture Is Established.

Electricity and Water to Run Our Autos

GASOLINE forms the nucleus of power in practically all automobile engines of the present day, and many inventors and chemists have expended considerable energy and money in an effort to find a satisfactory substitute for this all-important commodity, which has been rapidly and constantly increasing in cost. One of the latest attempts in this direction is that of Mr. Ernest E. Punches, who hails from Detroit, Michigan.

"Give me a suitable tank containing a set of plates submerged in water and a source of electric current, and I will drive your automobile engine without any gasoline whatsoever at reduced cost," says this sanguine inventor.

The secret of this remarkable invention lies in the fact that if an electric current is past between two plates submerged in water, it decomposes the water, evolving two gases, *oxygen* and *hydrogen*; the oxygen accruing from this process is liberated, while the hydrogen is collected and when suitably mixed with a proper amount of air, it forms a highly explosive mixture when ignited in the automobile engine cylinder.

The accompanying illustration shows how the proposed water-electric gas-generating plant would be fitted to a motor-car, the special dynamo together with the decomposing chamber and gas storage tank being placed with the engine under the same bonnet. The small Unipolar type dynamo is connected by suitable gears or driving chain to the timing gear on the crank shaft of the engine, and supplies a low voltage direct current. This current is past thru the electrolytic cell shown in the illustration, alternate plates being charged positively and negatively. The plates are preferably perforated so as to promote circulation in the gas-generating cell, and by the close arrangement of the positively and negatively charged electrodes, the gas generation is both rapid and efficient.

As before mentioned the oxygen is liberated by suitable automatic valves, and the hydrogen is retained and past thru a mixing valve, similar to the usual carburetor used on all gasoline engines and which can be controlled from the driver's seat, following the standard practise in motor-car equipment. A suitable quantity of air is taken in thru the mixing valve, and which, when combined with the proper quantity of hydrogen, forms a highly explosive gaseous compound. When this is fed into the engine cylinders and ignited by an electric spark, it produces a force many times more powerful than that obtained when gasoline vapor is used. Some of the hydrogen gas produced by the electrolytic cell (decomposition of water) is stored in a suitable tank under pressure, which makes it available for starting the car and emergency. The entire combination unit fits the carburetor side of the engine and is supported by the former manifold holding means and also by the frame of the auto chassis. It has been found by Mr. Punches from trial and also by calculation, that the hydrogen gas-generating outfit here described, and which it is proposed to substitute for gasoline, will require up to 5 per cent of the horse-power developed by the engine, this 5 per cent of the total engine horse-power being used to drive the decomposing current dynamo.

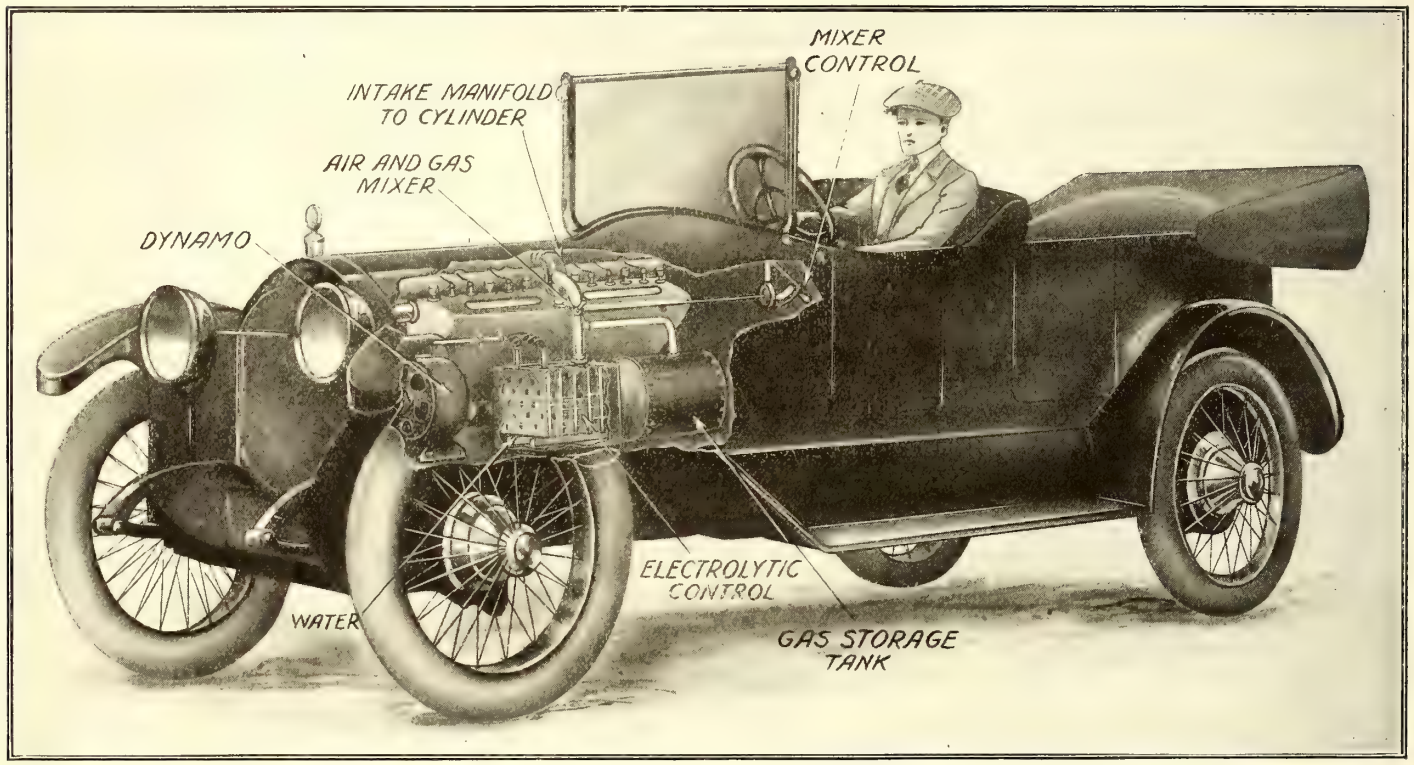
There are 1,257.52 cubic feet of hydrogen gas in one cubic foot of water, the gas at atmospheric pressure, zero degree Centigrade, and it will require 1,728 watts of electricity to decompose a cubic foot of water in one hour. Compare this with the following data, obtained from a Chalmers Motor Car Company engineer:—

The maximum revolutions of the Chalmers motor is 3,000 per minute under full load. The motor develops 45 h.p. on an average at this speed, and under full load, with a well worked in motor. The suction displacement per revolution is 244/2 equals 112 cubic inches; equals .0648 cubic feet. Then at 3,000 revolutions per minute and assuming 100 per cent volumetric efficiency, the number of cubic feet drawn into the motor per minute is 3,000 times .0648, or 194.5, and 60 times 194.5, or 11,670, is the number of cubic feet drawn into the motor, of mixture each hour, running at maximum speed and under full load.

The gasoline entering into that mixture is 7 per cent by weight, and the amount by volume will not depart far from the 7 per cent, as there is no great difference between the weight of air and gasoline vapor. So, in face of the fact that an explosion of hydrogen in a pure state, when mixed with air, is a *thousand times* as powerful, as is the same per cent of gasoline vapor and air, we shall be way above in figuring a 10 per cent mixture of hydrogen gas with air. As 10 per cent of 11,670 is 1,167, the number of cubic feet of hydrogen, we must generate in an hour. Bearing in mind that there are 1,257.52 cubic feet of hydrogen in a cubic foot of water, and that 1,728 watts will decompose the cubic foot of water in an hour, and also that 746 into 1,728 goes about 2¼ times, it is apparent that we will generate 90.52 cubic feet of gas per hour more than the Chalmers motor can use at maximum speed, and under full load, taking *less than* 5 *per cent of the* 45 *h.p.* to drive the decomposing current generator. The inventor has demonstrated his invention before the entire engineering staff of the Tecla Electrical Laboratory of Detroit, Michigan.

When it is understood that gasoline is simply a mechanical mixture of hydrogen and carbon gases and impurities, it will be seen that a mixture of pure hydrogen gas

(*Continued on page* 145)



A Detroit Genius Claims to Have Solved the "Gasoline Substitute" Problem for Automobiles. He Utilizes a Very Simple Electrical Phenomenon—That of "Electrolysis" or the Decomposition of Water by the Passage of An Electric Current Thru It. The Hydrogen Gas Evolved Is Mixed With Air and Past Into the Engine Cylinders. The Inventor States That It Is More Economical Than Gasoline Because of the Higher Explosive Value of the Hydrogen-Air Mixture.

OPTICAL DEVICE THAT RIVALS TELESCOPE IN STUDYING THE HEAVENS.

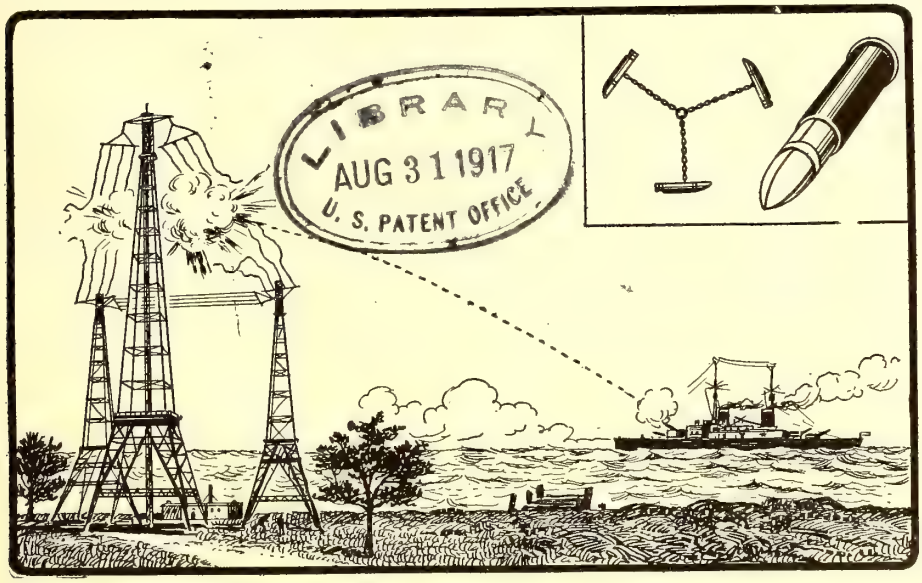
An optical device, which is said to rival if not surpass the telescope in revealing the mysteries of the heavenly bodies was exhibited at a recent meeting of the American Society of Mechanical Engineers in New York. The invention was exhibited by Dr. John A. Brashear, the grand old man of American astronomy, of Pittsburgh.

"This instrument is called a diffracting grating," said Doctor Brashear, as he showed what looked like a rectangular piece of metal about 2 by 4 inches long that changed colors under the electric lights. "On the plane surface of this polished plate, made accurate to one-tenth of a light wave, or within one-forty-five-thousandth of an inch, are ruled more than 45,000 lines between which there is no greater error than one-two-millionth of an inch.

"With this delicate piece of apparatus, made possible, first by rigorous scientific research; second, by the skill of the artisan; third, by a knowledge of a vigorous care to avoid temperature changes, and, fourth, by the accuracy of the mechanism, the astrophysicist has been able to tell the composition, temperature and distance of the stars."

REVIVING THE CHAIN SHOT TO DESTROY RADIO AND OTHER AERIAL WIRES.

An American inventor has recently proposed that the military and naval authorities revive a relic of warfare which was in vogue many years ago—this is nothing less than the generally well-known *chain shot.* In our grandfathers' and great-grandfathers' day it was considered quite a nifty idea to tie one or more cannon balls together with an iron chain—thus, the name *chain shot.* The accompanying illustration shows a clever form of split projectile composed of three or more pieces divided in the manner shown, so that by means of a time fuse or other arrangement, these pieces would fly thru the air as a solid projectile, and at the critical moment would explode and describe a path of considerable width thru the atmosphere, and proving, it would seem, of decided efficiency in destroying radio antennae, and all other elevated wire structures such as telegraph and telephone wires, power transmission circuits, et cetera.



A New War Invention Is a Split "Chain Shell" That Automatically Explodes at a Given Range. It Should Prove Particularly Valuable In Destroying Radio Antennae and Other Wire Structures.

GOVERNMENT TAKES OVER MARCONI STATIONS.

The U. S. Government has availed itself of the offer of the Marconi Wireless Telegraph Company of America, placing its staff and stations at its service and has taken over for the period of the war not only the Marconi stations but all other radio stations for military purposes. The eligible operators will be enrolled in the government service. Stations not required will be closed. The trans-Pacific stations will continue handling commercial traffic, but under government supervision. No ship traffic will be permitted on the Atlantic and Gulf Coasts and the Great Lakes excepting for the government, but it will continue for the present on the Pacific. Trans-Atlantic traffic via Glace Bay will not be disturbed. The Director of Naval Communications, Lieutenant Commander Todd, at Washington, will have charge of stations operated by the government. Enrollments will be made by commands of naval districts.



To Counteract the Poisonous Gas Fumes Blown Toward European Trench Rescuers Who Are Called Upon to Go Forth and Carry Prostrate Soldiers From Their Positions, They Have Guarded Themselves Against Being Overcome by a Novel Telephone Appliance Attached to the Gas Defying Equipment.

EUROPEAN SOLDIERS USE GAS MASKS FITTED WITH TELEPHONES.

The accompanying illustration shows in a marked manner one of the peculiar and particularly effective scientific devices brought out by the great European war.

Needless to say this war of all wars has developed hundreds, even thousands, of new inventions of every conceivable character. First the Germans invented the gas apparatus by which they attempt to overcome their enemies in the trenches with clouds of noxious fumes, and here we have the answer to this challenge in the form of a *gas mask* or helmets, which are worn by the members of the trench rescue brigade, who are called upon to go forth and carry prostrate soldiers from their positions where they may have fallen between the trenches, when overcome by the gas cloud. Each gas helmet and mask is fitted with a novel and specially designed telephone outfit, properly connected to a trailing wire leading back to the trench, so that the rescuers are able to telephone for aid without removing their helmets or apparatus.

GOVERNMENT RADIO BILL GOES OVER.

House leaders at Washington have decided definitely not to pass at this session the Administration bill for permanent Government dictatorship over wireless apparatus, unless the President specifically requests it.

It was learned that the House Merchant Marine Committee believes the President already has power enough over radio stations to prevent their use in time of war.

The principal feature of the bill is its provision for eventual Government ownership of radio companies. This feature is not considered by the committee to be strictly war legislation.

Shooting With Electricity

By H. Gernsback

YEARS ago, when the New York City elevated lines changed from steam to electricity, one of the elevated trains caught fire. An alarm was promptly turned in and in due time the firemen were on the spot. The stream from the high-pressure hose was played on the cars, and to prevent the fire from reaching the wooden structure on which the rails rested, as well as the wooden foot path, one of the firemen of necessity directed his stream on the third rail.

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The stars are not intended to indicate what happened and what that poor fireman saw; rather they are meant to illustrate how long he remained unconscious. As a matter of fact the man was almost electrocuted. Since that time firemen do not fight elevated fires unless they are assured that the power has been turned off.

Now, the N. Y. Elevated Lines only carry 500 volts direct current, but this pressure is sufficient to pass from the third rail line, then to the water of the fire hose, and from there into the metallic nozzle held by the fireman. Altho ordinary hydrant water is a poor conductor, a 500-volt current nevertheless finds but little trouble in passing thru the stream of water and thence thru the body of the fireman, with the result that he is knocked unconscious. If the stream had been sea (salt) water, there remains little doubt but that the man would have been electrocuted instantly.

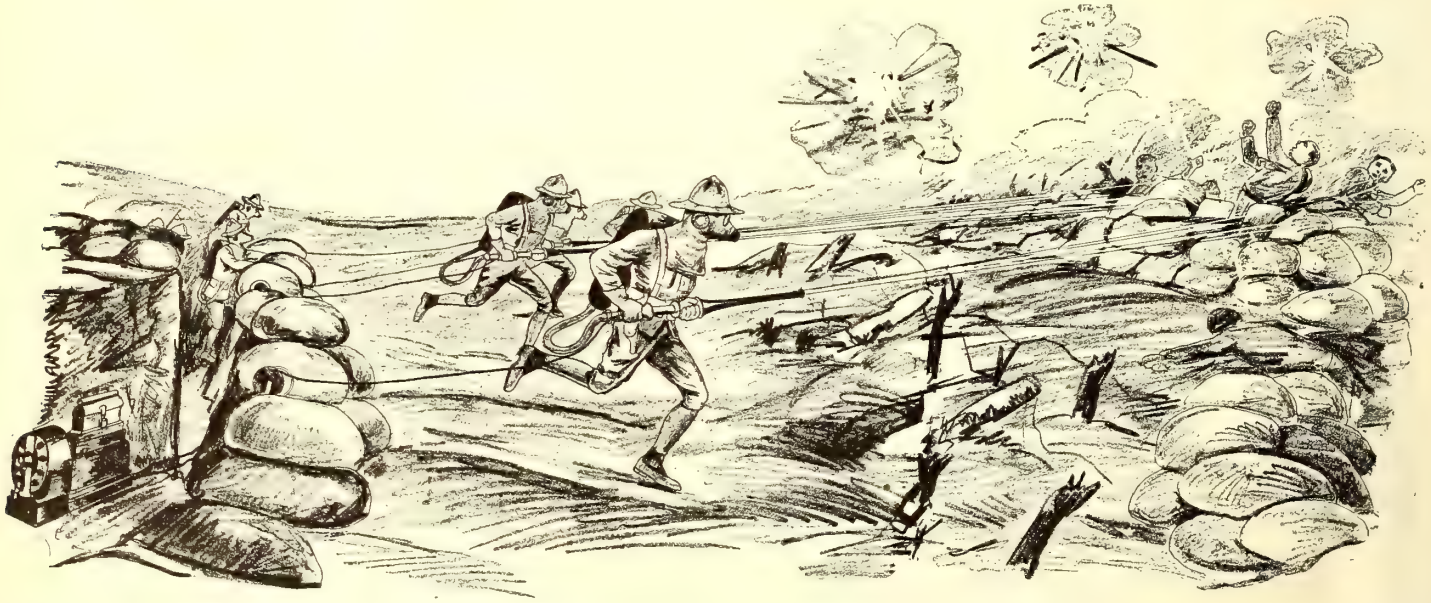
Upon this principle the writer has based his idea of *shooting electricity* at an enemy, impracticable as the scheme sounds at first thought. Many murderous ideas, of course, have been advanced for trench warfare, the German *Flammen Werfer*, whereby liquid fire is sprayed upon the enemy, being a parallel to the writer's scheme. While shooting flames over a distance of 50 feet or more has not proven a wonderful success, nevertheless the idea seems to have some merits. And if the Germans can shoot flames at us, why can't we return the compliment by shooting electricity at them? One is as easy as the other, with a few points in favor of the latter, it would seem.

HAVE you ever stopt to consider that a fireman does not dare to let a stream of water from a nozzle strike an electric wire, carrying any appreciable potential, say a thousand volts or more, as he may be electrocuted. Proverbially speaking, it is a poor rule that will not work both ways. Hence we have the unique proposal by Mr. H. Gernsback, that we charge the enemy with highly electrified streams of acidulated water under high pressure. This unusual invention is not intended as a substitute for guns, but to supplement them. It represents one answer to the German's "Flammen Werfer"—Liquid fire.

Briefly, the idea is as follows: Strapt to a soldier's back is a lead-lined metal tank carrying a solution of diluted sulfuric acid of about 1200° specific gravity. (A solution of chlorid of zinc or even ordinary salt water could be used.) By turning a knob on the outside of the tank a small quantity of zinc or iron filings is thrown into the acid and immediately hydrogen gas is evolved, causing considerable pressure inside of the tank. This causes the acid to be forced out thru the hose attached to the tank and from the hose the acid passes thru the long nozzle carried by the soldier. The acid leaves in a fine stream, less than a quarter of an inch in diameter, and with a fairly calm atmosphere, it should carry from 75 to 100 feet. For most purposes, 50 feet however, will probably be found sufficient.

Now, back in the trench (or behind the lines) there is a 10-H.P. gas engine driving a 5- to 8-H.P. Alternating Current Generator. The latter is connected to a step-up transformer delivering from 10,000 to 15,000 volts. A thin but extremely well insulated cable connects with the nozzle carried by the soldier. This cable is connected to one side of the transformer; the other pole is *grounded* to earth. If now the stream hits an enemy soldier (who is not insulated from the ground), the high-tension current passing thru the stream of highly conductive acid, runs thru the man's body and thence thru the earth, back to the transformer. In this case he probably will be electrocuted or else knocked senseless by the powerful current. Even standing on a piece of dry wood or a stone will not help him, for the acid running down from his uniform will turn the wood or the stone into an excellent conductor and the enemy will almost certainly be rendered unconscious. Probably the most efficient way of utilizing the new scheme will be found in directing the charged stream at a machine gun. The second the stream hits the metallic portion of the gun, the operators will be knocked unconscious or will even be killed. It is also understood that the entire electrocuting outfit, gasoline engine, dynamo, transformer, acid tank and all the rest of the equipment could be placed in an armored car. In that case, the operators would not be exposed to machine gun fire.

When used by the soldier, however, it is self-evident that his equipment must be such that he himself will not be electrocuted. To that effect he wears a special "high-tension" rubber shoe, capable of withstanding 20,000 volts.* Then too he uses "high-tension" rubber gloves, and in addi-



The Germans Invented "Liquid Fire" With Which to Destroy the Enemy. Here Is An American Invention—Shooting the Enemy With Piercing, High-Pressure Acid-Water Streams Charged to An Electric Potential of 15,000 Volts. Trench Gasoline Engine, Electric Plants and Transformers Supply the Necessary Power. The Nozzles Are Heavily Insulated and the Soldiers Wear Heavy Rubber Shoes As Well As Gloves and Masks.

The Best Way to Aid the President

By HOWARD H. GROSS,
President Universal Military Training League

A FIXT military policy which will protect the nation and strengthen her manhood is the special need of the hour. Each passing day demonstrates this. This League and its sponsors believe that in universal military training lies the nation's chief hope. They therefore urge two things:

First and foremost: Stand behind President Wilson in every way. He is bearing a tremendous burden. Assist him in all emergency measures, whether financial, military or economic.

Second: Use every influence to impress upon our Senators and Representatives in Congress that emergency war measures now pending will not solve our military needs except *temporarily*. They may carry the country along for the present, but they will not do for the future. The most democratic program as a *fixt military policy* for the United States is that of *universal compulsory military training*. It treats all alike, makes use of young men before they reach the age where their earning capacity is high and when they are yet unmarried, and gives them six months' intensive military training. Then it sends them back to work. These trained youth will form the backbone of a great, democratic citizen army. This is the only definite, simple and patriotic plan that will make America safe and ready.

I earnestly hope that every American will stand by President Wilson and the Government officials who, with the President, are bearing a gigantic responsibility. I have just returned from the national capital and I know and sense in a measure the weight that is taxing our silent and conservative Chief Executive. It would be shameful to see his plans for meeting this crisis defeated. Therefore, as should all citizens, I bespeak general co-operation with President Wilson in these mighty works.

They are emergency measures, as he has said. This universal military training plan is supplementary to the President's emergency measures. It goes further and will last longer. While he is doing all that he can do safely to pilot the ship of state thru the eddies just ahead, I ask all patriotic citizens not only to strengthen his arm in this effort, but to aid the nation as a whole in supplementing the President's labors by the establishment of universal military and naval training.



What Military Training Does For a Man. Compare the Two Recruits on the Left With the Two Erect Figures on the Right. They Are the "Same Men," Photographed Before and After Being Trained for Five Months in the U. S. Army.

The benefits resulting from such a democratic plan for raising an army in emergencies cannot be over-estimated. The last few weeks have shown how weak and futile other devices have been. The *volunteer* system is unfair, and because it is so thousands of young men who are as patriotic and loyal as the best in the land will not offer their services. They have come to realize that the strong, highest types of manhood go forward while the cowards and slackers only too gladly stay at home. The best blood goes to the front while the unpatriotic rejoice in secret in the opportunity to remain safe and sound at home, pile up money and have a good time.

Such a false premium upon patriotism is not only disgraceful in a national military program, but it is decidedly uneconomical and wasteful. In nine cases out of ten the slackers are able-bodied, and under proper tutelage would make good soldiers, while the patriotic fellows who rush to the colors are the sort who are needed most to man the commercial and financial craft of the nation. The best brains will go into the ranks as privates and leave the sluggards at home to conduct the nation's affairs. This is fundamentally bad in a democracy.

Selective conscription no doubt may be necessary at times, but it never will be popular. *Universal military training*, on the other hand, is, thru its very universality, plain, simple democracy. It says that all having the blessings of our institutions should, in time of need, contribute their aid to defending these institutions. It says, further, that the untrained soldier is so much "cannon fodder," and that the chances of the trained lad returning home in health from war are about three times greater than the untrained boy's.

Therefore, in universal military training, the secret of our general military and naval needs for today, tomorrow and All Time is found.

The Universal Military Training League makes special appeal to the people of the country to write their Congressmen to back President Wilson in all his emergency measures and to eradicate forever the doubt, uncertainty and weaknesses of present muddled military policy by establishing in law a fixt plan for universal, compulsory military training and service.

Stand by your President and strengthen your nation!

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tion to this the nozzle is heavily insulated from his hands by means of a special insulator, as grafically shown on our front cover. The tank of course must be well insulated by soft rubber pads from the back of the operator. Thus equipt he is in little danger of being shocked by the current.

In order to prevent the wind from driving his own acid spray against the operator's face, he is also equipt with a soft rubber mask, as illustrated on our front cover and on opposite page.

From a humanitarian standpoint, the scheme is far ahead of the German flame shooter; sulfuric acid of 1250° does not blind, nor does it destroy animal tissue, unless it remains in contact with it for a long period. Sprayed on the skin, but slightly itching results after a lapse of several minutes. On the other hand, the high-tension current kills either outright, or otherwise puts the enemy out of the fighting for the time being, with little bad after-effects. The acid, plus electricity, does not cause horrible burning wounds or burned off limbs as does the liquid flame.

As with all war-schemes, the wise ones will now ask the usual question: What happens, if the enemy too uses the electrocuting apparatus?

In answer the writer asks another question: What happens, if the enemy *too* uses liquid flames, or if the enemy *too* uses machine guns?

*This shoe was described on page 24, May, 1917, issue of this journal.

AUXILIARY SIGNAL CORPS UP-TO-DATE.

Perhaps the finest single auxiliary signal corps possest by any army has been given to the United States by the American Telephone and Telegraph Company. About 500 engineers already have been selected and some of them have been sworn into army service. The differences between government pay and their salaries with the telephone companies will be paid by the latter.

The corps will be made up of general plant and traffic engineers to plan, set up and operate telephone, telegraph and wireless plants. If the regular force of the army proves to be too small, men also will be provided to assist in the wireless work.

DATE OF ISSUE.—*As many of our readers have recently become unduly agitated as to when they could obtain* THE ELECTRICAL EXPERIMENTER, *we wish to state that the newsstands have the journal on sale between the fifteenth and the eighteenth of the month in the eastern part of the United States and about the twentieth of the month west of the Mississippi River. Our subscribers should be in possession of their copies at these dates. Kindly bear in mind, however, that publications are not handled with the same dispatch by the Post Office as a letter. For this reason delays are frequent, therefore kindly be patient and do not send us complaints as to non-arrival of your copy before the twenty-fifth of the month.*

Electricity's Aid to Women



Here We Have the Combination Electric Stove, Stript for Action—Said Action Being That of Frying Eggs. And They Do Say Electrified Eggs Taste the Best.



Cook by Wire—Without Fire. The Combination Electric Table Stove Shown Above Enables You to Fry Eggs, Broil Chops, Make Toast, Boil Water—Yes, and It May Even Be Used as an Oven.

Who Can Remember Ironing Day Without Wishing There Wasn't Any Such Animal. But All Is Changed. Behold the Electric Ironer That Really Does Wonderful Work at 4 Cents an Hour. Even the Chinaman Is Outdone.





Have You Ever Been Down South? If So, You Know "Waffles." Well Here's an Electric "Waffle Iron" That Makes Two Delicious and Geometrically Correct Waffles at One Time, Cooking Top and Bottom.





And There's the Sewing Machine. An Electric Motor Drives It Merrily at Half a Cent an Hour. Press the Treadle and Control the Power.



Remember the Fellow Who Told the Waiter the Steak Was Too Rare? Said the Waiter—"We Cook by Electricity." "Well, Give That Steak Another Shock," Said the Patron.

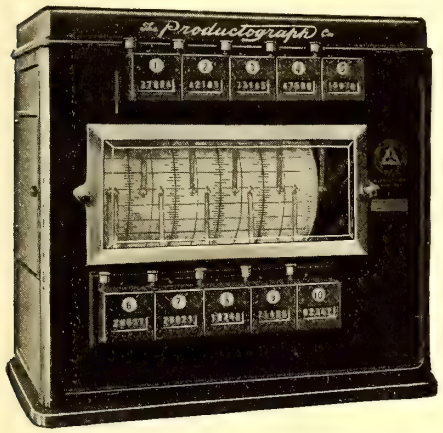
Do You Have to Polish Waxed Floors? This Back-Breaking Task Is Now Accomplished in a Short Time and in a Highly Efficient Manner, by the Electric Motor Floor-Polisher Shown.

Electricity's Place In Business

ELECTRICITY SPELLS EFFICIENCY TO THE BOSS OF TO-DAY.

Efficiency has reached a very important rôle in modern industry where the manufacturer manifests a desire to obtain the maximum output of his plant with a minimum input—in other words—Efficiency. Various schemes have been promulgated in the direction of increasing efficiency in machinery and it was found that the best means which the manufacturer can employ to determine the efficient output of his plant is to note the actual productive power of the *individual* output of each machine and employee. Schemes were introduced for this purpose, but the defects encountered in them were numerous and most of which had to be abandoned for the purpose for which they were made.

The distinct need of an instrument for increasing the efficiency in productive plants grew more and more urgent, which caused a number of prominent engineers to study this rapidly growing problem. This work finally led to the development of an instrument called the *Productograph*, herewith illustrated and which has proved the solution to this absorbing problem. The introduction of this instrument was made possible by the application of electricity.



The Business End of the Electric "Productograph"—the Instrument that Keeps Tally on the Daily Output of Each Worker in Shops and Factories.

The first illustration shows the complete instrument which is stationed in the manager's or superintendent's office. It consists of a drum upon which a sheet of specially prepared paper is placed. Over this paper there are ten recording needle arms, which are actuated by electro-magnets; these are located within the cabinet. Each needle is directed over the proper section of the paper and each needle is electrically connected to a single machine, of which the productive efficiency is to be found. The sections of the paper are longitudinally divided into 24 equal parts corresponding to 24 hours. Each division is subdivided into minutes. The cylinder is rotated by means of an electric motor connected to a standard clock, operating a series of electrical contacts. Normally, when the needle arms are not acted on by the electro-magnet, which is connected to a special switch attached to the machine the record of which is to be obtained, a straight line is made and every time the machine is in operation, it causes the switch to close the electrical circuit periodically, which operates the needle arm and this in turn traces a curve on the paper. If the machine stops for any reason, the indication on the paper shows this and immediately gives the owner visual indication of the fact. In addition to this equipment, an electro-magnetic counter is connected to the same circuit, which indicates the number of operations made by the machine. Thus, if this instrument is attached to a printing press, it will indicate exactly the number of printed sheets that the machine has made during a certain period. Each needle has its corresponding counting instrument and both are connected to a single switch. This particular instrument herewith shown is adaptable for ten machines.

The second photograph shows the adoption of this device in a clothing establishment, where it is used for checking up the number of coats made by each operative.



Here We See a Portable "Productograph." Connected to Each Machine It Enables the Young Lady in the Foreground to Readily Keep an Exact Record of Each Employee's Output.

APPLYING PSYCHOLOGY WITH THE ELECTRIC "PSYCHOMETER."

The latest device for testing speed and quality of human thought is the "Psychometer," which is an electrical apparatus now being used in San Francisco, where it is being applied to accurately measure the degree of alertness in employees in industrial establishments, as well as general mental alertness in all vocations.

The Psychometer is operated by either alternating or direct current and may be attached to the baseboard electric light socket. The clockwork attachments and electrical connections are operated by pressing a simple telegraph key which is connected with the baseboard plug. The instrument is built in a grip and may be easily carried around. The readings are made by an electric light, which is mounted on the side of the small suit case. The instrument is an accurate gage of memory and measures speed and quality of thought to the fifth of a second, besides charting alertness and ability to react quickly in mechanical work and emergency situations.



Photo from Press Illustrating Service.

Prof. Münsterberg Claimed to Be Able to Select the "Best" Ship Captains, Locomotive Engineers, Aviators, Etc.—All by Psychology. Here We See the "Psychometer" Being Used to Test the Mental Alertness of San Francisco Factory Employees. The World Do Move.

PROMINENT ELECTRICAL ENGINEER BECOMES ARMY MAN.

Appreciating the importance of securing the ability and training of the engineers of the country for use in national defense measures, President Wilson has appointed a number of prominent engineers in the country to positions in the army.

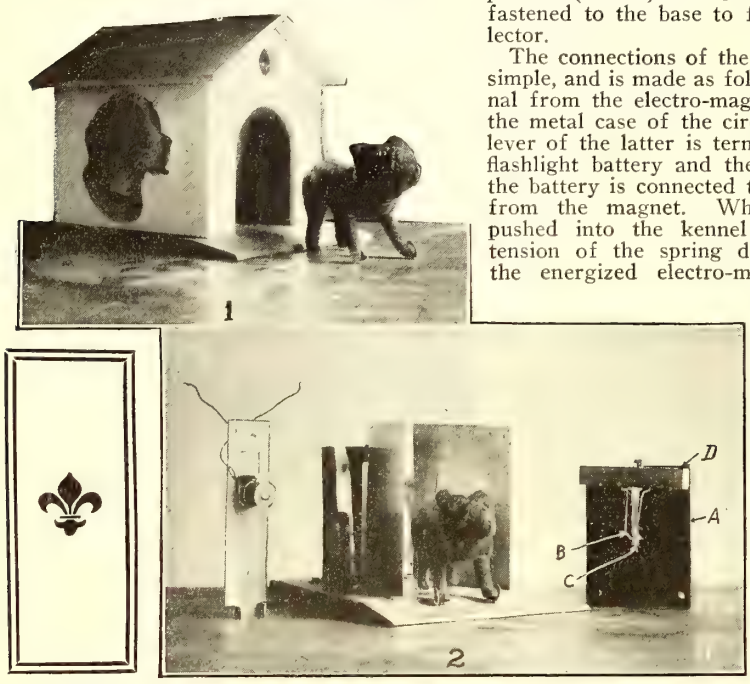
One of the appointments which will meet with the most hearty approval of the electrical engineering profession is that of Paul M. Lincoln, Commercial Engineer of the Westinghouse Electric & Mfg. Company, as Captain of the Engineer's Corps in the U. S. Army.

Announcement has just been made of this appointment together with a number of other prominent engineers.

Mr. Lincoln graduated from Ohio State University in 1892, and has for 24 years been associated with the Westinghouse Electric & Mfg. Company. He is a Past President of the American Institute of Electrical Engineers, and has always taken an active interest in the work of this association.

SOUND RELEASES TOY DOG FROM ITS KENNEL.

A very interesting toy has recently been introduced in the toy market and which is herewith illustrated. A similar toy was described in our June, 1916, issue, but the present one is of a simpler construction. The "Wireless Pup," as it is called, is shown in Fig. 1; this shows the dog standing outside of his kennel. The sensitive circuit-breaker and other apparatus are all placed within the kennel. This interesting and most amusing toy was originated and perfected by Mr. Christian Berger, a prominent physicist who has devoted most of his attention to developing scientific toys.



Two Views of New "Wireless Pup" That Springs Out of His Kennel at the Sound of a Whistle, the Voice, or the Clap of the Hands.

The operation of this toy depends upon the opening of a delicate circuit-breaker by sounding a whistle or by the production of any other sound. This circuit-breaker is connected in series with a battery and electro-magnet, which acts upon a flat metallic disc. This disc or plate is so arranged that when it is released by the electro-magnet, it will strike the dog, pushing him out of the kennel. The electrical circuit is only made when the flat disc is prest against the core of the magnet, which holds the same to itself until the circuit-breaker is excited by sound waves.

A detail photograph showing the various parts used in making up this toy is given at Fig. 2. The holding electro-magnet is seen at the left and consists of a core 5/8-inch in length and 1/4-inch in diameter; two insulated end pieces are placed on each end and the coil is wound with No. 30 B. & S. enameled wire. The complete magnet is mounted on an iron frame, as shown. The small projection on top of the magnet is used to strengthen the magnetic pull of the electro-magnet. The release or discharge disc is fastened to this frame in such a way as to permit the disc to spring forward when released by the electro-magnet. The complete arrangement is then mounted on a wooden base.

The sound operated circuit-breaker is seen on the right. This consists of a rectangular metal box A, in which the sensitive parts are placed. The horizontal lever B is made from a No. 18 bare wire, bent as shown; the ends are pivoted on a block of wood, the dimensions of which are those of the interior of the metal case. The lower part of the lever B, should touch lightly the metal surface of the case A, at point C. Of course this must be within the case. The complete circuit-breaker is placed behind the electro-magnet frame, as noted in the assembled apparatus (center). Two sheets of metal are fastened to the base to form a sound collector.

The connections of the toy "pup" is very simple, and is made as follows: One terminal from the electro-magnet is linked with the metal case of the circuit-breaker. The lever of the latter is terminated in a small flashlight battery and the opposite side of the battery is connected to the second lead from the magnet. When the "pup" is pushed into the kennel and against the tension of the spring disc, it is held by the energized electro-magnet. Then by making a sound such as by blowing a whistle, the circuit-breaker will be spurred up, thus opening momentarily the circuit which releases the spring disc, bouncing Mr. "Fido" out of the kennel.

A trap drummer has discovered that electric lights installed inside his drums keep the moisture out and makes the drumheads tight.

St. Patrick's Cathedral of Norwich, Conn., is lighted with six electric projector units, which bring out the chancel arch and altar in beautiful relief.

Buttons!

"Speakin' o' buttons," said Uncle Zeke,
Shifting his quid to the other cheek,
"Speakin' o' buttons, I want to say,
There's the beatenest kind, down New York way;
'Twaz in one o' them big hotels, by jing,
That melts your dollars like snow in spring,
That I see them buttons, along the wall,
Right in a bunch; mebbee six in all.
'Twas gittin' too dark to see outdoors,
An' I got to foolin' with them because
There wuzn't much else fer me to do,



When—Jiminy crickets; before I knew,
I thought I had sot the house afire,
And I yelled as loud as our old town crier,
Till the folks came runnin', licketty cut!
I told them what wuz the matter, but
They didn't do nothin' but laffe an' joke,
'Bout that dad blamed button I tried to poke,
Then they showed me just how it worked, an' gee!
'Twas the cutest thing I ever see.
Why, it made a blaze like a bonfire done!
They said 'twuz invented by Eddy's son;
I don't know just who Ed is, but say,
His *son* is the feller that gits *my* pay!"

By Pauline Frances Camp.

AN ELECTRIC SELF-WAVING FLAG.

One of the most talked of features at the Electric Railway Convention at Atlantic City, N. J., was a waving flag which fluttered from a 27-foot flagstaff in front of the General Electric Company's booth inside the spacious convention hall. Not a breath of air was stirring, yet the flag stood out on the pole as if a thirty-mile gale was blowing. The flag pole was of ordinary dimension and there was nothing visible to betray the source of the breeze. The base of the pole was surrounded with banked palms. It was only when visitors got very close to it that the scarcely audible hum of a motor gave a clue to the source of the breeze.



This Flag Always Waves, Whether There Is a Breeze or Not. A Motor-driven Blower Pumps a Strong Draft of Air Up Thru the Hollow Mast, Which Accounts for the Mysterious Effect Obtained.

The whole device is really quite simple in construction and easily explained, for the flagpole is a metal tube and an electric blower at the base shoots a strong current of air thru the flagstaff. The air escapes thru perforations in the top of the flagpole and imparts a waving motion to the flag.

PROCESS FOR DRAWING LAMP FILAMENTS.

A process for cold-drawn metallic filaments has recently been patented by Mr. K. Nishimoto, of Tokyo. Forming at first a consolidated stick of mixture of tungsten and a small proportion of thorium, an alloy is obtained by uniformly heating the mixture at a sintering temperature and then gradually keeping its temperature at dull red heat. The consolidated stick is then subjected to repeated hammering or rolling until it becomes so ductile that it may be hammered into bars, rolled into sheets or drawn thru dies into wires, much like the metals which are commonly treated in this manner at ordinary temperature.

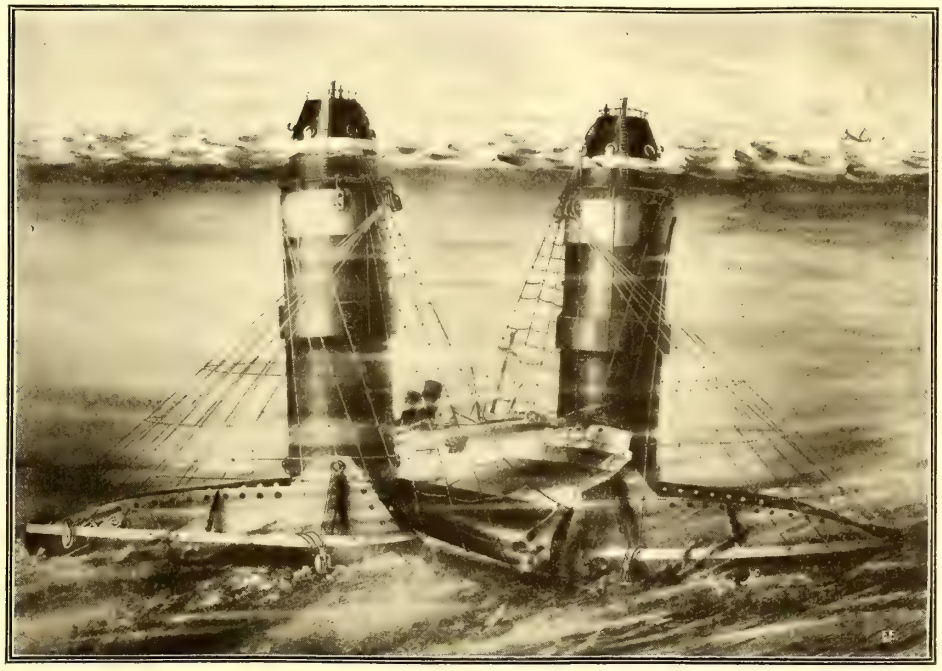
Powerful Hydro-Electric Salvage Apparatus to Raise Sunken Ships

By H. Winfield Secor, Assoc. A. I. E. E.

POSSIBLY more than one enterprising inventor of to-day has conjectured on the problem of raising some, if not all, of the hundreds of torpedoed steamers which lie scattered along the European coast in comparatively shallow water, not to mention the many sunken ships lying within the coast boundaries of our own country. It is not often that we hear of a sunken ship being floated and brought into dry-dock for the reason that the cost of performing such an engineering feat is generally prohibitive, and also in many instances, the problem of raising the sunken vessel at all has practically been beyond solution.

Now comes an American inventor, of Swedish birth, one Mr. Carl Linquist of New York, and formerly of the Swedish Navy, who has devised a remarkable new scheme for raising sunken ships of no matter what size, as long as they do not lie in too great a depth of water, and which idea he intends commercializing at an early date.

It goes without saying that if Mr. Linquist's idea, as outlined herewith, proves feasible and successful, that he will find plenty of work for several years to come.



After the War There Will Be Thousands of Vessels Lying on the Oceans' Beds. If Only a Fraction of These Can Be Floated and Repaired, Think What It Will Mean to Commerce. A New Invention Intended to Accomplish This Purpose Is Illustrated Here and Involves the Use of Two or More Powerful Cylinders Which, as They Are Emptied of Water and Made More and More Buoyant, Finally Exert Sufficient Upward Pull on the Cables to Lift the Vessel.

The inventor's idea involves the use of two or more telescopic cylinders or chambers as shown in the accompanying illustration, which are attached thru massive universal joints at their bases to the large horizontal submerging chambers or "feet" which rest on the bed of the ocean or lake. In the first place, it is of course paramount that the exact location of the sunken vessel be known. Having this information, the salvage expedition sets out from the nearest port with the necessary number of these large collapsible cylinders with their attached base members (or "Forts" as their inventor calls them). The vertical cylinders shown lie horizontally, and as do also the base members, which are made to float, and the vertical and horizontal sections double up like a jack-knife, permitting the several units of this equipment to be towed by tug boats to the scene of the wreck.

The present plans of the inventor consider that salvage operations may be successfully carried on for any size vessel in depths of water up to three hundred feet, and where necessary four to eight or even more of the raising cylinders are employed, placing an equal number of them on each side of the sunken ship.

Supposing that several units of the salvage equipment are ready and floated to the position where they are to be used, the engineers then proceed to fill the base member with water causing it to sink. As it does so, the upright cylinder naturally assumes a vertical position, and moreover the base member obtains a very powerful hold on the bed of the ocean or harbor by "sand-suction," besides the heavy water pressure bearing down on its outer surface. A number of strong cables are let down in the water, and with the aid of an operator inside the inner pontoon who directs the work, these cables are swept under the hull of the sunken vessel. When all of the cables have been properly placed, the engineers are ready to begin operations for raising the wreck. Here is where the remarkable genius of Mr. Linquist comes into play, for he does not attempt to raise the ship by means of steam or any other form of engine. He has called upon Dame Nature herself to furnish the wherewithal to raise any ship, no matter what the size. In brief, what he does is this:—

The upper telescopic and movable cylinders rising within the vertical floating chambers and guides, they are allowed to fill with water from the ocean itself, and as will be seen these will then sink to any required depth. When they have submerged until their upper structure is just above the water, the valves are closed, and by means of powerful electric pumps (in case the operations take place a considerable distance from shore, gasoline engine-driven pumps are available), the water within the movable upper cylinders is rapidly pumped out. But a moment's reflection is required to at once see that these upper cylinders will naturally become steadily more and more buoyant, and providing they are built of the proper size for the work in hand, they will exert a tremendous lifting power of thousands of tons. After these cylinders have gone up a suitable distance the lines are caught by the stationary vertical member and the ship is thus held while the floating cylinders re-fill and take a new bite; the same operation is then repeated to the surface.

Mr. Linquist intends building these cylinders, not of steel but of narrow strips of wood several inches thick, or steel may be used in certain cases. The wood strips are tongued and grooved and caulked and are held in shape by steel bands. The pressure of the water on the outside of the cylinders will in consequence tend to always tighten them, as becomes evident.

The inventor has broached and demonstrated by means of models, his unique idea to a large number of sea-going men, including commanders of salvage squadrons, and also to a number of naval men, and has received unqualified recommendations from these men, who should be qualified to judge as to the efficiency or inefficiency of such a device if anyone could. Not only is this idea of considerable promise and utilification in salvaging sunken vessels in times of peace, but it possesses according to Mr. Linquist, several valuable naval features. For one thing he has suggested that one of these hydrostatic units would prove very efficacious in the rôle of a "Submarine Base," the outfit being anchored several hundred miles from shore stations if desirable. Also they would serve as a resting place for the crew.

The inner cylinder would have a large capacity for the storage of oil and gasoline for submarines, and in the event of being sighted by a hostile war vessel, the upper cylinder and super-structure could be submerged so as to be invisible, and the inventor claims that no force, even the ocean itself, cannot budge his suction foot member an inch, once it has got its grip on the bed of the ocean by natural "sand-suction," and besides most of the floating member lies in calm water, the action of the waves not reaching very deep. A means is provided for releasing this all-powerful grip upon the ocean-bed when it becomes desirable to move the unit to some other location. U. S. Naval Officers have been favorably imprest with this idea.

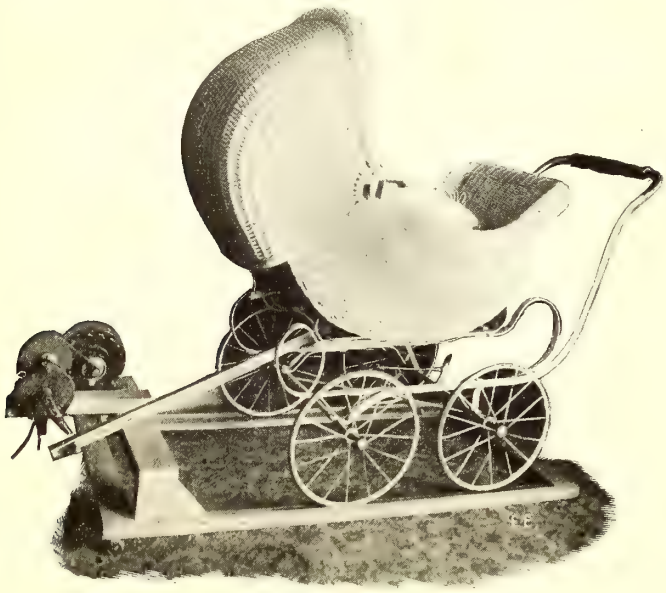
In closing, it is interesting to note that another valuable possibility of this device is that of releasing stranded vessels which

(*Continued on page* 144)

AMONG the hundreds of new devices and appliances publisht monthly in The Electrical Experimenter, there are several, as a rule, which interest you. Full information on these subjects, as well as the name of the manufacturer, will be gladly furnisht to you, free of charge, by addressing our Technical Information Bureau.

ELECTRICITY NOW ROCKS THE CRADLE.

"The hand that rocks the cradle, rules the world"—runs an age old proverb, and, albeit, one that embodies more truth than fiction nowadays, perhaps, when we have



A Chicago Genius Has Evolved a Clever Combination—a Baby Carriage Plus an Electric Motor and Part of a Small Grinder Reduction Gear. Result—No More Pushing the Baby Carriage Back and Forth. We'll Bet His Wife Is a Suffragette!

the suffrage party to conjure with. But the "suffs" will have to look to their laurels, for here is an electric motor that rocks the cradle. Yes, and it doesn't object to twins or triplets. "Come one, come all," is its motto.

This device not only will rock the cradle but will trundle a baby carriage back and forth on a little track, with a gentle, soothing motion which may be better than the traditional cradle rocking movements. The device was made for private use by Mr. Nels Joleen, of Chicago.

Mr. Joleen's little girl required so much of Mrs. Joleen's time that the resourceful father decided that as long as the gentle pushing to and fro of the baby carriage seemed to be a sovereign pacifier on all occasions, he would provide something which would perform the mechanical work, leaving the mother free to go about her other duties.

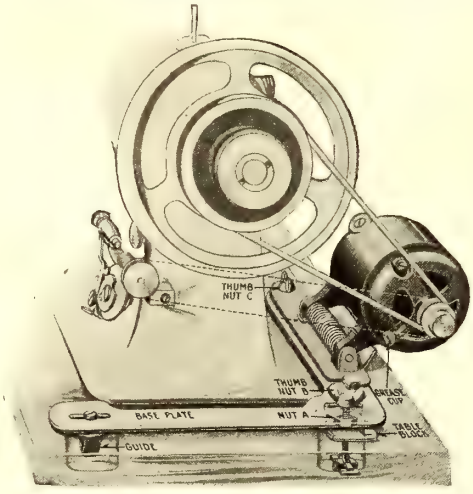
Accordingly, Mr. Joleen made the little wooden frame, shown under the wheels of the carriage; attached thereto a grinding wheel designed to be operated by hand, something which he had in the house for sharpening tools; and then attached a small motor of the kind which was once used as a sewing machine motor, accomplishing the connection by means of a belt from a very small pulley on the axle to the perifery of the grinding wheel. The driving pulley had to be made so small that he simply cut a short section of a broom handle, bored a hole thru the center, and fastened it on with a small set-screw. The gearing in the grinding wheel mechanism, originally intended to speed up the grinding wheel with reference to the number of revolutions performed by the handle, now works just the other way to all intents and purposes, as the speed of the motor must be reduced to the slow circular movement desired.

In order to transmit this motion and at the same time translate it into a back and forth movement Mr. Joleen then took a small piece of wood about three feet long, notched it at one end where it rests over a brace underneath the body of the carriage, and sawed a slot into it for a distance of a foot at the other end, this slot passing thru a hole bored in it of the size of the wood handle on the grinding mechanism, which is inserted thru the hole and then the two parts of the connecting rod brought together upon it by means of a little bolt.

Only a minute is required to trundle the little wooden frame to any place in the house, one end being provided with little casters, also shown in the picture. The motor can be attached to any lamp socket by means of a flexible attachment cord, and in this circuit near one of the binding posts on the motor Mr. Joleen has inserted a small push-button switch for starting and stopping the motor. When the carriage is set on its little track the connecting rod can be instantaneously connected by simply laying it on the bar so that the slot engages the latter, and the apparatus is ready to work. Who will be so kind as to invent an electric bottle feeder? Next!

SEWING MACHINE PLUS MOTOR, SAVES LABOR.

The sewing machine was one of the first household appliances to be equipt with an



This Electric Sewing Machine Motor Drops Out of Sight with the Head and Drives Very Efficiently Owing to Its Spring Base Mounting.

electric motor. The first motors employed were just the ordinary type, but later designs have resulted in the development of a motor having necessary speed control for use solely on sewing machines, and the efficiency and operating features of such motors have been greatly improved.

The latest and most desirable features are to be found in the special motor shown in the accompanying illustration.

This type can be readily attached to any make of stationary or drop-head sewing machine, new or old, with the exception of a few obsolete models. When not in use the motor, if mounted on a stationary head machine, can be pushed back out of the way and the cover put on, or dropt with the head if used on modern types of drop-head machines. When desired, however, the motor can be removed readily by loosening one thumb screw, as it is light and portable.

The speed regulator is slipt on the treadle and held by a spring, making the mounting exceedingly simple. The operating chain is attached to the metal framework directly above the controller and pulled taut.

The regulator is light and substantial. The case is made of prest steel and the principle of operation is entirely new. When there is no pressure on the treadle the circuit is open. With a slight pressure on the treadle a contact is made and as a greater pressure is applied the resistance is cut out turn by turn. By varying the pressure, one stitch, or several hundred stitches a minute can be taken. There are approximately 100 steps in the controller, giving a corresponding number of speeds.

When folding up the machine it is only necessary to loosen the belt, disconnect the plug, and swing the motor around under the head. Felt pads underneath the base prevent the motor from scratching the finish of the machine.

The motor itself is out of the way when operating. This leaves both sides of the machine table clear so that the operator can use this space for sewing material.

The outfit, which is compact and light, consists of a small motor which operates on either alternating or direct current, mounted on a nickel-plated base, a speed regulator with operating chain and ten feet of cord and plug, and a round leather belt. The weight, including the speed regulator, is only 7 pounds.

The cost of operating this motor is so small as to be almost negligible. At 10 cents per kilowatt hour, it costs less than one cent an hour or less than it takes to run the ordinary incandescent lamp.

THE ELECTRIC TEA KETTLE IS HERE.

The recognized convenience and growing popularity of heating small quantities of water by electricity has prompted the development of the electric tea kettle illustrated.

The successful operation of an electric tea kettle depends largely upon the type of heating element—method of application of heat, etc. The heating element here used is of the submerged type, located on the bottom of the tea kettle and when in use is entirely surrounded by water. Thus all heat generated is efficiently utilized.

The tea kettle has a capacity of 2½ pints, is made of drawn copper, spun into shape; spout of white metal; has bail handle, sides of which are steel, grip made of ebonized



Here We Have the Electric Tea Kettle. Hot Water When You Want It and Where You Want It Is Now an Actual Fact.

wood comfortably shaped for convenient pouring. The lid has no hinge to come off —locks on securely. The knob forms an integral part of the metal lid.

THE PROPERTIES AND COMMERCIAL APPLICATIONS OF SELENIUM.

By W. F. Alder.

Selenium was discovered by the Swedish scientist, Berzelius, in 1817 as a by-product of the distillation of sulfuric acid from iron pyrites. It has an atomic weight of 79.5 specific gravity in its electrical conducting form of 4,788, its vapor sp. gr., at 2,588°F., being 5.68.

Selenium, like sulfur, with which it is isomorphous, exists in different allotropic forms, three of which are as follows:

(1) Amorphous Selenium is formed as a finely divided brick-red powder, when a solution of selenous acid is precipitated by sulfur dioxid gas, or when the acid is reduced by suitable agents. Amorphous selenium has a sp. gr. of 4.26 and is soluble in carbon disulfide.

(2) (a) Semi-colloidal red amorphous Selenium is formed when solutions of dextrose and selenous or selenic acid are gently heated together. At 100°C. it is partially transformed into ordinary black Selenium.

(b) Colloidal Selenium can be obtained in a blood-red solution by an aqueous solution of the red precipitate obtained by the reduction of Se 0_2.

(3) Vitreous Selenium is formed when the amorphous variety is heated to 218° C. and then suddenly cooled when it forms a brittle, black, glassy mass, soluble in carbon disulfide having a sp. gr. of 4.28.

All three of the above forms have so high an electrical resistance that they may be regarded as non-conductors.

The Selenium as used in the electrical arts belongs to still another modification, viz., the crystalline or metallics state; metallic selenium is obtained when the melted vitreous variety is cooled to 210° C., and then maintained at that temperature for some time.

The gray crystalline modification which makes possible the selenium cell occurs in two forms, viz



Selenium Cell in Vacuum.

(1) Round granular crystals, stable at 140°C., an insulator in the dark and not very sensitive to changes in light intensity.

(2) Which is readily formed when the above granular form is heated to 200°C. In this form it is a relatively good conductor. It will, however, instantly respond to succeeding exposures. The general belief, also erroneous, seems to be that the shortest wave lengths, *i.e.*, the violet, are the ones which have the most pronounced effect upon the conductivity of Selenium, but exhaustive research has proven that the waves having the greatest activity for increasing the conductivity have a length of over 5,000 units.

The writer encountered innumerable difficulties which were, however, overcome in the type of cell illustrated herewith.

Electro-Deposited Mirrors Now Used for Photographic Work

IN splitting the light from a certain source, the problem of dividing the rays in definite portions may strike one at first thought as an exceedingly difficult task. In certain kinds of photographic and optical work, however, it is very essential to divide the rays in such a manner that one portion of the light will go in one direction and the remaining portion in one or more other directions. Partly transparent mirrors are used for the purpose, and in order that the precise division of light may be known beforehand, the thickness of the thin layer of metal which is deposited on a plate of glass to form the mirror must be exactly known.

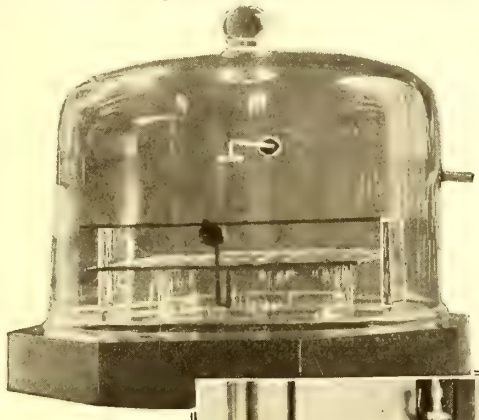
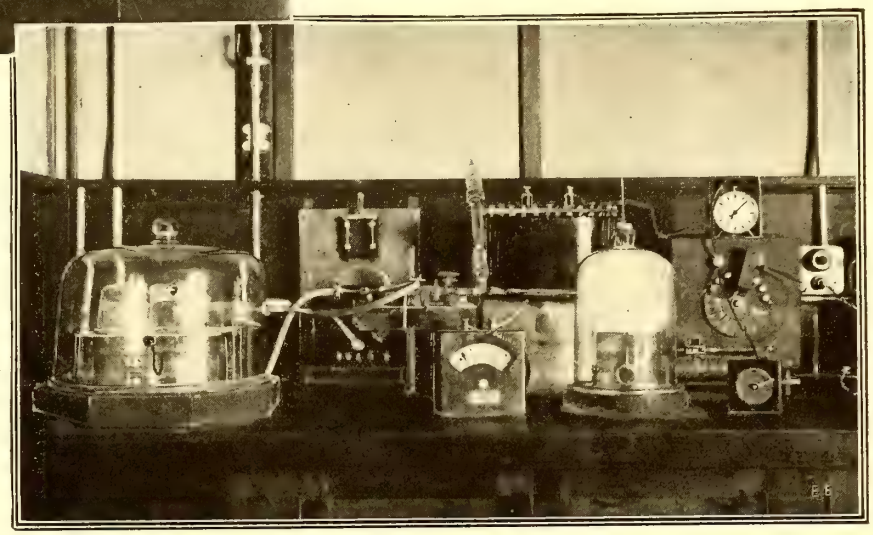


Fig. 3 (At Left). Jar for Making 11-inch Partly Transparent Mirrors. The Cathode Is at the Bottom and Consists of a Thin Sheet of Gold or Platinum-iridium Alloy. The Glass Plate to be Coated Is in a Plane Parallel to the Cathode.

Fig. 1 (Below). Arrangement of Apparatus for Electroplating Partly Transparent Mirrors in a Vacuum, the Smaller Jar Being in Operation.



In Fig. 1 is shown the apparatus developed in the research laboratory of one of the leading camera manufacturers for use in making mirrors of different degrees of transparencies employed in certain important photographic experiments. Two inverted glass bell jars are shown, each of which is connected to a vacuum-pump system. By means of this arrangement the air pressure inside the jars is reduced to a scant millimeter. This is done because in a rarefied gas the passage of electricity from the cathode, the terminal at the bottom of each jar, to the anode—the upper terminal, is greatly facilitated. The cathode consists of a very thin sheet of metal, which usually is of gold or an alloy of platinum and iridium. A short distance above this sheet of metal in a plane parallel to it; the glass plate to be coated is placed on glass pillars as shown.

The larger jar is 16 inches in diameter and 11 inches high and is used for coating mirrors 11 inches square. With the air exhausted the atmospheric pressure on this jar (about 15 pounds per square inch) mounts up to approximately five tons. The current is measured in thousandths of an ampere (milliamperes). The voltage, however, is very high and is stept up by a transformer from a value of 156 volts to 5,000 volts.

As soon as the current is turned on a pink glow is noticeable in the jar. Just above the thin metal cathode, however, there is a certain dark region which is called the Crooke's dark space. The action of the current causes minute particles of metal to leave the cathode and to be deposited on the glass plate which is placed just at the edge of the Crooke's dark space, where the metal is most cohesively deposited. With the current constant it is only necessary to record the time of operation; the amount of metal deposited can then be easily determined, since it will, according to Faraday's law, be proportional to the time and current.

In Fig. 2 is shown a set of interesting curves obtained in a typical run with a

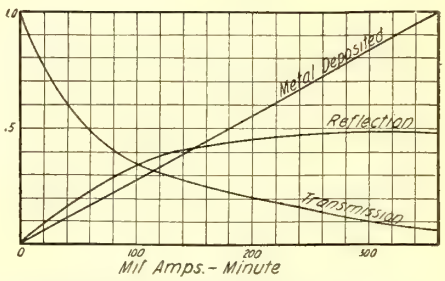


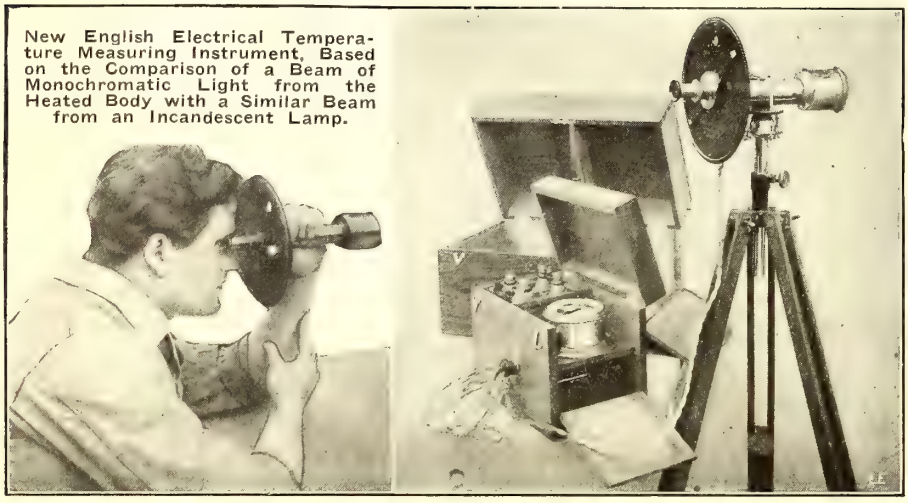
Fig. 2. Curves Showing Reflecting Power at 45 Degrees Incidence and Percentage of Metal Deposited and Light Transmitted for Platinum-iridium Mirror With Varying Products of Time and Current.

cathode of 70 per cent platinum and 30 per cent iridium, measuring 120 millimeters by 120 millimeters by 0.1 millimeter. These curves show the reflecting power at 45 degrees incidence and the percentage of light transmitted and metal deposited on a unit of area for varying products of current and time. It was found that a mirror whose transmission was equal to its reflection required a deposit of 3.4 milligrams per square decimeter.

Photos courtesy of Eastman Kodak Co.

A New Optical Pyrometer

The new pyrometer here shown is a practical, convenient, and at the same time, accurate instrument, which can be successfully used by unskilled workmen. Temperatures from 700°C. upwards are read directly upon clear, open scales. Owing to the rapidity with which readings can be taken, and the ease of sighting upon small objects, this pyrometer is particularly suitable for research purposes and in many processes in steel, pottery, glass and other works. It has been developed by an English concern.



New English Electrical Temperature Measuring Instrument, Based on the Comparison of a Beam of Monochromatic Light from the Heated Body with a Similar Beam from an Incandescent Lamp.

The instrument may be regarded as a photometer, in which, by simply rotating the eyepiece, a beam of selected monochromatic light from the hot body is adjusted to equal intensity with a beam of similar light from an incandescent electric lamp. It is not a color-matching instrument, and in consequence of the simple construction, accurate readings can be taken repeatedly by different observers with remarkable consistency. The formula, which expresses the relationship between the intensity of the radiation of a hot body and its temperature, has been examined both theoretically and practically by many investigators and has been shown to give results of great accuracy up to the highest temperatures. The constants of this formula for every instrument are individually determined at several temperatures before calibration.

The general arrangement of the instrument is shown in the figure and includes:—The pyrometer, consisting of the optical system, the electric lamp, the shield carrying the temperature scale and pointer; the teak carrying-case with fittings for fixing the pyrometer and standard lamp for checking; 4-volt accumulator, ammeter and regulating resistance, complete in teak case; the standard lamp and an adjustable tripod stand.

The following is a brief explanation of the construction. Behind the enlarged part in the front of the pyrometer in which is fitted the electric lamp, are two holes. Light from the object (such as a furnace) under observation passes thru one, and light from the lamp thru the other. These beams of light then pass thru a system of lenses and prisms, are polarised in different planes and rendered monochromatic. Finally the two beams of light pass thru a single ocular. The observer sees an illuminated circular field divided into two semi-circles One semi-circle is filled by an image of the hot body under observation, while the other is uniformly illuminated by the electric lamp. The two semi-circles are brought to an equal intensity of illumination by turning the eyepiece to which the scale pointer is directly attached as seen.

In this manner the unknown rays are compared with those of known intensity from the electric lamp. As the accuracy depends upon the constancy of the light from the electric lamp, a small ammeter and regulating resistance are fitted in the box containing the accumulator to ensure that whatever the voltage of the battery may be, the current passing thru the lamp is constant. To ensure that the candle-power of the lamp shall remain constant over long periods as the filament ages, provision is made for calibrating the instrument from time to time against a standard amyl-acetate lamp, and thus ascertaining the correct reading of the ammeter, when the electric lamp is giving the correct illumination. This test need only be made at long intervals and the standard lamp need not be carried into the factory or plant.

The pyrometer is supplied fitted with one or more temperature scales of any desired range from 700°C. upwards, but the following standard ranges are suggested as suitable for most practical considerations: single scale instruments, 700-1400°C.; single scale instruments, 900-2000°C.; double scale instruments, 700-1400°C. and 1200-2500°C.; double scale instruments, 900-2000°C. and 1400-4000°C.

ELECTRIC COUCH INDUCES CURRENTS IN THE BODY.

By H. H. Parker

The electric couch described in this article makes possible a simple application of the commercial alternating current in the electro-therapeutical treatment of insomnia, hardening of the arteries, nervous disorders and other similar ailments; a number of sufferers from such troubles claim that they have been greatly benefited thru its use. While the apparatus has been constructed in various forms, the one described has the advantages of simplicity, lightness, neat appearance and ease of operation, provision being made for connection to any lighting circuit carrying alternating current at 110 or 220 volts and any frequency.

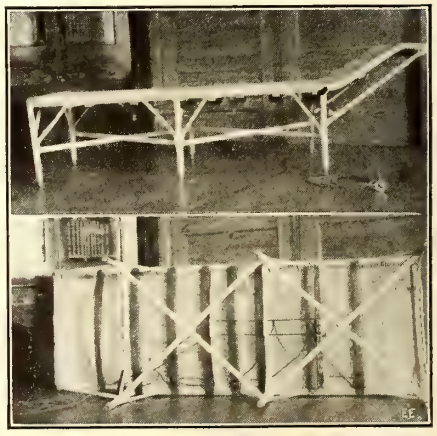
The couch itself is an ordinary wicker-work affair, to the bottom of which are fastened a series of coils, wound upon laminated sheet iron cores. In the one shown in the illustration eight coils are used, connected in series for 220 volts and in series-parallel in groups of four in series when operating on 110 volts. At a convenient point at the head of the couch is placed a wall key socket for cord and plug.

Owing to the use of alternating current, laminated iron cores must be provided for the coils; these are built up of No. 22 gage iron strips one and a half inches wide by twenty-six inches long, the completed core being about half an inch thick. The strips are shellacked before being put together, and are held by paper insulated rivets in order to prevent the formation of eddy currents in the iron or rivets. After insulating the cores they are wound with two layers each of No. 20 D.C.C. magnet wire, coated with shellac or insulating varnish, wrapt with cotton armature binding tape and then bent to conform somewhat to the curve of the couch surface when sagged by the weight of a patient lying upon it.

As part of the equipment a *Test Coil* is provided. This comprises a built-up iron core similar to the others, but only about three-quarters of an inch square in section. At its center is wound two layers of No. 25 D.C.C. magnet wire in a coil about six inches long, the terminals of which are carried to a miniature lamp socket at the end of the core containing a two-and-a-half volt battery lamp. This wand-like contrivance is considered by the patient an indispensable part of the outfit, and is used to determine when the couch is "working." When brought into the influence of the rapidly alternating, magnetic field surrounding the coils the little lamp is lighted, the dimensions of its coil being such that the core may be laid upon the couch in close proximity to the coils beneath without danger of burning out the bulb. By moving the *test coil* away from and around the couch a visible demonstration of the strength and extent of the magnetic field is afforded.

To operate the couch the patient merely lies down upon it and switches on the current. No physical effect is noticeable beyond a slight vibration due to the alternating current, the beneficial results obtained being supposedly an effect of the rapidly alternating magnetic field surrounding the body.

There appears to be a difference of opinion among medical men as to the exact action of this magnetic field upon the human system, but in looking at the subject from the engineer's instead of the physician's viewpoint, the following theory suggests itself: Do the blood circulatory passages, the veins and arteries, or any of the organs or other parts, form, as it were, the closed *secondary circuit* of a transformer, in which currents are induced through the action of the magnetic field produced by the alternating current flowing in the *primary* winding of the coils beneath the couch?



Unique Electric Couch Which Passes Powerful, Alternating Magnetic Fields Thru the Body.

SIR OLIVER JOSEPH LODGE.
June, 1917, Marks His 66th Birth Anniversary.

One of the most profound scientific workers and thinkers we have ever had, is Sir Oliver Joseph Lodge, who is still an active figure in the field of scientific research, and all of us expect in the near future to see something even more wonderful than any of his preceding discoveries and inventions.

Sir Oliver Joseph Lodge was born on June 12, 1851, at Penkull, Staffordshire, England. He received his early education in the Newport Grammar School and later he entered the University of Coll, London, where he specialized in scientific and mathematical research. His scientific trend was noticed by the professors of different universities, and after he had graduated from this institution he was elected as Professor of Physics at the University of Liverpool. Since 1900 he has been principal of the University of Birmingham.

He has had many honors and degrees conferred upon him and is an active member of many of the leading scientific institutions. Sir Oliver Lodge was presented with the honorary degree of Doctor of Science from Oxford, Cambridge, Victoria, Liverpool and others, also that of LL.D. from St. Andrews, Glasgow and Aberlaide. He was president of the Mathematical and Physical section of the British Association in 1891 and President of the Physical Society of London. His most important work in electro-physical science is that of *wireless telegraphy*, in which he has introduced some of the most fundamental steps in commercializing this fascinating art, and in fact he is called by many the father of wireless. The Lodge coherer was the first instrument used for successfully receiving radio waves.

He discovered in 1889 that two metallic surfaces in perfect, but not conducting



Sir Oliver Joseph Lodge, Famous English Physicist and Savant. He Is Regarded by Many as the Dean of Present-Day Scientists.

contact, were welded together when an electric discharge past between them, and later on studied the propagation of electric waves along wires. He thus came into close contact with the researches of Hertz on the creation of electromagnetic waves in free space, and this work he both expounded and extended.

His interest in these matters was, however, scientific rather than technical, and he himself has admitted that before the matter had received attention from others it had not occurred to him to suggest the employment of Hertzian waves for practical telegraphic purposes. In the course of his scientific work he had directed much attention to the phenomena of electrical resonance. Hence, when it had been indicated that the chief practical importance of Hertzian waves might be in their application to space-telegraphy, Lodge was not slow to apply his knowledge to this subject.

On May 10, 1897, Lodge applied for a provision patent protection in Great Britain for improvements in Syntonizing Telegraphy Without Line Wires, and in this document he states that the subject of his invention was to enable an operator to transmit messages across space to *any one or more of a number of different individuals* in various localities, each of whom is provided with a suitably arranged and "tuned" receiver. The subject-matter of the specification deals exclusively with the utilization of electromagnetic waves. This is the noted Lodge tuning patent which is universally employed in all forms of radio transmitting apparatus today. The patent recently expired and became public property.

Sir Oliver Lodge is a noted author, and some of his most important works are "Elementary Mechanics," "Modern Views of Electricity," "Pioneers of Science," "Signalling Thru Space Without Wires," "Life and Matter," "Lightning Conductors and Lightning Guards," "Modern Views of Matter," "Man and the Universe," and his latest book, "Raymond—A Treatise of Life and Death," which purports to prove that the author actually received communications from his dead son, who was killed while serving with the English army in France. His theory however was received coldly by the scientific world.

Prof. Bell Receives "Civic Forum Medal" For 1917

The accompanying photo shows the presentation of the "Civic Forum Medal" for 1917, to Dr. Alexander Graham Bell, the inventor of the telephone. Those in the picture from left to right are: John J. Carty, chief engineer of the American Telephone and Telegraph Company; Union N. Bethell, president of the New York Telephone Company and senior vice-president of the American Telephone and Telegraph Company; Dr. John H. Finley, (presenter of the medal); Alexander Graham Bell, inventor of the telephone, and Thomas A. Watson, associate of Dr. Bell, maker of the first telephone instrument and receiver of the first telephone message. On the table are the first instruments used by Dr. Bell.



Copyright by International Film Service.

The Inspiring Moment When Professor Bell, Inventor of the Telephone, Was Presented With the "Civic Forum Medal" at New York, on March 21st. Reading Left to Right—John J. Carty, Union N. Bethell, Dr. John H. Finley, Prof. Bell and Thomas A. Watson, Who Made the First Telephone for Prof. Bell.

On March 21, in Carnegie Hall, New York, Dr. Alexander Graham Bell, was formally presented with the Civic Forum Medal of honor for distinguished public service, in recognition of his invention of the telephone in 1876.

The medal was established in 1914 to express the sentiment of the American people toward their great living men and women. Its purpose is to promote more general appreciation of distinguished public service and inspire ambition to emulate such service.

The medal this year was awarded to Dr. Bell by vote of the members of the National Council of Seventy, representing the whole country, geographically and so far as possible in all other respects.

The medal was first presented to Maj. Gen. George Washington Goethals, U. S. A., in 1914 for his work in building the Panama Canal. In 1915 it was presented to Thomas A. Edison in recognition of his contributions to electrical inventions.

HOW ELECTRIC VEHICLES BOOST EFFICIENCY.

A New York department store speeds up the loading of its delivery wagons by running its "electrics" inside of the building and transporting them to various floors on large elevators.

Joe's Experiment

By C. M. Adams

"AND another thing," Mr. Robertson checked Pete; "don't bring that blind kid around here any more. He's just in the way, and if he gets hurt the company'll have the damages to pay. What business has a blind kid got around an electric plant, anyhow? You keep him out of here, understand?"

Pete Foley whirled and surveyed the nervous, drawn face of his chief for a moment, and then flung back hotly:

"Look here, that boy's a friend of mine and a mighty good friend. He's not in your way when he comes around here, and I'm responsible for his safety. As for what business he's got around an electric plant, let me tell you that he knows more about electricity right now than some men who are paid big money for what they are supposed to know. He'll make his mark some of these days when he gets into the electrical world, you'll see. And furthermore, he's going to come here whenever he wants to, as long as I'm around."

Mr. Robertson's white, haggard face flushed angrily and his lips parted as if to speak. But he was silent as Pete swung out of the power house and up the trail to the company's tool shack. Pete Foley was a good electrician, a very good electrician, and men with this particular kind of goodness were so scarce in these mountains that it behooved Mr. Robertson to stand for much from this member of his construction crew.

Half way up the road to his home on the mountain-side, Joe Benson paused and listened to the faint purr of unit No. 1, far away down the slope. Ever since the Snake River Power Company had started the first day's work on this water power project, Joe had been an interested listener of everything that went on. Listening had been his chief avenue of impression, for his eyes were useless, and had been so for several years. He had heard the rumble of the blasts, and the grit and grind of drills and steam shovels as they prepared for the big concrete dam which held back the water. He had listened and been interested, but mystified, until Pete Foley, a member of the electrical construction crew, had come to board at his home.

It was Pete who had answered his *hows* and *whys* about the plant and its operation, and during the year which had elapsed Joe absorbed electrical information like a dry sponge taking in water.

At first he had listened to the conversation of the men, but had been loath to take part in it because he felt his own ignorance of their work. However, as time past, and Pete's daily instructions bore fruit, he began to take a more active part in the talk of the men during the evening.

At first they had regarded him as an outsider, whose ignorance of their work was to be tolerated for politeness sake only. But gradually, as Joe's comments and questions became more intelligent, they began to look to him as an equal—as one of their own number professionally.

"I'll be hanged if that kid don't know as much about the plant as I do," one of them ejaculated admiringly, after Joe had come off victorious in a technical argument.

"Sure he does," Pete retorted. "Don't think he don't know anything because he can't see. He'll make his mark—you watch."

At first the size of the Snake River project had dazzled Joe. Then with a realization of the extent of the undertaking had come, at first as a dream, and then a resolve, the idea that he, too, would become an electrical man, an electrical engineer. True, he was blind. But he was attending the high school up the valley and in two years would be ready to enter the university. Other blind men had done things equally as wonderful. Why could he not enter this field?

And what a day this had been, what a wealth of impression and sensation. He had stood beside the great towering masses of iron and copper and had felt with his own sensitive hands the giant castings and coils of the great generators, while Pete explained how they were built and worked. So this April afternoon he went home warmly glowing with new impressions and desires.

Pete did not have time to talk after supper. He went upstairs for his clothes and then disappeared down the slope in the company car, on his way to Merwin to complete preparations for the transformers in the sub-station there. And so Joe sat on the porch and listened to the faint hum of the generators below him,



"No, you don't. Not me," Pete interrupted, as Mr. Robertson turned to him. "Here's the boy you want to thank. He saved your plant and not me."

LAST month we publisht a rattling good story—"Eddy Currents"—by Mr. Adams. We confidently believe that the present tale will appeal to all dyed-in-the-wool electrical readers. You don't require an electrical education to become "en rapport" with the author, as he possesses that happy faculty of weaving the technical and personal aspects in such a way that the moral cannot be mist. The facts related in this story are human, pertinent every-day affairs. Similar obstacles to those facing invincible Joe Benson, the hero of this narrative, have confronted all of us at one time or another. But true "Philosophy" will unlock all doors and surmount the greatest of barriers.

while he dreamed of his future.

Two days later when Pete returned from Merwin, Joe was waiting for him after supper as the group of boarders gathered on the porch.

"Pete," Joe began, "I've been wanting to ask you something since day before yesterday, but you weren't here to answer it."

"Go ahead, but don't go too deep. Remember I'm only an ordinary electrician," Pete warned.

"Well," Joe went on, "on one of those switchboard panels you showed me the other day there was a rheostat, but you didn't say what it was for. What does it do, anyhow?"

"Oh, that's the rheostat for the exciter's field," Pete responded. "It's connected in the shunt winding of the exciter field coils. It controls the voltage."

"What does it do that for?" Joe insisted, going to the bottom of the matter.

"Well, here's the idea," Pete explained. "You see the exciter supplies current to the field of the big alternator. Well, the voltage of the alternator will depend on the voltage of the exciter, because if the voltage of the exciter changes the strength of the field will change and affect the alternator's voltage. So if they want to raise or lower the voltage of the big alternator, they just raise or lower the exciter voltage by putting in more or less resistance with this rheostat. Do you understand?"

"Oh, yes," Joe replied. "Then by adjusting this field rheostat on the exciter you can change the voltage of the big alternator."

"Exactly," Pete assented.

Joe sat for some moments, thinking of this new addition to his store of electrical information, while the men about him talked lazily.

"Robertson's getting grouchy about those transformers, I tell you," one of the men said a moment later.

"If they don't come, the company won't be able to get its franchise, and he seems to think it's up to him to get them here."

"I know that all right, but he oughtn't to treat the rest of us like we were to blame," Pete retorted. "He's been a fright for the last two weeks."

"What transformers are those?" Joe asked.

"The transformers for the Merwin substation, the step-down set," Pete informed him.

"Haven't they come yet?" Joe asked in surprise.

"No, they've been shipt a week but can't be located on the road or anywhere else."

"What will he do if they don't come?" Joe asked in concern.

"I don't know. That's what's bothering him, I guess," Pete replied.

The generators at Portage Falls developed current at low voltage which was then past thru a set of transformers which stept it up to sixteen thousand, five hundred volts, at which tension it was transmitted to Merwin, fifteen miles away over the mountains. There it was stept down to two thousand, three hundred volts for distribution thru the service lines of the city. Joe knew this as well as the rest of the men. He also knew now that if the step-down transformers did not arrive, the Snake River Power Company would be in a very awkward position.

Its franchise required it to supply current to Merwin on May first. Today was April twenty-seventh.

Joe knew that the sixteen thousand volt current could not be turned directly into the city lines. He knew that burned out equipment and electrocuted people would be the result. The voltage had to be lowered, but how? He wondered about it and tried to think what Mr. Robertson would do, as he sat on the porch and listened to the men talking, and far away the faint hum of the generators in the power house, limbering up their bearings.

Of what use would this power be if there were no transformers at Merwin? Without the intervening coils the big machines would be as useless as if their windings were stript from them. He thought of this and tried to answer for himself the question that was puzzling the chief of construction.

"What do you suppose Mr. Robertson will do?" he asked Pete as the latter started upstairs for bed.

IN THAT "JULY" E. E.

Are There Currents About a Magnet?—with a number of original photos and charts never publisht before. —by F. F. Mace.

"Cold Light" or La Lumière Froide, as the French call it. The work of Prof. Dussaud.

Back to the Days of "Volta"—with some extremely interesting photos of Volta's original apparatus—by Jacques Boyer, our Paris Correspondent.

"Ham Jones—Scientist"—a rollicking good electrical story with a live-wire wallop in every line by H. W. Eveleth.

The Marvels of Radioactivity by Jerome S. Marcus.

Lightning—How to Protect Yourself from It—An article everyone should read by W. G. Whitman. With illustrations.

Where the Radio Amateur Fits in the U. S. Naval Reserve Force by M. B. West.

A Page of Marvelous X-Ray Skiagraphs, including one of a four-legged chicken.

The Calculation and Measurement of Inductance—Conclusion by H. Winfield Secor and Samuel Cohen.

Besides these and a large number of other valuable and interesting articles, there will appear a liberal sprinkling of timely summer-time topics of interest to all readers. Don't miss the "July Issue!" It'll be right there waiting for you with a wallop on every page.

"Go crazy, if those transformers don't come," Pete replied unconcernedly.

The next day Joe found himself thinking of the problem again as he heard the machines purring away on his way home from school. That night as he sat on the porch he was still thinking of it, and yet had found no ready solution for the difficulty.

"I don't see how they're going to fix that up if those transformers don't come," he complained to Pete.

"Great guns, you aren't trying to figure out a way, are you?" Pete exclaimed.

"Why yes, I ought to be able to, or try anyhow," Joe protested.

"Let Robertson do that. He's paid for worrying," Pete returned easily.

But that did not satisfy Joe. The plant below him had grown under his very doorstep. He had heard every bit of metal and concrete put into place, and he felt as if the thing were his own. Then, too, was he not going to be a consulting engineer some day; would not a problem similar to this be put to him for solution? He ought at least to attempt to solve it now. So he puzzled his brain over the thing that night and all the next day, suggesting, rejecting, scheming and pondering. But by the evening of the twenty-ninth he had not reached any solution.

He was not the only one who was thinking of this problem. The worried, anxious face of Mr. Robertson, with its black-ringed eyes, glittering with sleeplessness, testified too plainly of his own struggle over the proposition.

He remained at Portage Falls directing bits of finishing work, while he hoped and almost prayed for the momentary arrival of the coils so much needed. Hourly he telephoned to Merwin to see if they had arrived. Hourly he hoped that they might have come, and then grew despairing as he was told they had not.

On the morning of the thirtieth he went to Merwin with the determination of staying there until they came, and hoping against hope that service could be started on time.

Pete and the others stayed behind at Portage Falls, finishing up fine points of the work there. The plant was in order, each great machine ready to send its thousands of kilowatts over the line to Merwin to be used for every sort of work, provided the intervening transformers were there to step down the deadly high tension to a safe voltage. But at noon a message to the Falls reported that no transformers had arrived.

Pete loafed up the steps of the Benson home at dinner time. Worry over what would happen to the company did not interfere with his appetite, and he was ready for the food awaiting him.

But five minutes after he had sauntered leisurely inside, he dashed out, leaped off the porch, and raced down the steep hillside, recklessly speeding toward the company's tool shack at the bottom. A minute later he flung open the doors of the building and was cranking the little service automobile. Two minutes later and the pebbles were flying in a stream from his tires as he bumped away over the rough roads toward Merwin

An hour and a half later he stopt Mr. Robertson's big high-power roadster before the building, while the chief himself sprang out and dashed down to the power house, with Pete closely pursuing him.

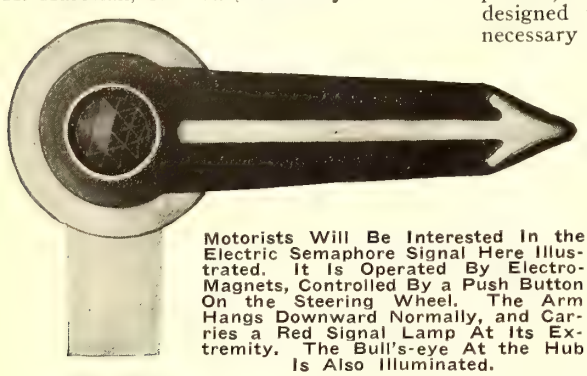
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It was a varied group which clustered about the switchboard, handsomely drest directors, oilers and workmen in overalls,

(*Continued on page* 150)

AN ELECTRIC SEMAPHORE FOR AUTOISTS.

The accompanying photograph shows a cleverly designed automobile electric signal device which has recently been developed by the well-known civil engineer, Mr. H. Hartman, of New York City.



Motorists Will Be Interested In the Electric Semaphore Signal Here Illustrated. It Is Operated By Electro-Magnets, Controlled By a Push Button On the Steering Wheel. The Arm Hangs Downward Normally, and Carries a Red Signal Lamp At Its Extremity. The Bull's-eye At the Hub Is Also Illuminated.

This, like other inventions of Mr. Hartman, is really quite simple in construction and performs its functional duty just as well, or perhaps better, than many existing and more complicated similar devices. The sole purpose of this instrument is to warn an automobilist in which direction the machine ahead of him is going to turn, either to right or left.

It consists of a magnetic field having two magnetizing coils similar in design to the field of a motor. An armature coil is placed in this field, and its shaft is attached to the signal or semaphore arm. The field and armature are enclosed in a waterproof metal case which is seen on the left. One end of the pointer is fitted with a red lamp so as to serve as a danger signal.

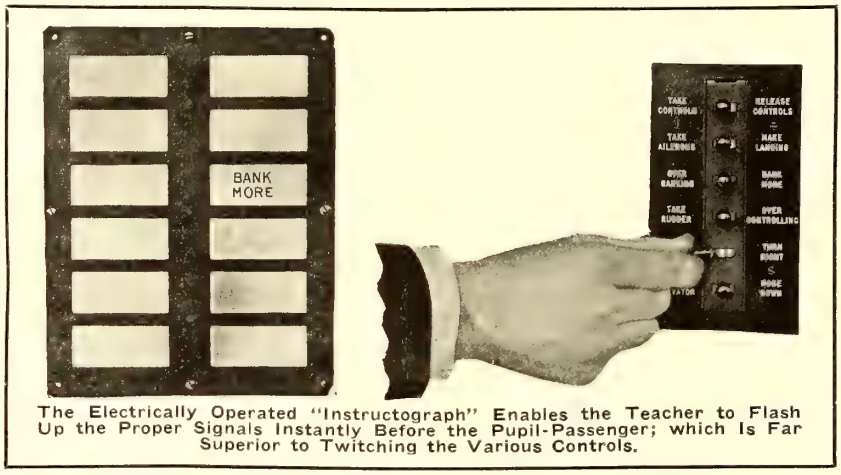
The armature and field coils are connected to a storage battery and a simple switch, so that the autoist can throw the arm either towards the left or right, whichever the case might be. The principle upon which this instrument is based is that of the repulsion and attraction of two different magnets, one stationary (the field), while the movable magnet is the armature. The arm at its normal position points downward, and as soon as the proper current is past thru the field and armature, the pivoted arm turns instantaneously to that direction, by virtue of the attraction between a field coil and the armature coil. Automobilists of to-day whose slogan is *Safety First* will appreciate this very valuable device, as it cannot be mistaken owing to the relatively large moving surface called into play.

AN ELECTRIC INSTRUCTOGRAPH FOR TEACHING AVIATORS.

One of the latest Sperry devices for aviators, or rather for would-be aviators, is known as the *Instructograph* and is illustrated herewith. It is intended to facilitate the instruction of pupils in the modern two-passenger tractor aeroplane. Prior to the advent of this clever device the Pilot-Instructor, occupying the rear seat of the machine, depended on twitching the various controls, after attracting the attention of his pupil-passenger by kicking the back of the forward seat, for imparting such instruction as was necessary. This crude method of communication is very dangerous, as at times neither pupil nor instructor know whether the control of the plane is in their hands or not, as becomes readily apparent.

The Instructograph consists of three units: the transmitting unit, the receiving unit and a battery case, and while the pieces are of light and compact construction, the complete installation weighing but six pounds, without batteries, they have been designed for the strength and durability necessary for the hard usage they will be subjected to in service.

The *Transmitter* consists of a case, of light metal construction, about six inches long, three inches thick, and an inch wide. A series of six double throw keys project from one edge, to the right and left of which extend engraved plates, bearing all of the instructions commonly used in teaching the art of flying. The keys, which are of such size that they can be easily handled with gloved hands, can be thrown to either the right or left, remaining in the position placed until released by a touch, when they fly up to their normal vertical position. The twelve instructions themselves, neatly lettered, have been chosen with great ingenuity and are so placed that actual air work cannot necessitate the use of both of the two directions, placed by each of the keys, at the same time. The case itself can either be fastened by the side of the instructor, or set into the instrument board before him, as found convenient.



The Electrically Operated "Instructograph" Enables the Teacher to Flash Up the Proper Signals Instantly Before the Pupil-Passenger; which Is Far Superior to Twitching the Various Controls.

The *Receiver* is a box approximately seven inches long, five inches wide and slightly over one inch thick, adapted to fasten on the wheel of the front control itself in the front cockpit of a tractor, under the cowl, or in the instrument board. Its cover is perforated by twelve oblong windows, closed by translucent white celluloid, with no lettering of any kind visible to confuse the pupil. When one of the keys of the *Transmitter* is thrown, the corresponding direction appears on a window in dense black against an illuminated white background. Three of the directions: "Nose Down," "Over Banking" and "Over Controlling" flash out in black against a red background, clearly indicating the urgency of the command. An ingenious arrangement of small electric light bulbs enables this method of communication to possess the advantage of positively attracting the pupil's attention whenever a word of instruction is given, it having been found experimentally that the flash of light accompanying the change of direction catches his subconscious attention. To safeguard against the possibility of a burned out bulb preventing the direction from being received, the circuits are so arranged that a second lamp remains lighted.

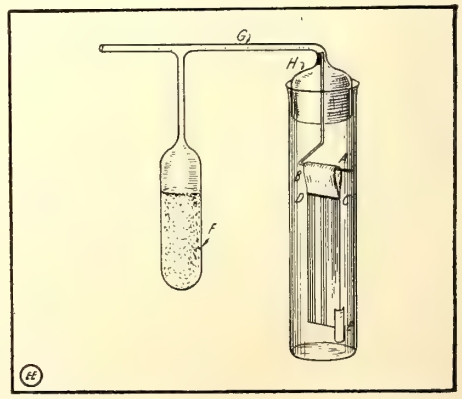
NEW METHOD OF MEASURING PRESSURE OF LIGHT.

In a paper to the Physical Society, Mr. Gilbert D. West describes the measurement of the pressure of light by a method requiring few of the elaborate precautions generally necessary in such experiments. The essential feature of the apparatus was a strip of gold leaf suspended in the middle of a test tube containing air or hydrogen at reduced pressure. Radiation from a 32 c.p. carbon filament lamp, impinging directly on one side of the strip, was sufficient to cause a microscopically measureable deflection of the end.

The pressure of normally incident radiation on a perfectly reflecting surface has been shown by Maxwell and others to be numerically equal to twice the energy content of the radiation per unit volume, and hence, if this quantity be measured in the way described below, a check on the original observations can be made. A mean of the results of several successive experiments with the deflected strips gave a value for the pressure of radiation which only differed from that calculated from the energy density by a small percentage. The accuracy and constancy of the final results seemed to preclude their being seriously affected by gas action; but, as gas action had to be taken into consideration, the present research was undertaken with a view to its fuller investigation, and if possible to complete elimination.

In measuring the energy density, the initial rate of rise of temperature of a blackened copper plate, enclosed in the tube, was measured by means of an attached copper eureka thermo-junction. Due allowance was made for cooling corrections, and the lamp black was assumed to absorb 95 per cent of the incident radiation. The cold junction was immersed in oil contained in a vacuum flask, and during an experiment a delicate indicating thermometer in the oil only showed negligible variations. The calibration of the thermo-junction was carried out in the usual way, and a number of minor matters received full consideration.

When from the measurements thus taken the energy reaching 1 sq. cm. in one second



Arrangement of Apparatus for Measuring Pressure of Light.—H is Hollow Stopper, E Is Cover Glass Cemented to Tube, F Contains Pith Charcoal, G Is Tube Which May Be Connected to Gaide Pump.

is known, the energy per 1 c.c. can be calculated from a knowledge of the velocity of light.

(*Continued on page 142*)

NEW TELEPHONE SIGNAL A PATIENCE SAVER.

Patience vanishes rapidly while holding a telephone line. Save your time and attend to other important matters while waiting for the other party to resume conversation, say the sponsors of the new Hold-the-call-signal here illustrated. This clever



How Often Do You Feel Like Cussing the Telephone When Party No. 2 Says "Hold the Line"? The Answer Is—Don't. Place the Receiver On the Amplifier Here Shown and You Will Hear the Party Answer.

device will let you know when the speaker is ready. No electrical connection is needed. It simply rests alongside of the instrument and the receiver is placed on it while line is held open.

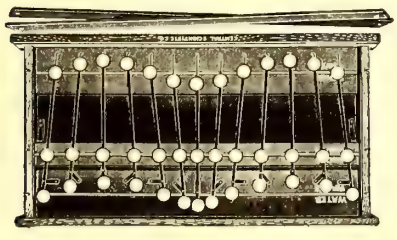
HOW STUDENTS STUDY WAVE MOTION.

When the college "Prof." tries to drum the principles of wave motion into his pupils' craniums, he has available today the mechanical wave reproduction machine here illustrated. The small white discs form into various lines representing curves or waves of certain kinds, depending on how the apparatus is operated. This remarkable model was invented by Dr. Charles Forbes of Columbia University. With this apparatus the formation and propagation of the three general classes of wave motions may be demonstrated, namely:

Water or Surface Waves, in which the elliptical motion of the particles of water, the advancing of the crest tending to form breakers, the recession of the trough tending to form the undertow are exhibited.

Sound Waves, or waves of condensation and rarefaction, in which the amplitude of vibration may be changed by lowering the disc support. The lowering of the distant end of the support will also represent the decrease in the loudness of sound.

Ether Waves, or transverse vibrations, represented. Comparison of Phases. The apparatus admits of a ready comparison of similar phases in the three systems of wave motions, a very desirable feature not possest by any other form of wave machine. By means of the covers resting upon the framework of the apparatus any one or two of the wave systems may be hidden from view, thus leaving the remainder for special examination when desired. The front of the apparatus exhibits the conversion of rotary into direct and lateral reciprocating rectilinear motions. On the back, the action of the crank handle, the rod connecting the individual cranks, and the operation of the double parallel rule mechanical motion, first used in this apparatus, are clearly exhibited. Its large size is especially advantageous, since the wave forms can be clearly seen across a large lecture room.



By Means of This Oscillating Pendulum Cabinet It Becomes a Sinecure for the "Prof." to Inculcate His Pupils with the Fundamentals of Various Wave Motions.

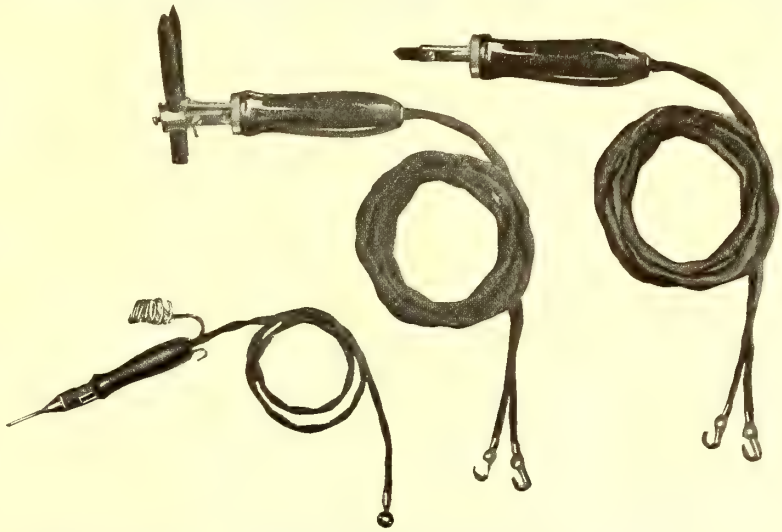
resenting the production of light, heat and electric waves. The progressive undulations of a vibrating cord are also repre-

UNIQUE ELECTRIC SOLDERING TOOL.

A Buffalo concern has recently brought out a new form of electric soldering tool. Among these tools is a two-prong iron with prongs of solid bar brass with nickel-plated finish. This type of iron is furnished in capacities of 150 watts, 250 watts and 500 watts. All are designed to work on low pressure, from 6 to 15 volts, either direct or alternating. This pressure can be obtained from an ordinary lighting or power circuit, either 25 or 60 cycles by interposing a low-voltage transformer, or a storage battery operating at a pressure of 12 volts can be used. Under no circumstances may these irons be used on any voltage over 15.

Another type is the two-handle portable soldering outfit. This is composed of a single prong soldering tool attached to one wire of the secondary side of the transformer and a solder-feeding tool attached to the other secondary wire of the transformer. When a storage battery is used the single prong soldering tool is attached to the negative side, and the solder-feeding tool to the positive side of the latter.

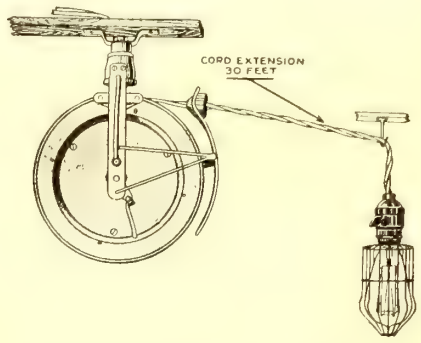
When soldering with this outfit the single prong point is brought to bear upon the object to be soldered, and the solder-feeding tool is brought to bear upon the spot where soldering is needed. The instant the circuit is closed the heat point glows with a white heat, and the solder is held until the work is done. The current ceases to flow as soon as the heating point is taken from the work. This outfit is made in 150- and 300-watt capacities and is designed for use on direct or alternating currents up to 12 volts pressure.



Several Styles of a Unique Electric Soldering Iron That Operates On Low Voltage A.C. or D.C. Closing the Circuit Causes the Points to Heat Up, When the Solder Is Applied.

AN AUTOMATIC EXTENSION REEL FOR DROP LIGHTS.

The automatic extension reel here illustrated is intended for drop or portable electric lamps. It is simple in construction and positive in operation.



A Clever Invention in the Form of An Automatic Extension Reel for Portable Electric Lamps, Which Winds the 30-foot Cord Up and Swivels in Any Direction.

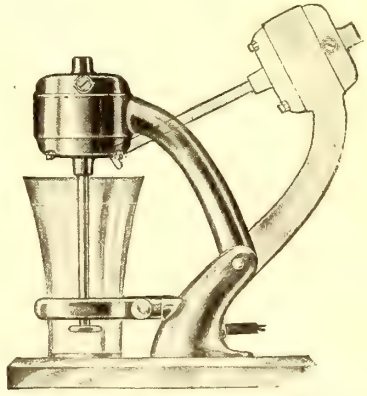
It is designed especially for garages, blacksmiths, factories, stores, or any business requiring an extension light. This reel is equipt with 30 feet of lamp cord, easily secured by fastening the arms of the swivel joint to ceiling or beam, as shown.

This swivel joint enables one to walk in any direction with the lamp. It has an automatic lock ingeniously arranged to lock and hold the lamp any distance from the reel. A slight pull forward unlocks the ratchet and the reel revolves, winding the cord back as you advance toward the reel with lamp in hand.

A HANDY ELECTRIC DRINK MIXER.

The soda clerk used to cuss (inwardly) merrily whenever a patron called for a drink that required a fancy mixture—a chocolate milk shake for instance. Wherefore and hence we have in our midst the electric drink mixer that never tires—no matter if you had a thirst like an Arabian camel.

The electric drink mixer is mounted on a swinging bracket. When the machine is pushed back and removed from the glass it takes the position indicated by the dotted lines. Throwing back



When You Ask for a Fancy Drink at the Soda Fountain the Dispenser Now Places the Glass Under An Electric Drink Mixer.

the bracket operates a switch which breaks the circuit. The swinging down of the bracket automatically closes the circuit.

Electricity and Life

The Uses of High-Frequency Currents in Medical and Lecture Work

By FREDERICK FINCH STRONG, M. D.
Lecturer on Electro-therapeutics, Tufts Medical School, Boston

(Third Article)

THE phenomena of high-frequency currents offer us a fascinating field from which to select experiments for public lecture demonstration. In his lectures on *"The Realms Beyond the Senses,"* the author has used high-frequency phenomena to demonstrate the existence of force and matter beyond the range of human perception. In *"The Science of the New Age,"* he has employed similar means in calling attention to the fact that the investigators of to-day are leaving the crude matter of earth and are dealing more and more with *Etheric Force* —and with matter of a *super-gaseous* nature. The scientist of the future will have to provide himself with instruments far more delicate than anything hitherto dreamed of or else he will develop supernormal powers of perception by the manifestation of faculties already latent in the human organism.



Hardening of the Arteries—Most Dreaded of Ailments in Later Life—Is Successfully Treated By Placing the Patient Within a Wire Cage, Thru Which High-frequency Currents Surge at a Frequency of 600,000 Cycles Per Second: D'Arsonval's Method.

For the traveling lecturer who wishes to employ high-frequency currents in his work, the large resonator described in the last issue of THE ELECTRICAL EXPERIMENTER may prove somewhat cumbrous and difficult of transportation. Those who wish a lighter, more compact apparatus may use the small resonator shown in Fig. 1.

It is quite small, yet it sends out streamers two feet in length, and may be operated by a ½ K.W. "wireless" (step-up) transformer. With this little apparatus beautiful luminous effects may be obtained—as, for example, by connecting the terminals with a tin-foil star glued to a sheet of glass; with a suspended umbrella (opened); with a long wire running out over the lecture hall, etc.

For each of these experiments different tuning will be necessary—the series inductance coil being adjusted to balance the different capacities added to the resonator terminal.

This little resonator is made by winding 600 turns of No. 30 triple cotton covered wire upon a shellacked paper cone, 12 inches in diameter at the bottom, 5 inches at the top, and 14 inches high. It is a difficult matter to insulate this small coil as the turns of the winding are very close together; it can be done, however, by the use of from six to eight coats of *Armalac*. The primary coil is a ring, 18 inches in diameter, formed of five concentric turns of thin copper ribbon 1 inch wide. The exciting apparatus is the same as that described in the last paper in connection with the large resonator, except that a ½ K.W. transformer is used instead of the heavy 1 K.W. (See Fig. 2.)

The writer also employs a standard Clapp-Eastham ¼ K.W. Tesla coil excited by the same apparatus (see Fig. 3). Connected with two parallel upright wires the spark from this coil will run up and repeatedly reform again at the bottom, producing a very spectacular effect (Fig. 4).

Another brilliant experiment can be performed with two large glass flasks (ordinary carafes or water-bottles will do). One is filled with water containing a few drops of *fluorescein* solution—(a coal tar dye)—the other with water to which a small amount of *bi-sulfate of quinine* has been added; the bottles or flasks are placed about six inches apart and a wire from the Tesla coil terminal inserted into the solution in each. The current passes down thru the water and the arc takes place between the glass walls of the two flasks. The ultra-violet rays from the discharge cause the water in the flasks to become luminous—the quinine solution with a pale blue light, the fluorescein with a beautiful apple-green. The discharge apparently passes directly thru the glass walls of the flask; in reality, of course, the current passes by *induction* rather than *conduction,* the flasks acting as condensers in series. (See Fig. 5.)



Photos from Jacques Boyer

The "Effleuve" or High-frequency Brush (or Spray) Treatment Has Proven Highly Efficacious In the Treatment of Nervousness (Nerve and Brain Exhaustion)—"Neurasthenia." American Electro-therapeutists Find It Very Valuable.

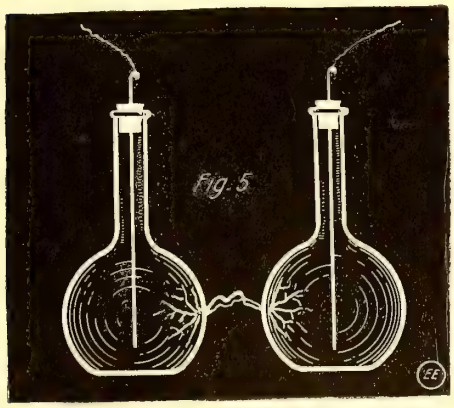
The Use of High-Frequency Currents in the Treatment of Disease.

High-frequency currents are employed by physicians in four principal ways, each adapted to the treatment of certain types of diseased conditions. These are:

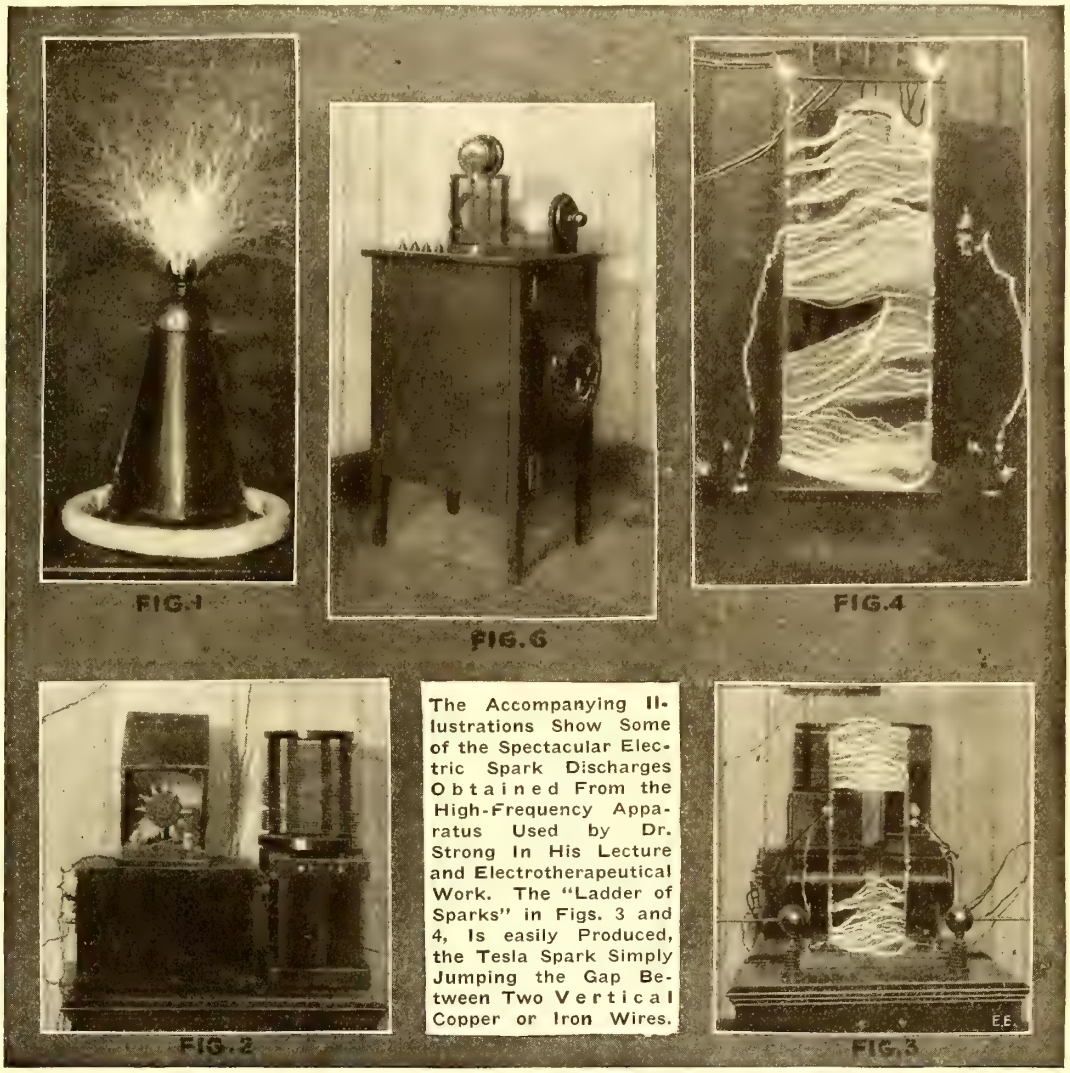
1. "Tesla" treatment with vacuum electrodes ("Violet-ray treatment").
2. "Effleuve" or high-frequency spray.
3. "D'Arsonval auto-condensation."
4. "Diathermie."

1. The method most frequently employed applies the Tesla current thru glass (vacuum) electrodes for the relief of local pain or inflammation. The little muscular pumps around the veins—the "vaso-motor system," which keep the blood circulating by withdrawing it from the capillaries and sending it back to the heart—act more vigorously in tissues over which the vacuum electrode is applied. In this manner waste products which cause rheumatism and gout are dissolved and washed away and fresh blood and white corpuscles are brought to infected parts, thus aiding nature in destroying disease-producing germs and their poisonous products.

In most of the smaller high-frequency machines for physicians' use, but one Tesla terminal is provided; a coil of the resonator type being connected to the glass electrode by a flexible wire. The effects are largely local, but the method is of value in relieving pain, swelling and congestion. The writer has always advocated the bipolar method, even for treating purely local conditions. The best results will be obtained from the use of a Tesla outfit of the type described in last month's ELECTRICAL EXPERIMENTER. The patient is to be connected to one terminal of the Tesla coil by means of a metal electrode held in both hands (a piece of thin nickeled pipe will answer, 1 foot long and 1½ inches in diam.). In this way the current is diffused thru the entire body. The vacuum electrode, connected with the opposite Tesla terminal is applied to the skin over the affected part for from five to twenty minutes, a very short spark-gap being used. This method—employed by the writer for years—enables us to obtain the wonderful *vitalizing effect* of the high-frequency currents on the whole body simultaneously, with the local effects from the vacuum electrode.



Startling Experiment With Two Glass Water Bottles Connected to Tesla Coil. The Spark Jumps Between the Glass Surfaces and Illuminates Solutions Within the Bottles.



The Accompanying Illustrations Show Some of the Spectacular Electric Spark Discharges Obtained From the High-Frequency Apparatus Used by Dr. Strong In His Lecture and Electrotherapeutical Work. The "Ladder of Sparks" in Figs. 3 and 4, Is easily Produced, the Tesla Spark Simply Jumping the Gap Between Two Vertical Copper or Iron Wires.

For the past few years the writer has been in the habit of connecting the Tesla coil with an *Auto-condensation pad* (as used in the "D'Arsonval" and "Diathermic" methods). This is formed of two plates of Bakelite, ⅛-inch thick, hinged to fit the seat and back of an ordinary chair. To the back of each plate is cemented a sheet of tin or copper foil, covered with leatherette. Suitable flexible conductors connect these metal plates with each other and with the Tesla terminal. This folding pad may be used in both "Tesla" and "D'Arsonval" treatment, and is quite as efficient for ordinary use as the cumbrous and expensive *condenser chair* or *couch*.

2. For the "Tesla Effleuve" treatment a brass *bell* electrode is used. This can be made from a common brass oil can, the flat bottom being removed and the resulting hollow hemisphere being mounted on an insulating handle; the discharge occurring from the sharp edge of the brass. The patient is seated on the Bakelite pad, which is connected to the Tesla coil. The opposite terminal is attached to the brass bell electrode and a sufficient number of turns of the inductance coil are placed in series with the Tesla primary to give a full, smooth "effleuve" or purple brush discharge, when the electrode is held from four to eight inches from the patient. By careful tuning a beautiful effect may be obtained. Close examination of this discharge will show it to be literally an electric "brush", formed of thousands of distinct, delicate, purple threads. Upon each of these hair-like paths of light countless millions of *ions* (electrically-active atoms), are being shot from the electrode to the patient at a speed of over 60,000 miles per second; the treated surface is therefore being submitted to a literal bombardment by countless microscopic projectiles which are thrown out in periodic showers from the electrode, once for each cycle of the oscillating current. Two effects are produced—one due to the penetration of the tissues by *ozone-forming ions:* the second to the rhythmic or *periodic impact* of the discharge upon the nerve endings in the skin and superficial tissues. The writer hopes ultimately to produce an apparatus of a frequency *exactly synchronous with the rate of vibration of the sensory nerves;* an "effleuve" from such a coil would produce a harmless and efficient local anæsthesia so that operations could be performed without the use of ether or cocain. The effects obtained from the "effleuve" as now used are stimulating and vitalizing to a marked degree. The nerve endings of the skin may be regarded as sensitive antennae of a complicated radio-system, and any intense sustained vibration to which the apparatus is attuned will be transmitted by them to the receiving station. The effect therefore, is not merely superficial but *systemic* as well. Tuber-

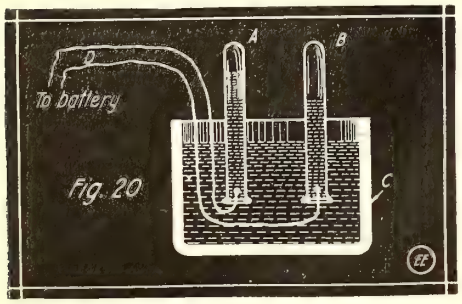
(*Continued on page* 152)

Experimental Physics

By JOHN J. FURIA, A. B., M. A.
Instructor in Physics and Science Master, Riverdale Country School

HYDROSTATICS.
LESSON FIVE.

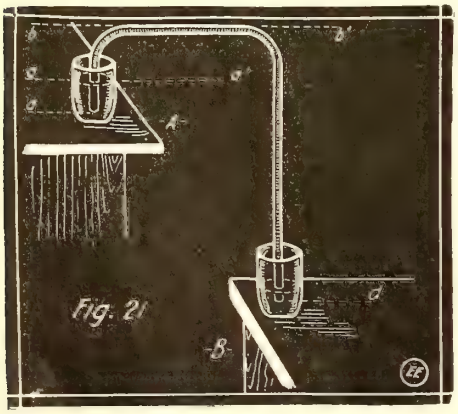
WATER is so plentiful, and we are accustomed to use so much of it, that very few of us ever stop to think what a great part it plays in our daily lives. It is without doubt an absolutely indispensable sub-



A Small Battery and a Couple of Test Tubes or Bottles, Together with Connecting Wires, Will Serve to Clearly Show How the Electric Current Decomposes Water.

stance. We drink it—we clean ourselves and our belongings in it—our crops depend upon it—ourselves and the fruits of our toil are transported from one continent to another by means of it—practically every manufacturing industry makes use of it. Finally and most important, we swim in it. What would be the use of living if we had no Palm Beach or "the old swimming hole in the creek"? We naturally ask what is water anyhow? One could never guess the answer. Water is nothing more than the result of the combining of two gases—Oxygen and Hydrogen. Oxygen, we remember, is the constituent of the atmosphere necessary to life. Hydrogen is the gas which burned with a pale blue flame in the lesson on "Gases." (See March and April issues of this journal.) The following experiment can be easily performed successfully:

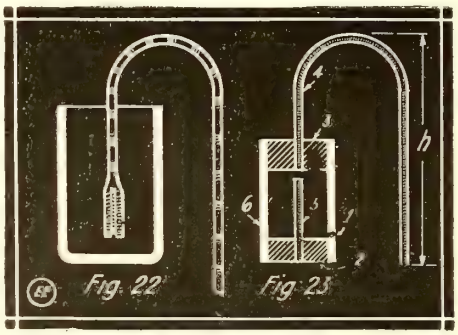
EXPERIMENT 25—(See Fig. 20)—C is a jar nearly full of water to which a few drops of sulfuric acid have been added. (The sulfuric acid is added to make the water a better conductor of electricity. Water alone is not a good conductor of electricity, *i. e.*, is more or less of an insulator, just as glass is.) D represents lead wires from a battery of at



Demonstration and Controlling Factors of the Hydrostatic "Siphon". A Simple and Effective Method of Emptying Tanks and Even Reservoirs When Occasion Requires It.

least six dry cells in series, or from a storage cell or from the house current if it is direct current. If possible the electrodes should be of platinum. A and B are test tubes held in the hand after being inverted full of water and are placed over the electrodes. Immediately, and with a rapidity dependent upon the strength of the battery used, bubbles will form at the electrodes and rise to the top of the test tubes. These bubbles are the result of the decomposition of the water into its constituents. We notice that in one tube the bubbles form more rapidly and that there is always about twice as much gas in that test tube as in the other. Call that test tube "B." After the test tubes have been filled with the gases, raise them carefully without tipping. Insert a glowing match-stick in "A." It is found to burn brightly. This we remember was the test for Oxygen. If a flame is applied to "B" a slight explosion results, which is the test for Hydrogen. Thus we see that water is composed of two parts Hydrogen to one part Oxygen.

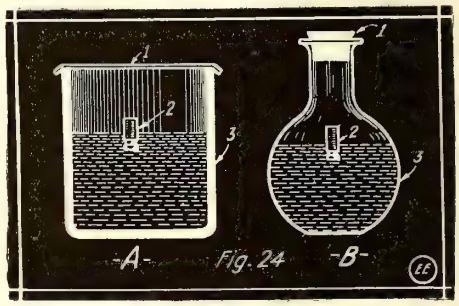
EXPERIMENT 26—(Fig. 21)—Illustrating the principle of the *siphon*. A and B are vessels at different levels, A being higher than B. The vessels are connected by a piece of tubing; bb^1 indicates the level of the top of the tubing and aa^1 the level of the water in vessel A. d, indicates the level of the end of the tubing. If the tube is placed in position as indi-



Two Forms of Automatic Siphon. Details for Constructing the One on the Right Are Given Herein.

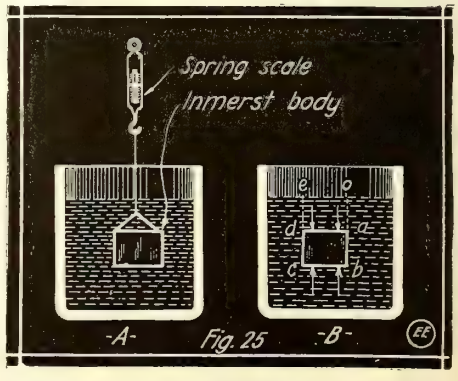
cated in the figure, and A contains water (or any liquid) at a level aa^1, nothing happens. If, however, the tube is filled with water before it is placed in position, the water begins to flow from A down to B. The siphon will also act if the tube is placed in position, and if one sucks at the lower end; for this is equivalent to filling the tube with water. The explanation of the action is as follows: The upward pressure in the short arm of the tube, is due to the atmospheric pressure (discust in the last two lessons). In the tube ab, this pressure is equal to the atmospheric pressure *minus* the downward pressure due to the weight of the column of water ab. The upward pressure of the tube at b^1 is the atmospheric pressure *minus* the downward pressure due to the weight of the column of water b^1d. The force tending to drive the liquid from A to B is greater than that tending to drive it from B to A. It is greater by the amount equal to the difference in the weight of the columns ab and b^1d and hence corresponds to the weight of the column a^1d. Evidently if d, were at the level aa^1, the siphon would not operate; and if above aa^1, it would operate in the other direction. If the column ab (for water) were greater than 32 feet the atmospheric pressure could not raise the water this distance, and the siphon would not operate.

EXPERIMENT 27—Recently an automatic siphon has been put on the market, and it can be very easily constructed. Fig. 22 shows the automatic siphon in the act of starting. It should be noticed that the tube is filled alternately with bubbles of air and water. This condition prevails only



Apparatus With Which the Principle of the Submarine Can Be Demonstrated. The Small Vial 2, Can Be Made to Perform Many Wonderful Tricks By Pushing Down on Diafram 1, or Squeezing Bottle 3 in "B".

upon starting and shortly after, the water comes out solidly. Fig. 23, shows a home made automatic siphon and all those interested should make one. 6, is a piece of lamp chimney about 3 inches long. 5, is a piece of glass tubing about ¼ inch in diameter stuck thru a rubber stopper 2. 4, is some more of the same kind of tubing past thru the stopper 3. The height h, should be about a foot and a half. 1, is a small hole drilled thru the lamp chimney 6. 5 and 4, should be about ¼ of an inch apart. As soon as our auto-siphon is placed in a liquid it begins to operate WITHOUT OUR FILLING IT FIRST. Thus we see that one made entirely of glass, as are the commercial ones, is very convenient in transferring poisonous liquids and acids, as we need not touch the liquid at all. There is nothing mysterious about this siphon and it is easily explained. When the *bulb* is immersed in the liquid, the liquid rushes in at 1 and at the lower end of tube 5. The liquid rushing in at 1 tends to compress the air in chamber 6. The liquid rushing in at 5 streams up past the gap and thru 4. Hence the outgoing air takes with it some liquid, and, as noted before, we see alternately passing thru the



Proving the "Law of Buoyancy," i. e., That Objects Weigh Less In Water Than In Air.

tube bubbles of air and water. As there is less and less air left in 6, larger and larger quantities of the liquid pass with small bubbles of air intervening, until finally the air being all gone, the liquid

(*Continued on page* 152)

The RADIO LEAGUE of AMERICA

HONORARY MEMBERS
CAPT. W.H.G. BULLARD, U.S.N. NIKOLA TESLA,
PROF. REGINALD FESSENDEN. DR. LEE DE FOREST.

H. Gernsback, Manager W. H. Kirwan, Master of Radio Relays

Denver Wireless Station Wins Prize Loving Cup

By W. H. KIRWAN (9XE),
Master Radio Relays, Radio League of America.

TO a Denver boy goes the honor of winning the trophy cup for the best *Amateur Wireless Station* in the United States. This cup was donated by 9XE to the most efficient and best equipt amateur wireless station in the United States.

We intended to call in a committee to decide upon the merits of the best amateur stations in the country, but station 9ZF in Denver was so far ahead of all other amateurs in sending, receiving, and efficiency, that it would have been a waste of time and energy to have consulted anyone at all.

This station, 9ZF, is known to every progressive amateur in the United States, and is one of the star stations of the Colorado Wireless Association, and of which you have all read in a previous issue of this magazine. The winner is Mr. E. F. Doig, of No. 848 South Emerson Street, Denver, Colo. Mr. Doig made nearly all his apparatus himself, and has been assisted by Mr. W. H. Smith of the Y. M. C. A. Radio Club and the Colorado Wireless Association. Mr. Doig was for four years Master Signal Electrician in the Signal Corps of the Colorado National Guard. He now holds a special receiving and sending license from the United States Government. His equipment, altho not as large as the Government station, is very complete, as you can clearly see from the photograph.

Mr. W. H. Smith, also well known for his skill as an operator, is associated with Mr. Doig and has worked on his night shift at this station. Mr. Doig is also secretary of the Colorado Wireless Association and Mr. Smith is the chief operator. This station will hold this cup for one year, and if they win it again in 1918 it will belong to this station absolutely.

The cup has been properly engraved and you will see a picture in this magazine shortly of the cup holding a prominent place in the Laboratory of Mr. Doig. The Government Call Book gives Station 9ZF as belonging to Captain Smith of the Colorado National Guard, but the license was issued some years ago to Captain Smith; however, the station really belongs to, and was made by, Mr. Doig, as explained above.

A record of messages handled at 9ZF from January 13th to March 18th, 1917, shows that 251 messages were received and sent. A number of them were transcontinental messages from coast to coast. Station 9ZF held a very strategic position in the *Washington's Birthday Relay* of February 24th, 1917, and without the assistance of this station it would not have been possible to have sent the message thru from coast to coast, nor for the return message to have been brought back.

We believe that nearly all of the stations thruout the United States can well pattern their installations, as far as general arrangement and efficiency is concerned, after Station 9ZF. Another point in favor of 9ZF was the fact that, while this station was affiliated with nearly every Radio Club and organization extant, the owners never refused a message, nor did they feel that Station 9ZF was too proud to work with anyone.

In the receiving cabinet is a large loose coupler for reception of long wave stations like WG, GW, SL, OUI and POZ, as well as the Government arc stations. A smaller receiving cabinet is used for the shorter wave stations, including the commercial coast and sub-stations on the spark system. There is also a short wave regenerative receiver, which is used in working with the amateur stations. This cabinet also contains an amplifier which can be used in connection with each of the other sets. There is not much to tell about the Rotary Quenched Gap, as the cut shows just what it is, and there are not very many amateurs but what have had the chance to read about this outfit.

The 1 k.w. outfit which is used mostly, radiates from 12 to 14 amperes on a wave length of 425 meters, and the oscillation transformer is made with edgewise wound copper strip, a type with which you are all familiar, and which is clearly shown in the photograph of the equipment.

There are three towers to Station 9ZF, one of them being 90′ high and the other two 75′ high. One aerial has six No. 12 aluminum wires, 150′ long, and the other aerial has four stranded aluminum cables with 7 strands of No. 14 in each cable, and is 200′ long. Both of these aerials are connected L type.

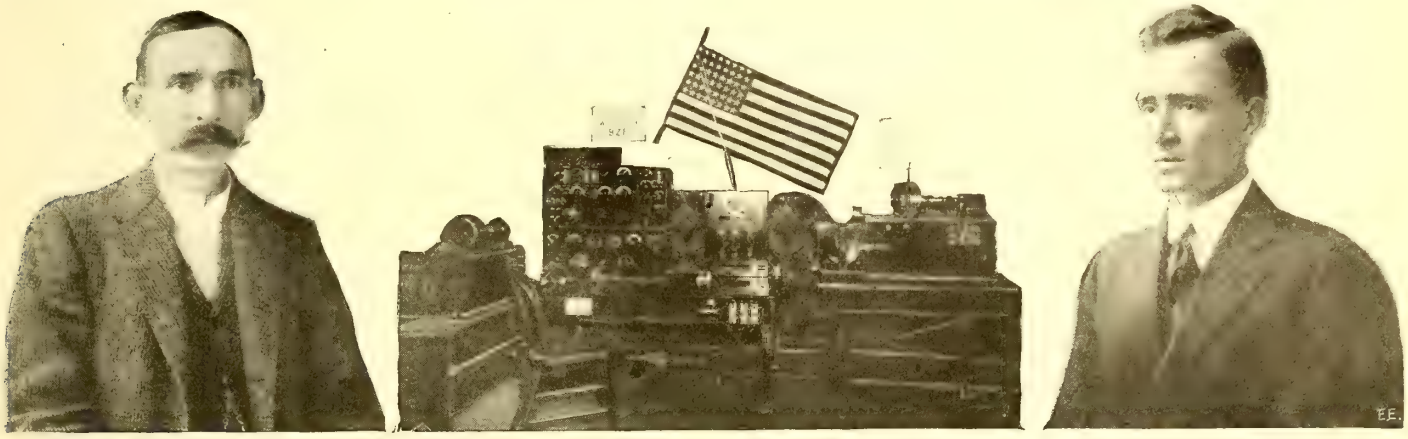
This station has been working regularly with amateur stations on both the Atlantic and Pacific coasts. Working with 6EA in Los Angeles, Cal., has been a continuous past performance, and recently this station has worked directly with 2PM in New York City. We claim that this is truly wonderful work for an amateur station, and we do not think that there will be any question whatever but that Station 9ZF is well entitled to the prize.

Since holding the *Washington's Birthday Relay*, which you will all remember was held in the interest of preparedness, with instructions to all sending stations to interest all wireless amateurs in the United States Radio Coast Reserve, Station 9ZF worked the hardest for recruits of any station in the United States.

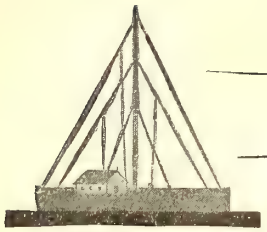
We have radio clubs in the United States of minor importance, which seem to think that they were the only ones that had a divine right to exist, who have not, with all their membership, done as much good work in enlisting the amateurs under the Navy Department for coast reserve work as Station 9ZF.

All of the stations have been closed by the Navy Department, on account of the war, for the period of war, and we believe it will be some little time before all of us are working again. In order that your interest will not lag in wireless work, and for the benefit of the many amateurs who have enlisted thruout the country and are now assigned to the various warships, we will continue these write-ups each month, with something of interest to them, and something to remind them of home and

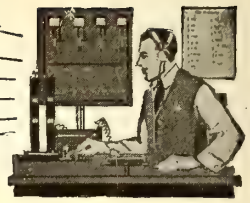
(*Continued on page* 143)



The Trophy Cup for the Best "Amateur Wireless Station" in the United States Has Been Awarded to Station 9ZF, operated by Messrs. E. F. Doig (at Right) and W. H. Smith (Left), of Denver, Colorado.



RADIO DEPARTMENT



Notice to All Radio Readers

As most of our radio readers are undoubtedly aware, the U. S. Government has decided that all Amateur Wireless Stations, whether licensed or unlicensed, or equipt for receiving or transmitting, shall be closed.

This is a very important consideration, especially to those who are readers of THE ELECTRICAL EXPERIMENTER, *for the reason that we desire to continue to publish valuable articles in the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have publisht in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools thruout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment.*

Therefore, and in view of the foregoing explanation, we feel sure that every reader will thoroly understand that altho articles on transmitting, as well as receiving, apparatus may appear from time to time in these columns, he is not permitted to connect up any radio apparatus whatsoever to any form of aerial.—The Editors.

The Naval Radio Operator

SCHOOLS are established at the Navy Yards at New York and San Francisco for the purpose of furnishing Radio Electricians for the fleet from the enlisted personnel of the Navy. After the required sea service has been performed such electricians are transferred to shore duty at Naval Radio stations and other places.

The electrical branch of the schools is divided into two parts. One branch for general electricians and the other for radio (wireless). Applicants capable of passing the examination are enlisted as landsman for electrician (either general or radio) and are detailed for a course at the Electrical School. The pay of landsman for electrician is $17.60 per month while under instruction and in addition he is furnished with a complete outfit of uniform, board, lodging, text books, tools, and materials with which to work. The length of the course is about eight months. Upon completion of the course at the school the men who are qualified are given the rating of electrician third class (radio). In both courses the following subjects are covered: machine shop work, electricity, magnetism, alternating currents, dynamos, motors, and batteries. It also embraces the principles and management of radio stations and installations. The general course covers the application of electricity to shipboard appliances.

Competent operators of the Morse code or men with a sufficient foundation in radio telegraphy may be enlisted as landsmen for Radio Electrician. The applicant must be able to take dictation at the speed of twenty-five words per minute and pass a creditable examination in spelling and penmanship.

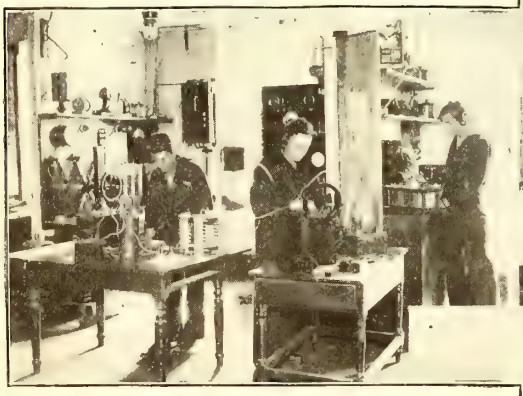
The problems in arithmetic include multiplication, division, simple proportion, percentage and square root. Testimonials as to the good character and skill of the applicant as an operator must be presented either from a former employer or from the principal of a school where the applicant has been a student of radio or telegraphy. The applicant must be able to receive about twenty words a minute.

In addition to the above, men holding commercial radio licenses and who pass an additional examination at the Electrical School, Navy Yard, New York, or Mare Island, Cal., may be enlisted as electricians third class (radio). In both cases, whether enlisted as landsmen for electrician or electrician third class (radio), the regular course at the school follows. The opportunity for advancement in the Naval Radio Service is at present exceptionally good and is worthy of consideration by every commercial telegraph and radio operator.

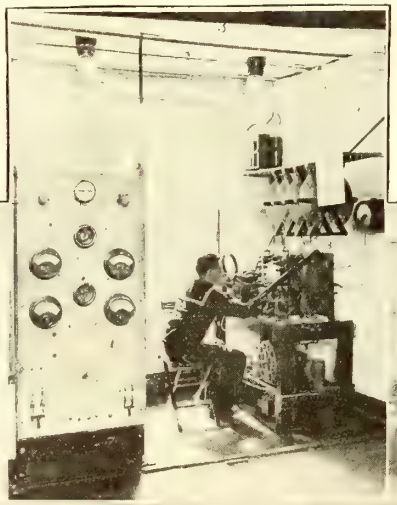
The pay of electricians both general and Radio is as follows: Electricians third class, $33 per month; Electricians second class, $44 per month; Electricians first class, $55 per month; Chief Electricians (acting appointment), $66 per month, and Chief Electricians (permanent appointment), $77 per month. This pay is increased with each enlistment.

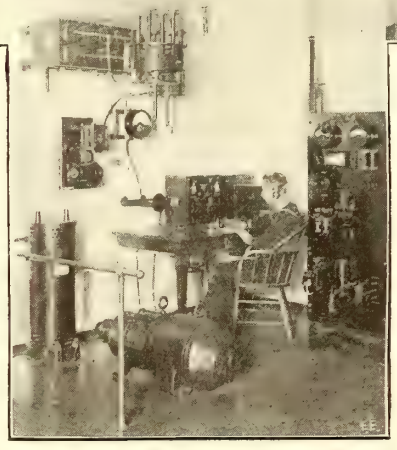
The present policy in the fleet is to advance electricians third class (radio) to electricians second class at the end of a year if their proficiency mark is at least 3.2. Electricians third class (radio) serve

(*Continued on opposite page*)



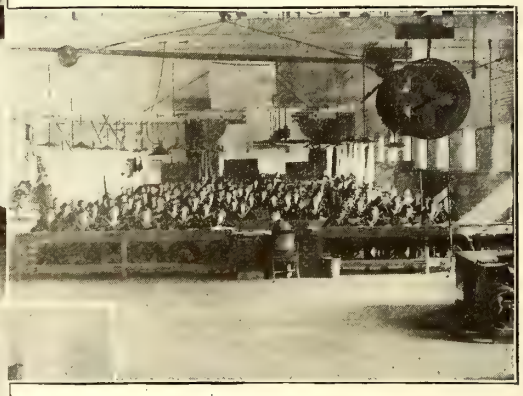
Future Naval Radio Men Learning How to Measure Length and Frequency of Etheric Waves.





Top:—Naval Radio Operator Handling 2 k. w. Transmitter.

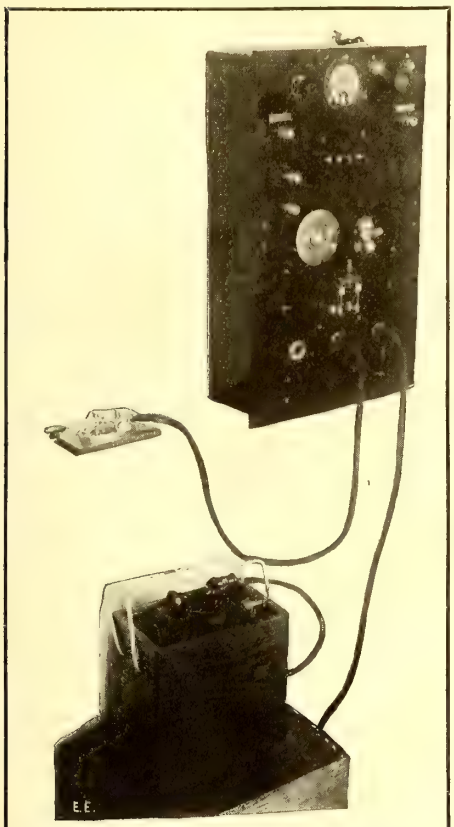
Below:—One of the Up-to-Rate Radio Sets Which U. S. Naval Operators Learn to Handle



Operating Room of Radio Class at the Navy School, Brooklyn, New York.

NEW RADIO TRANSMITTER FOR U. S. "MOSQUITO" FLEET.

The accompanying photograph shows a complete radio transmitter operated from



One of the Latest Designs of Extremely Compact and Light Weight Radio Outfits Intended for "Mosquito" Fleet Service.

a current derived from a storage battery. It was designed for supplying the mosquito fleet with an efficient low power transmitting outfit.

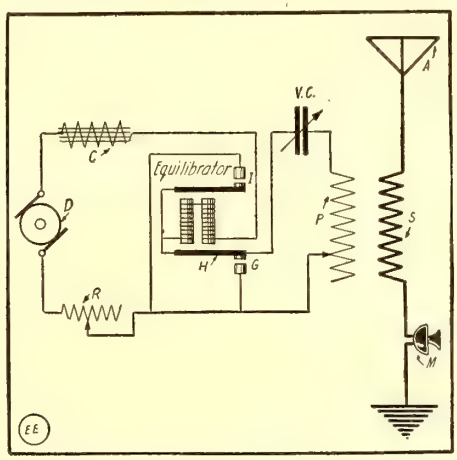
This outfit was developed by A. B. Cole, a New York radio engineer. It consists of a quenched spark gap of the open air type which is mounted on the panel. The sparking surface consists of two large special alloyed discs. The gap is excited by a spark coil of unique design; this is placed behind the panel, its interrupter, which is of the independent type, being stationed on the front of the panel and visible on the center right. The oscillating circuit consists of the usual arrangements; namely, a high tension glass condenser and aerial inductance. A transfer switch is also provided for permitting the receiving and transmitting instruments to be connected at any time desired. This is shown in the upper right hand corner. A hot wire ammeter is also furnished, and this is seen in the upper center of the panel.

The three plugs at the bottom are used for several purposes; the left hand one is employed for connecting the receiving instruments with the aerial; the center one connects the key with the primary of the coil and battery, and the right-hand plug links the storage battery with the supply source. The plug at the upper left hand corner is used for connecting the power source with the test buzzer of the receiving set. A set of binding posts are furnished for connecting the aerial and ground with the set, and these are seen at the upper part of the panel, each being fitted with the proper name-plate.

During some recent tests, the outfit has proven to be very efficient.

THE JAPANESE T. Y. K. RADIOPHONE SYSTEM.

Among the early distinguished workers in radiophony we find that Messrs. Wichi



The Simple Connections Used in the Japanese "T. Y. K." Radiophone System.

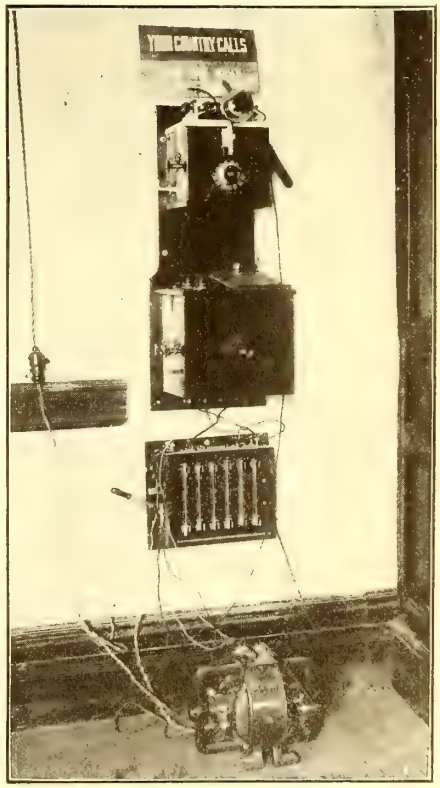
Torikata, E. Yokoyama and M. Kitamura of Japan have done very notable work in this direction, and the system which they have evolved is a radio frequency spark system of unique design, which we herewith describe in detail.

The complete equipment is shown in the photograph and resembles very much an ordinary standard "wall telephone." The transmitting apparatus outside the generator is enclosed within the top cabinet, while the bottom one contains the receiving instruments and aerial control switch. The direct current rotary converter is seen standing on the floor. It runs on a 110-volt direct current source, and delivers 500 volts D. C. for the arc. Protective resistances and choke coil are used, and these are mounted on a separate base; they are seen below the instrument proper.

The transmitting equipment consists of a specially constructed arc, its electrodes consisting of iron and brass. The distance between the stationary and movable electrodes are automatically controlled by means of an electro-magnet so arranged as to adjust the arc terminals in order to keep the oscillatory condition operative. This arc is operated in the open air and, the same is mounted on top of the transmitting cabinet. Its connections are made thru the control electromagnets of the *equilibrator,* as indicated in the wiring diagram. The movable electrode G is controlled by an armature H, which is acted upon by the electro-magnet. The contact I, is broken as soon as the arc has properly started. This break of current at I, is due to the decrease of the arc resistance which permits a large steady flow of current thru the coil, consequently attracting the contact. The arc is shunted with the usual type of oscillatory circuit, P.V.C., namely, the primary of an oscillation transformer, which inductance is controlled by means of the side switch on the left of the transmitting cabinet. A variable high-tension condenser is also mounted in the same cabinet and its capacity is varied by means of a multiple-point switch, indicated on the front. An ordinary carbon microphone is linked in the ground circuit of the secondary of the oscillation transformer, as shown in the wiring diagram. This microphone is stationed on a movable bracket on the front of the cabinet.

The receiving equipment is inclosed in the lower compartment and consists of a standard loose coupled receiver, with a crystal detector. This is placed in a metal housing equipt with a metal door, seen on the left of the case. Adjusting the crystal is performed by a vertical rod protruding from the top cover. Two variable condensers are used and these are mounted on top, while the coupling of the primary and secondary is varied by turning the front knob. A change-over switch is supplied for connecting the receiving and transmitting instruments whenever desired, and the control handle for the same is seen at rear, left-hand corner of the lower cabinet. The primary switch is mounted on the left.

Excellent results were obtained with this system, and a number of sets have been installed in several Japanese land and boat



The Japanese "T. Y. K." Wireless Phone System Is One of the Simplest and Most Efficient Ever Devised. It Greatly Resembles the Familiar "Wall" Type Telephone.

stations. The efficiency in watts per mile of talking range is remarkably high. Also the design of the complete equipment is marked by distinctive simplicity.

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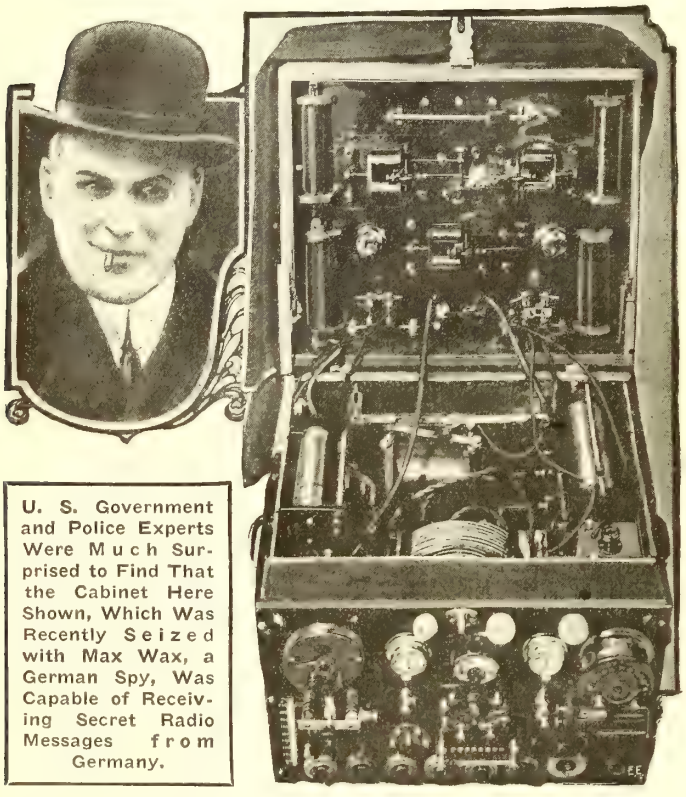
on the large vessels and Electricians second class are sent in charge of the installation on destroyers and gunboats. Men who have served two years at sea, in radio, and who have advanced to second class are eligible for shore duty. The pay and allowances and retired pay of the Navy, and the fact that all men get shore duty, makes the Naval Radio Service more attractive than that of the commercial services. A comparison of the two pays and allowances in the Naval Radio and Commercial Radio favors the former.

The physical and moral qualifications required for entrance to the Naval Service apply in all respects to these branches. If the recruit is unable to complete the course of instruction at the Electrical School because of incompetency or inaptitude he will be transferred, if he desires, to such rating in the general service as he is qualified to fill or he will be discharged from the Navy for inaptitude.

(*Continued on page* 153)

Remarkable Radio Outfit Built By German Spy

A LITTLE black box of mystery, seized recently by the police in the belief that it was nothing more than a modern adaptation of a time worn contrivance for swindling unsophisticated persons out of their savings, was revealed as a clever wireless telegraph outfit, capable of receiving messages from as far away as Berlin.



U. S. Government and Police Experts Were Much Surprised to Find That the Cabinet Here Shown, Which Was Recently Seized with Max Wax, a German Spy, Was Capable of Receiving Secret Radio Messages from Germany.

Police and government experts who examined the mechanism in the box declared it to be as perfect in construction as any they ever had seen. It is (or was) the property of Max Hans Ludwig Wax, a German citizen, and graduate of the University of Berlin. Wax, as soon as he found the police had learned the real nature of the intricate contents of the box, assumed an air of stolid indifference, denied he knew the box could be of service either in sending or receiving telegraph messages or that he knew anything of telegraphy, and asserted that apparently useless bits of paraphernalia contained in the box had been placed there by him merely to make the contrivance "look pretty."

Then, the police say, Wax informed prospective dupes that the little black box contained machinery devised by German scientists for reproducing American banknotes and currency bills. If he would place a one-thousand dollar bill in the "press" inside the box the contrivance would print ten duplicates of that bill. It then was the duty of the "loyal" German, the police say they were informed, to pass the spurious notes off for American gold, so that eventually this country would be flooded with counterfeit notes and persons loyal to Germany would be in possession of most of this country's gold.

Just after Wax was arrested the police learned that he had left the box in a machine shop in New York City. The police finally located the box in a trunk which they said was equipt with a false bottom. It was not until Sergeant Pierce, in charge of the police wireless station, rigged up as part of the scheme for military defence by Arthur Woods, Police Commissioner, looked at the contrivance that it was recognized as a genuine and extremely effective portable wireless outfit.

The box is about two and a half feet square. It is covered with black enamel and has silver handles and brass hinges and clasp. It must have cost at least $800, according to the estimate of experts.

As soon as Sergeant Pierce recognized the use to which the queer arrangement might be put the outfit was rigged up, its batteries were set in motion, and in a moment the hissing sounds and sputtering and flashing sparks that attend the operation of a wireless outfit were in evidence.

Wax persisted, despite the effectiveness of this demonstration, in his assertion that the batteries, tiny dynamo and intricate coils were placed in the box by him to make the apparatus "look pretty." Eventually he said he intended to use them to give color to a motion picture scenario he intended to write.

Persistent questioning, however, drew from Wax, according to the police statement, the admission that he, having bought the materials, the box and its outfit were put together for him by a seaman on board one of the interned German ships lying at Hoboken. He refused to reveal the identity of the man, asserting he knew him only as "Frank" and had met him only a few times.

When the examination of Wax had proceeded that far L. R. Krum, chief radio officer of the federal government for the New York district, arrived at Police Headquarters. He examined the machinery contained in the box carefully and then verified Sergeant Pierce's declaration that it was a wireless outfit of great strength. He agreed with Sergeant Pierce that the apparatus was easily capable of receiving messages from as far away as Berlin. Both experts, however, declared the apparatus probably could not be used to send a message much farther than one hundred miles.

Despite the readiness with which Mr. Krum and the police wireless operators were able to set the wireless outfit in motion, many contrivances in the box were a mystery to them. It appeared as if there were three sets of batteries, where only one was necessary. The operators exprest the belief, however, that any one of the three battery sets might have been connected with the rest of the apparatus, so that, even if two batteries failed, there still would be power to keep the contrivance in operation.

The only incomplete thing about the outfit was that the police were unable to find a sending key and a transformer, both of which would be necessary if the machine were to be used for sending wireless messages. Wax, however, is described by persons who stayed in the house where he lived as having been in the habit of carrying a small hand grip. The grip has not yet been found.

After the police were satisfied of the nature of the equipment in the box they asked Wax to operate it. He fingered several parts of the mechanism for a moment or two and finally succeeded in causing a short circuit, which effectually put the whole thing out of commission. The damage, however, can be repaired easily.

In the examination of Wax the police drew from him the statement that he came to this country from Germany in June, 1914.

He denied he had served in the German army, asserting he was rejected for military service because he had a weak heart. Dr. Baker and Dr. Hamilton, police surgeons, were called in to examine the prisoner. They pronounced him an almost perfect physical specimen and said there was no indication that he ever had suffered from heart disease.

Considerable interest was manifested by the police and federal investigators in papers and letters found in Wax's possession. They declared some were written in code. All of them were in duplicate. One of the papers, according to the police, was a draft for $12,000 and another was for 2,300 marks. The latter was drawn on the Deutsche Bank, of Berlin. It was declared by the police that Wax received some of these papers thru the office of the German Consul in this city several weeks ago. The money, the police said they learned, was sent to Wax by relatives in Germany, who the prisoner declared were both wealthy and influential there.

ELECTRICITY REDUCES FIRE HAZARD.

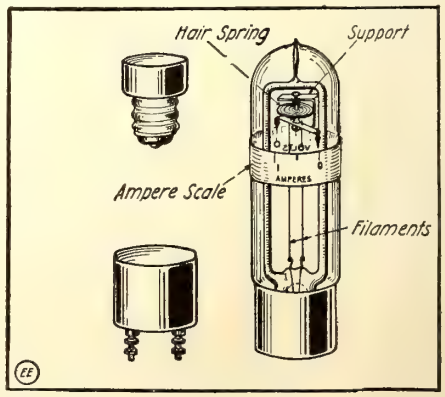
One-fourth of all the fires occurring in Waterbury, Conn., for a year might have been avoided by the use of electricity, according to the report of Fire Chief Heitman.

A NEW VACUUM CURRENT GAGE FOR RADIO.

Herewith we present the vacuum ampere gage, a new Marconi device.

The demand for a small, sensitive, robust instrument suitable for use equally on alternating and continuous current circuits is not new, and inventors have made many attempts to satisfy it.

The instrument is designed primarily as a maximum current gage to indicate the condition of syntony in wireless circuits, and may be employed as a substitute for a *thermo-junction and galvanometer combination* in the measurement of wave lengths and decrement. The principle involved is that of the bifilar suspension, one pair of the filament ends being fixt, and the other pair attached to a pivoted arm, the



By Placing the Delicate Moving Parts of This High Frequency Current Gage in an Evacuated Bulb the Action is Made More Stable and Reliable. It Can Be Used with a Wave Meter to Measure the "Decrement."

rotation of which is controlled by a spring acting against the tension of the filaments. When a current passes thru the filaments, heating them and causing them to elongate, the arm takes up a new position and the angular displacement as indicated on the scale is a measurement of the current.

The movement is enclosed in a glass bulb exhausted of air. The sensitiveness is thus greatly increased, and the movement protected against damage and preserved from dust or corrosion.

The drawing shows quite clearly the construction of the little instrument, which is made up in such a way as to resemble an electric lamp. In one form the bulb is attached to a brass cap with projecting pins identical with that used on standard English lamp bulbs, and the size of the instrument can be gaged by noticing this feature in the drawing.

The variation in zero which is characteristic of hot wire instruments in general is negligible in this type of instrument, and the natural damping renders the movement especially dead-beat.

The instrument, suitably calibrated, may also be used as a low reading volt-meter or ammeter, or as a shunted ammeter. The normal resistance of the commercial type of vacuum instrument is approximately 12 ohms.

Enclosing the working parts in a vacuum has enabled the makers to place on the market an instrument which should prove of great general utility on account of the fact that, at a reasonable cost, it is possible to provide the means of measuring direct and alternating currents of the order of .01 amp., without sacrificing any robustness of construction. The small size makes it a matter of no particular difficulty to insert the instrument in a circuit where no previous provision has been made for a measuring instrument.

With a wave meter using the new vacuum gage the wave-length of the primary circuit of a 1½-kw. set can quite easily be read when the wave meter is held with the plane of its inductance coils parallel to that of the primary of the oscillation transformer at a distance of two to three feet. The noise of the spark, which often hinders the reading of a wave meter by means of a crystal and telephones, in the case of the vacuum gage gives no trouble, as the variable condenser has simply to be rotated until the pointer of the gage gives the maximum reading. In this way circuits can be tuned rapidly as well as accurately.

MISS WINIFRED DOW A RADIO ENTHUSIAST.

Herewith find picture of my radio experimental outfit. My receiving set consists of a Murdock variable condenser, an Audion and variometer.

With this set I hear the calls of KPH; KPA; NPC; NPE and of course all Amateurs in this vicinity.

At the present time I am using only a spark coil and dry cells for transmitting but have a 1 kilowatt set nearly complete.

I thank you in advance for the interest you have taken. Wirelessly yours, Winifred Dow, Tacoma, Wash.



Among the Girls "Radio" Has Now Become a Promising Vocation. At Least Miss Winifred Dow, of Tacoma, Wash., Seems to Think So.

There are lots of worse jobs than that of Radio operator for Uncle Sam. Besides, he pays you while learning. Why not inquire about it? Both women and men are eligible.

MRS. CANDLER AN ABLE RADIO OPERATOR.

Mrs. Candler of St. Marys, Ohio, says, "I surely am very much interested in wireless and not only interested but have been operating our set ever since it has been in existence. I now hold a first grade commercial license. The first photo of our set was sent you last year by '9XE' and appeared in the EXPERIMENTER in connection with the report of the *Washington's Birthday Relay* in the May, 1916, issue. This year our station (8NH) again took prominent part in the *Presidential Relay*, being a prize winner. We have been subscribers to the ELECTRICAL EXPERIMENTER for more than a year."

There Is Now an Opportunity for All Radio Women. One of the Best Qualified Operators Is Mrs. Chas. Candler, of St. Marys, Ohio.



PHILADELPHIA'S NEW RADIO STATION WILL SEND THREE-FOURTHS WAY AROUND WORLD.

Preliminary work on construction of one of the most powerful wireless stations in the world has begun at the Philadelphia Navy Yard, according to an official announcement made recently. The construction of a hangar which will house eight battle hydroairplanes also is under way.

The new wireless station will have a sending radius of approximately three-fourths of the distance around the globe, making possible direct communication with the Philippines and other insular possessions of the United States. The aerial structure will be more than 700 feet high.

"THE CRUISE"—A RADIO STORY. By MARGARET L. CAMPBELL.

Early in August, 1916, I transferred my wireless set from my radio station to my father's new sixty foot yacht, the Wahama. She is a flush deck cruiser with all modern improvements and powered with a large four-cycle gasoline engine. She also has two masts about thirty-five feet apart, which I used to support my aerial. There is a large cabin, ten by twelve feet in size, in which I installed my transmitting and receiving apparatus, which consists of a two inch spark coil, two Leyden jars, helix, spark gap and key. Also, two variable condensers, loose coupler, tuning coil, loading inductance, Ferron, galena and silicon detectors mounted upon a movable cabinet.

Miss Margaret L. Campbell, of Rockport, Mass., Has Long Been a Radio Enthusiast and Has Operated the Apparatus Shown on Frequent Trips Made on Her Father's Yacht. She Has Achieved a Distinct Success with Her Station, Having Become Thoroly Conversant with All Radio Matters.



One of the interesting cruises made last summer was with a company of Marine Boy Scouts of which my father is the commander. We sailed along the coast of Massachusetts Bay, visiting various harbors and spending several days in Marblehead harbor during the festivities of "Marblehead Week," when the great racing events of that notable yachting center are held.

The harbor was filled with yachts of all types and age, from the majestic steam yacht of the millionaire to the small sailing dory of some aspiring youth. I was surprised to find how few of these boats were equipt with wireless apparatus, also how few of them so equipt appeared to be using their apparatus or even listening in. I held conversation with some interested amateurs on shore.

We did not send or receive any "S.O.S." calls, but did have occasion to render timely assistance to a motor boat whose engine had broken down out at sea and towed her to a place of safety before a severe thunder storm broke upon us.

I might say that I detected little difference in the workings of my apparatus aboard the boat as compared with the same on land.

I found my set to be of the greatest service in the evening when the crew gathered about to get the *time signals* and the news of the day.

WIRELESS TELEGRAPHY ON BRITISH SHIPS.

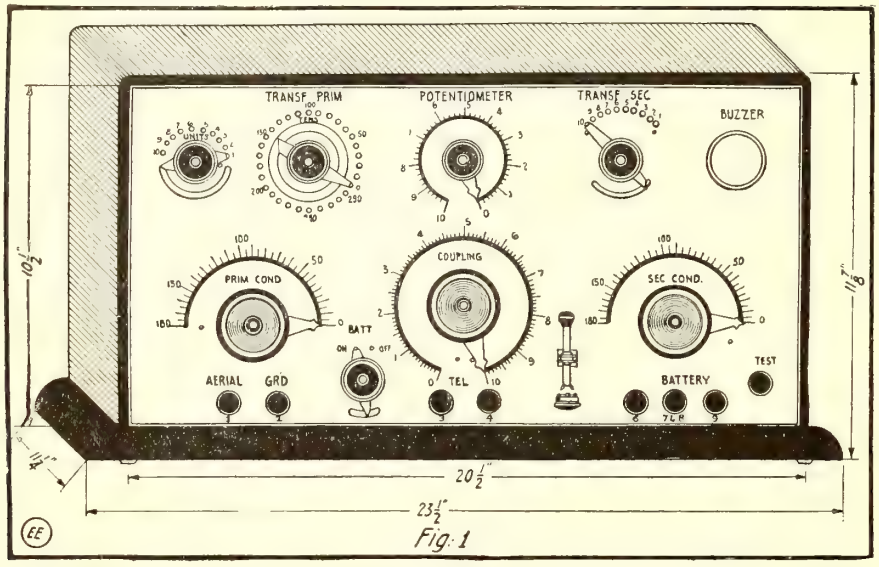
By an Order in Council, issued on July 28 last, every British ship of 3,000 tons gross or upwards is required to have a wireless installation.

The Marconi Type "106" Tuner

By WORTH MacKNIGHT

THE receiver consists of a type "106" tuner and a crystal detector. This receiver consists of a variable inductance primary circuit. One end of this inductance is connected to the antenna thru the antenna switch. The other end of the inductance is connected to the ground thru a variable condenser, which can be short-circuited or thrown into circuit at will. The secondary circuit is so constructed that its inductance may be varied, and also its inductive relation with the primary circuit can be changed. A variable condenser is provided, which permits a variation of wave length and also the variation of the ratio capacity to the inductance, while maintaining the same wave length. A battery and potentiometer is provided which permits controlling the current thru the detector. A pair of head telephones is used for receiving the signals. A buzzer is supplied which permits the local excitation of this receiver, so as to determine its condition of sensitiveness. A battery furnishes current for both the detector and buzzer.

Fig. 1 is a front view of the type "106" tuner and shows the exact position of the different switches and parts for its operation.



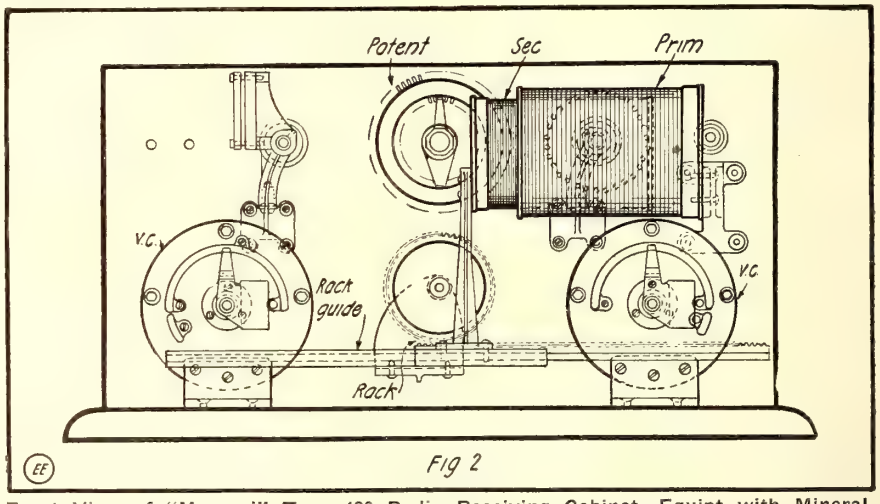
Front View of the "Marconi" Type 106 Radio Receiving Cabinet. Radio Students Will Find It Beneficial to Study It Thoroly.

The switches marked *Transformer Primary* are for the purpose of varying the amount of inductance in the aerial circuit. The switch marked *Units* varies the inductance in *one-turn* steps. The switch marked *Tens* varies this inductance in *ten-turn* steps. The *Primary Condenser*, when in zero position, has a minimum capacity. If this condenser is turned beyond the 180 degree mark, it automatically short-circuits itself, so that the aerial circuit will have no series capacity in it. The terminal marked *Aerial* is connected to the antenna switch. The terminal marked *Ground* is connected to the ground. When this primary circuit is connected to the aerial and ground the circuit is as follows: The aerial is connected to one terminal of the inductance, so that by varying the transformer primary, a greater or less amount of inductance can be inserted between the aerial and ground. This either increases or decreases the natural period of the primary or aerial circuit. It is necessary, therefore, to make these adjustments to bring the circuit in tune with the received signals. If the wave length of the received signal is shorter than that of the aerial circuit, it is necessary to insert the primary condenser in the circuit. This has the effect of shortening the time period of this circuit. The secondary circuit consists of a variable condenser marked *Secondary Condenser*, and a variable inductance marked *Transformer Secondary*.

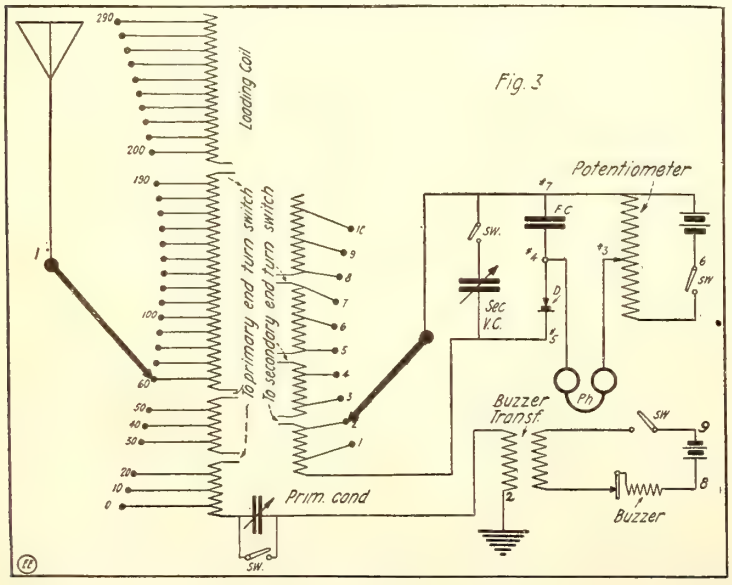
By varying either the transformer secondary switch or the secondary condenser, this circuit can be tuned to the wave length of the incoming signals. It is also possible to vary the ratio of capacity to inductance, while maintaining the same wave length adjustment. It is often found to advantage to vary this ratio. The handle marked *Coupling* is for the purpose of varying the inductive relation of the primary circuit and the secondary circuit. After these circuits have been tuned to the incoming signals, the coupling should be varied until a maximum response is found. The handle marked *Potentiometer* varies the current thru the crystal detector. The detector is situated between the coupling and condenser handles. A switch marked *Battery* is provided, so that the crystal may be used either with or without the battery. A buzzer is mounted on the front of the panel and is operated with a button marked *Test*. Terminals are provided to connect to the battery; they are marked *Battery*. Two terminals are provided for connecting in the telephone receivers, and are marked *Telephones*.

The internal as well as the external connections of this receiver are shown in Fig. 3. Fig. 2 is a back view of the panel.

This hook-up is of interest to all radio amateurs and students who expect some day to become commercial operators. Among other things, note that the buzzer test is linked up with the aerial-ground circuit inductively by a two coil transformer. Note how the secondary coil is moved in and out of the primary by a rack and pinion arrangement, giving great precision to the coupling adjustments as well as rotary control.



Front View of "Marconi" Type 106 Radio Receiving Cabinet, Equipt with Mineral Detector and Loose Coupler.



Hook-Up for Complete "Marconi" Type 106 Receiving Set, Showing Inductively Coupled Test Buzzer.

The How and Why of Radio Apparatus

NO. 4—SPARK GAPS.

From time to time we will describe one particular instrument used in either the radio transmitting or receiving set, explaining just how it works, and why. We have received so many requests from new readers asking for such explanations, that we have decided to publish this matter in serial form. In the course of several issues all of the principal transmitting and receiving apparatus will have been covered. The subject for the fourth paper is the SPARK GAP.

THE spark gap forms one of the most important parts of any oscillatory circuit, and this proves particularly so in radio transmitting circuits, where everything must be designed to realize the utmost efficiency. This means careful and scientific design at every turn, and it takes into consideration such important topics as the proper dissipation of the heat produced in the gap; the proper arrangement of the gap to give the desired tone, and a number of other vital points.

The part played by the spark gap in an oscillatory circuit is to allow the condenser in this circuit to charge to the required voltage, and then to break down and permit the charge stored in the condenser, to surge back and forth across the gap in the form of sparks, until all of its energy is dissipated. For several reasons the ideal spark gap would be one which would insulate perfectly, or be *non-conducting* during the time when the condenser was being charged, and conducting perfectly, while the condenser was discharging.

The nearer these requirements are fulfilled in any spark gap, the more efficient will this piece of apparatus perform its function. While the discharge is passing, the resistance of the gap depends upon two factors: the resistance increasing markedly with the length of the spark, and decreasing rapidly with the oscillatory current, amounting with a half-inch gap to several hundred ohms when a fraction of an ampere passes, and but a small fraction of an ohm when say sixty amperes flow across the gap. If the spark length is above one-half inch, the resistance with the same oscillatory current flowing, can be taken as approximately proportional to the spark length. However, in a condenser circuit, the quantity of electricity is stored up in the condenser, and in consequence, the amount of oscillatory current increases with the spark length. Hence, we find two conditions working against each other, as regards the influence of the spark length on the spark resistance. However, we can increase the amount of current passing thru the gap without increasing the length of the spark, by simply increasing the size of the condenser, and the most efficient circuit for a given amount of power, is that in which there is a moderate spark length with a large condenser.

When the condenser has been fully charged, the spark gap breaks down, and the gap becomes filled with metallic vapor, and for the time being forms a high frequency alternating-current arc. The conductivity of the spark is due to the presence of metallic vapor in the gap. After the discharge ceases, and if this metallic vapor is not quickly removed from the gap, the insulation will in consequence be very low at the time that the condenser is passing thru its next *charging period,* which of course occurs in a small fraction of a second, usually.

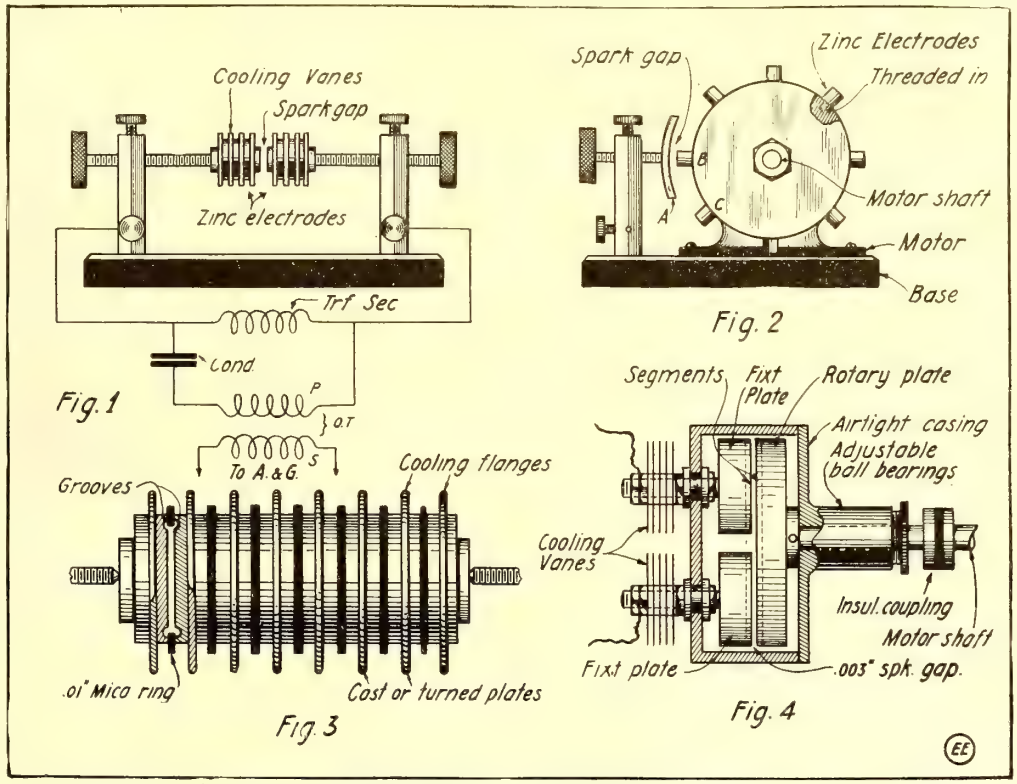
It is therefore paramount that we remove this vapor completely as soon as possible after the discharges of the condenser have ceased. This has been attempted in various ways in the past, such as by providing spark gaps having large cooling vanes attached to the spark electrodes, as in Fig. 1, and also by causing one or both of the spark gap electrodes to rapidly rotate, so as to constantly refresh the air in the gap. This latter condition, which is usually met by arranging a number of small spark electrodes on a rotary disc attached to the shaft of a motor, or to the shaft of a motor-generator in the case of synchronous spark gaps, the spark being caused to jump thru the air between the constantly moving electrodes, and one or more fixt electrodes mounted on the base of the spark gap.

Fig. 2 shows a *non-synchronous* type of spark gap in which the speed of the rotating disc bears no definite relation to the frequency of the alternating-current in the transformer or spark coil. As a spark is apt to occur, or want to occur, at most any indefinite time, it is best with such non-synchronous rotary gaps, to provide a stationary electrode "A," in the form of a segment, having a pitch equal to the distance between two of the rotary electrode points.

For synchronous rotary gaps, driven by a synchronous A.C. motor or by mounting the disc on the same shaft with the motor-generator, as is done in the best types of commercial radio transmitting sets, the fixt electrodes need not be any larger than a single electrode point on the rotary disc.

One of the most efficient spark gaps used very successfully by commercial stations and also by numerous amateurs, is the *quenched* gap illustrated at Fig. 3. This gap, which is very well known to-day, is designed on several important basic principles. The foremost of these desideratums is that each gap shall be preferably not over 1/100 of an inch in length, and moreover, that the gap shall be absolutely airtight. Further, not over 1,000 to 1,200 volts should be applied to each individual gap, and for higher voltage a suitable number of these short gaps are placed in series, as shown in the illustration herewith; two gaps being adapted to 2,000 volts—three gaps to 3,000 volts, etc. The action of this gap has been described at some length in a semi-technical manner by Mr. Charles R. Ballantine in the March, 1917, issue of THE ELECTRICAL EXPERIMENTER. Briefly, the action of the gap is based upon the fact that a small quantity of air is trapt between the spark surfaces separated by a mica ring of proper thickness. After the first few sparks have past the oxygen in the trapt air is burned up, resulting in a partial vacuum in the gap. This conduces to the rapid quenching thereafter of the spark discharges, due to the condenser, and gives rise to a very ideal set of conditions for the entire radio transmitting circuit. This is because the oscillations in the spark gap-condenser circuit are cut off after the first few beats or sparks, but the oscillations induced in the aerial-ground circuit are left free to oscillate for a longer period. This prevents the reaction of free oscillations in the spark gap circuit upon the aerial or secondary circuit—a condition which is invariably found in ordinary radio transmitters fitted with a plain fixt spark gap, and a condition which mitigates seriously against the best efficiency of such an equipment. The quenched spark gap usually consists of a number of these small gaps as above described, which are placed in a suitable frame so that considerable me-

(*Continued on page* 153)



Various Styles of Radio Spark Gaps Which Have Been Found Efficient for Different Types of Sets. The Rotary Quenched Gap, Fig. 4, Is One of the Best for Small and Medium Power Sets Operating on Low Frequency Circuits.

THE CONSTRUCTOR



The Clock Craze

By Thomas Reed

BEING cooped up in a flat, late years, I've had to give up experimenting. Mine's a fine flat, as flats go—all modern conveniences, two kinds of cold water as the fellow says, and a fire-escape with a sparrow's nest on it; even a little safe let into the wall, big enough to hold most of the Wiff's diamond tiaras if you pack 'em tight. Yes, it has all the conveniences but one, and that's the only one worth having—a workshop.

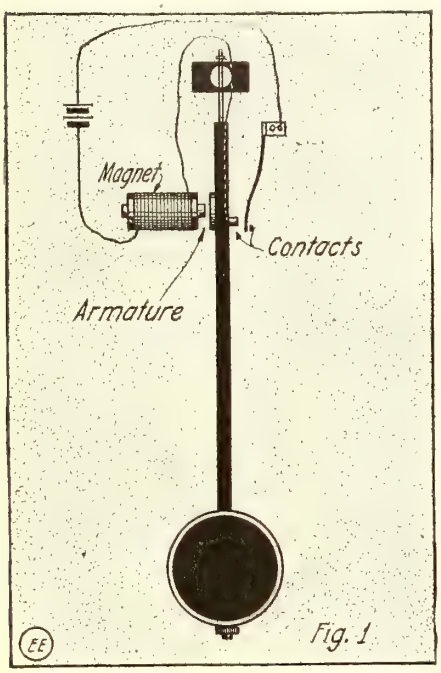


Fig. 1. Attempt No. 1 in Electric Clock Research as Tried Out by the Author—Did It Work? Read the Accompanying Text if You Think So, Bugs.

The nearest I can get to it now is reading the good old ELECTRICAL EXPERIMENTER. When she blows in, I sop her up from front cover to back—every word. Advertisements and all. Well, I'll say so; and I'm not the only one that does it, eh, Bugs?

One place I always stop and smile, and that's the heading "How-to-Make-It Department." I guess my department is the "How-*Not*-to-Make-It." Usually e v e r y - thing I started went wrong the first time; but the finding out why it wouldn't work, and making it over till it would, wasn't the worst fun in the world. In fact, I think it was the best. No fun simply copying.

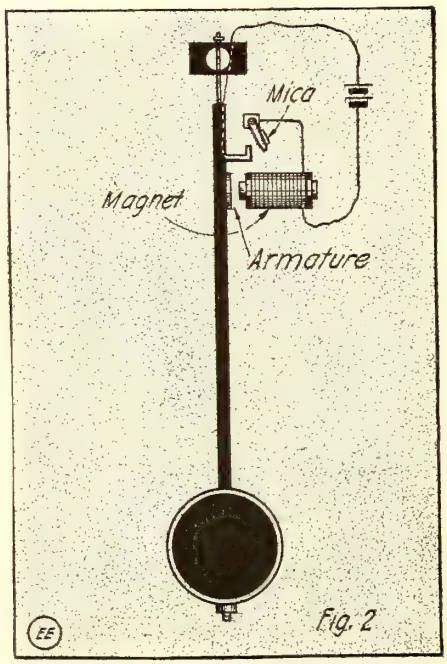
When it came to the electric clock, though, that nearly beat me. There's a thing that looks easy, and isn't; yet it's simple enough once you're wised up.

I was sort of forced into the clock craze. You see, our kitchen clock was on the blink. Father didn't blame it—good old clock, he said, it had served him faithfully twenty-five years, and was worn out. Worn out nothing! I'll bet old Jerome turned over in his grave at that libel, for one of his excellent brass clocks ought to go for 100 years, and only be talking baby-talk then. I knew what ailed it all right; it was so full of my contact-springs, wires, magnets and other junk, that its regular works had become discouraged. But that was a secret between me and the clock, and there were good reasons why the secret was safe with me.

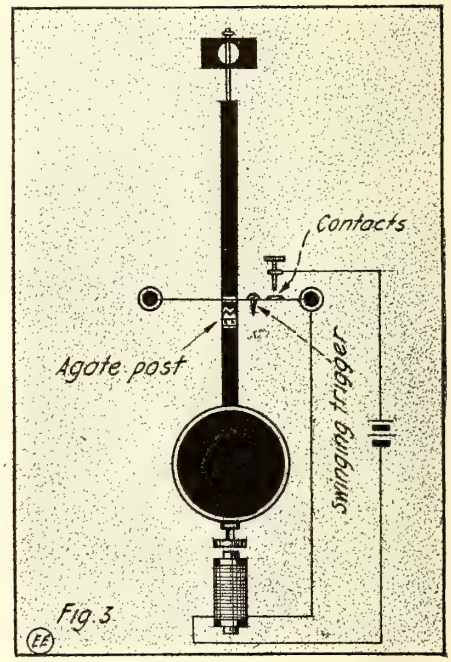
Anyhow, when the clock took to stopping, something had to be done, and done quick, because mother would figure wrong with her Saturday baking, and Mrs. Skillings would get her hot pies out on the window-sill first, which was an awful catastrophe to mother, and made her feel as peevish as the Standard Oil does when a competitor sells a quart or so of gasoline right under its nose.

I had pondered a little on electric clocks, and as I say they looked easy, so I made the family a proposition: for half the price of a new clock I would turn the old one into an electric clock that would go all the time without winding. Father liked the idea because his back got twisted climbing up on a chair to wind the thing, and any clock at all looked good to mother provided it was a going institution. I said this one you couldn't stop if you wanted to; and it would be so accurate that Mrs. Skillings would be running over to ask humbly what the really correct time was. This is known as promoters' language, and is powerful. It clinched the deal. Father handed over the kale with a feeling which if magnified a few diameters would have been enthusiasm.

Everybody (including myself) expected it would be not over two weeks at the outside before I had the clock rigged up and was after Mrs. Skillings' goat with it. I took the old clock to pieces for the last time, pulled out a few superfluous wheels and springs, and inserted a pawl and ratchet-wheel where they would do the most good. Then I started gaily on the electric pendulum that was to drive it. I wished afterward I'd made the pendulum first.



Attempt No. 2, in Electric Clock Design. This Arrangement "Worked Too Well." But the Magnet's Successive Pulls on the Pendulum Accumulated till it Banged Against the Magnet Like Jess Willard Administering a K. O.



Finally the Electric Clock Problem Settled Down to a Resurrection of Hipp's Famous Pendulum. But Oh! that "Agate" Post !X? Likewise Zowie.

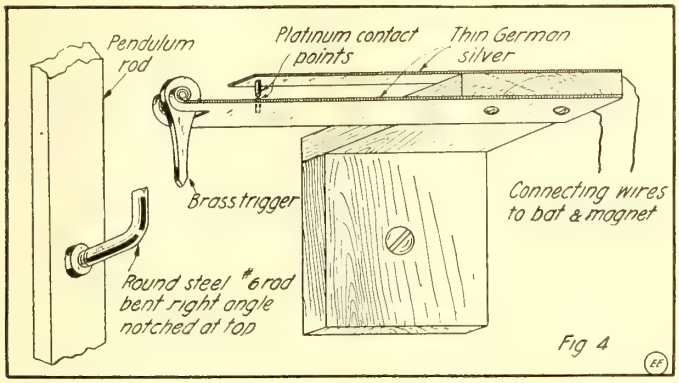
It was a grand pendulum I made—a seconds-pendulum of the due length of 39.1 inches, with wooden rod and a fine heavy bob. I was so cocksure that I polished up all parts as I went along. But when it was done, it wouldn't work.

There were two or three main reasons why. To begin with, it was hung on pivots, like a telegraph key; and the heavy bob set up so much friction there that it would have taken about a kilowatt to drive it. Of course it should have been hung on a suspension spring, which lets the pendulum oscillate while supporting its weight without friction. Bonehead play number one.

Well, I discarded my pivots—tho I hated to, they looked so pretty—and with my pendulum swinging easily from a spring, I looked to see her go. But nix. Good strong magnet, clean contacts, and

all that, but nothing doing. Could anything be wrong with my arrangement? Answer, oui, oui.

You see I had it rigged as in Fig. 1, following the idea of the electric bell. When the pendulum swung over far enough to make contact, the magnet gave a vigorous pull; but unfortunately it checked the pendulum just as much as it pulled it, and the result was nil. The slow, free-swinging pendulum acted differently from the rapid, springy bell-hammer.



Finally I Contrived a Substitute for that "Agate" Post on the Clock Pendulum, Relates the Author, and Decided that the Thing to do Was to "Substitute." Steel Proved Excellent—but I Guess a Piece of Cheese Would Have Sufficed.

The two weeks were already up, and mother was beginning to peeve, because meanwhile Mrs. Skillings had put it over her again on the pies; so I hid my chagrin under what I hoped looked like a confident smile and attacked the problem anew.

The next attempt is shown in Fig. 2. I made a flapping contact, metal on one side and insulating mica on the other. This arrangement worked too well, if you get me. The magnet gave a nice pull, and on the back-stroke it let go, all as per intention. But now the pulls accumulated till the pendulum ended by banging against the magnet like Jess Willard administering a K-O. This pendulum thing began to seem decidedly not as easy as it used.

Anyhow, to have it go at all was some consolation. All that was needed now was some arrangement to cut the current off as soon as the pendulum had all the impulse it needed, and switch it on again when more was required. Now I began to appreciate Hipp's pendulum, described in the text-books. In Hipp's device (Fig. 3) the electric contact is made by means of a notched post attached to the pendulum, which normally pushes past a little swinging trigger attached to the contact-spring. As the pendulum loses its amplitude, there comes a moment when the notch in the post just catches the trigger, and then when it starts the other way the trigger is raised and the contact made, the magnet is energized, and gives the pendulum a push. The notch now brushes by the trigger again, until the narrowing swings allow it to catch once more, and the process is repeated. As the battery runs down, the push is weaker and the contact has to be made oftener; but the mechanism does this automatically until the battery is exhausted.

Hipp's rinktum looked effective, if one could only make it; but being a clock-maker, old Hipp had specified agate as the material for his notched post. Agate, he says, just like that: "Take a piece of agate, you know, and put a notch in it." Oh, yes. The only agate I had ever heard of was an agate marble; and it didn't look exactly like easy stuff to make anything of.

Four weeks had now gone by, and the family had lost all their peevishness; that, is, they had exchanged it for black looks and language not calculated to please. I was reaping the usual reward of the sanguine promoter. My stockholders, ignorant of the exactions of science, were clamoring for quick returns on their investment. Stockholders in this mood fall naturally into sarcasm. They say, "Oh, you were just as sure as anything when you were after our money, and now you admit you didn't know what you were doing. Of course you're right on the track of it this time—pooh, pooh! Have it all ready tomorrow morning at breakfast, I suppose. Well, a fool and his money——" all that encouraging stuff. I know just how to treat impatient investors now; but at that time the situation, coming on top of my defeat at the hands of Nature, got my goat, and I'm ashamed to say I declared bankruptcy and quit. Father bought a new kitchen clock, and issued a manifesto (having got an inkling of what ailed its predecessor) that if I monkeyed with its insides to the 100th part of a monk, he would monkey with my outside; and, in the vigorous language of the day, I was not to forget it.

I knew why a prophet is without honor in his own country. Believe me, my home reputation as a budding scientific and business man was badly damaged; to be more exact, it looked like the place where a 42 cm. shell has recently landed. But the clock craze had struck in; and oblivious of everything, in cloistered seclusion behind the barn I pondered upon Hipp and his exasperating agate.

I pondered long before, in a burst of enlightenment, the great truth of Bugdom burst upon me—use some other material, even if it isn't as good, anything at all for a starter. Couldn't I use steel, brass even? it would last long enough to try it anyhow. It makes me laugh now, my great discovery; but do you know that sometimes the getting rid of a fixt idea is the hardest part of an undertaking? Why, I could have used pewter, paper, I guess even cheese if you took it near the rind.

Don't let anyone discourage you, Bugs, by specifying costly and unusual materials. The inventor's describing his rinktum the way it looks after he's got it all babied up in its final Easter dress; but just for a trial you don't need the platinum, Bakelite, Empire cloth, and "S.C." wire—no, sir, you'll find all you really require in the good old junk-box as usual. Me, I grew so independent finally in the matter of materials that I hardly recognized more than two kinds—conductors and insulators!

So, having got the agate out of my head —"solid agate" I guess my old bean was— I used steel for the post and brass for the trigger; and as to durability, let me tell you that after nearly twenty years use I can't with the naked eye detect any wear.

Oh, yes, I made the clock, but I had a long hunt for something on Hipp's principle in a form which the amateur workshop might turn out. After many trials I evolved the form shown in Fig. 4; and I make you free of my invention, Bugs, hoping someone will be interested enough to make himself an electric clock. There's lots of enjoyment in listening to its sedate tick-tock as it breaks up infinite time into the small units we need to make our good or bad use of. Maybe, now that the war will debar us from wireless work for a while, you'll feel inclined to take up this fascinating subject of clocks; and if so, I have many valuable "wrinkles" which I should be delighted to share with you. Only, avoid my experience, and don't make a business proposition of it at first. C-U-L, O-M. .-.-. -.-

NEW RESISTANCE MATERIALS.

A New York concern is now marketing *tungsten* and *molybdenum* in sheet, ribbon and plate form. This development makes these metals suitable for new uses and opens to them a much wider field of usefulness than has heretofore existed. The tungsten and molybdenum ribbon is being made in widths of about ¼ in. (6.35 mm.) and in lengths of several yards. In this shape the ribbons ought to be ideal material for the manufacture of heaters of various descriptions and suitable for high temperatures, the manufacturer points out. The United States Government has already placed an order for plates of these metals for spark gaps on wireless outfits to be used on its Mosquito Fleet.

KINKS FOR THE DRAFTSMAN.

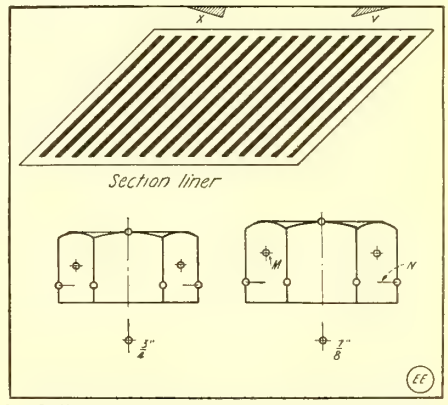
The first "kink" shown is a new section-liner. There are a great number of appliances on the market for this purpose, but the one described will do the same work as the most expensive device, its advantage being simplicity.

It consists of a sheet of celluloid cut as shown. The parts shown in black are cut away with a sharp knife, leaving a kind of grid. To use this section-liner place its base close to the Tee-square and place the pen or pencil into the opening and draw a section-line, following the outline of the grid. Without moving either Tee-square or section-liner, place pen into the next slot and so on.

The two corners "X" and "Y" are cut away to the angle of threads used and these may come in handy when drawing bolts, etc.

The second "kink" will save those draftsmen that are on repetition work much time and trouble. It consists of the following: Draw all those bolts, nuts, washers, fittings, etc., that are used over and over again in numerous sizes on a sheet of tracing cloth and ink it in. Be sure to mark, in the case of nuts and bolt-heads, from where you strike the radii; see point "M"; point "N" shows the height of the bolt head arc.

As most offices use transparent drawing cloth, the standard sheet can easily be slipt under the paper and the outlines traced thru. In the case of many hundred bolts, etc., required, say in details of bolts for pipe lines, etc., the saving of time will be several hours and a much neater drawing will be the result.



A Celluloid Section Liner for Draftsmen and a Scheme for Quickly Drawing Nuts or Bolt-Heads of Any Size.

Contributed by C. A. OLDROYD.

The Influence of Light upon the Contact Potential of Selenium and of Cuprous Oxide

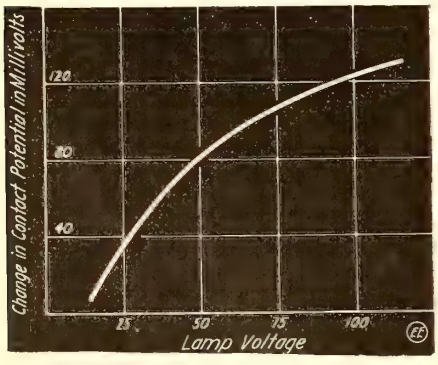
By. E. H. KENNARD and E. O. DIETERICH
Department of Physics (University of Minnesota)

THE change in resistance of crystalline selenium and other light sensitive substances, such as stibnite, cuprous oxid, etc., under the action of light and other agencies, has been explained on the assumption that it is due to a liberation of conducting electrons from the atoms of the material in question.* In other words, the change may be considered as due to a change in the atom itself. If this explanation is correct, then other properties of these substances, which also depend upon inter-atomic forces, should show a variation from light to dark. The authors investigated the *influence of illumination upon the contact potential* of selenium and of cuprous oxid, since this property is one of those mentioned above.

Using, as a check upon each other, two different methods, Figs. 1 and 2 of determining contact potentials, it was found that a change did take place in both substances upon illumination. In the case of selenium, this difference amounted to something over —0.1 volt, several specimens being examined. The value, in the dark, of the contact potential, relative to clean copper, was about —0.4 volt, in the light about —0.5 volt, i.e., the selenium surface becomes more *negative* on being illuminated. With cuprous oxid, of which but one specimen has been examined thus far, the effect is not so great, being about —0.025 volt.

In the case of selenium the effect is very marked, even when light of very low intensity was used, as can be seen from the curve in Fig. 3, which shows the relation between the change in contact potential and lamp voltage. Thus, with a lamp voltage of 25 volts (normal 110) the change amounts to about 0.035 volts, yet at 110 volts at which the intensity of illumination has increased by a factor of about 2,000 over that at 25 volts, the effect is only 3½ times as great.

Until recently the most widely accepted theory of the change in resistance of selenium with a variation of the intensity of illumination has been that proposed by Professor A. H. Pfund, of Johns Hopkins University. According to this theory, the effect of light is in the nature of an *internal photo-electric effect,* i.e., the atoms of selenium expel electrons, the velocity of which is too low to allow their escape from the



Curve Showing Relation Between Light on Selenium and the Contact Potential.

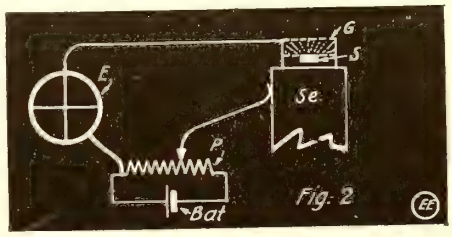
interior, hence they produce increased conductivity. The true explanation, however, does not seem to be as simple as this, for on the above theory, in the regions illuminated, the concentration of *free* electrons would be increased, and one should expect diffusion of these electrons into the darker portions, leaving the part illuminated more *positively* charged. The *negative* sign of the change in contact potential, however, at once rules out the diffusion hypothesis and makes the simple theory mentioned above inadequate. An hypothesis which better fits the facts is that contained in a theory recently proposed by Professor F. C. Brown of the Iowa State University, which assumes that the action of light consists in changing the rate of recombination of conducting electrons with the selenium atoms, or, in other words, it decreases the potential energy of the electrons in the inter-molecular spaces.

* A more complete discussion of this work is to be found in the *Physical Review* for January, 1917. This article prepared for THE ELECTRICAL EXPERIMENTER."

POPULAR DISCUSSION ON THE PRODUCTION OF HELIUM

By Mark Fushman.

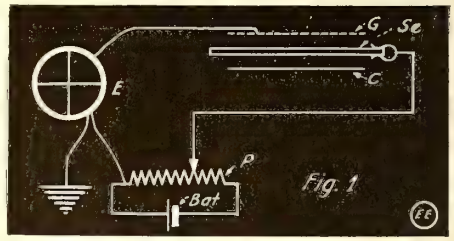
In a spectroscopic investigation, Janssen and Norman Lockyer observed in the atmospheres of the sun and many fixt stars, a bright yellow line which could not be associated with that of any known substance. To this new substance they gave the name "Helium." Helium was discovered on the earth in 1895 by Ramsay and Travers, who obtained it by heating the rare mineral *Cleveite.* Later on, it was found that this element is a companion to *Argon.* Lastly, it was also discovered in the atmosphere.



Ionization Method of Measuring Contact Potential. This Method Is Also a Null Method as the Diagram Indicates. S Is a Copper Strip Coated with Polonium, the a-Particles from Which Ionize the Air Above the Selenium, Se, But Do Not Strike the Selenium Surface. G, as in the Other Method, Is a Brass Gauze Connected to the Electrometer.

Helium has an atomic weight of 4.00 and is monatomic, i.e., that is—the helium molecule consists of only one atom. At ordinary temperatures, helium is a colorless gas; it boils at about 269°C., and by evaporation at a pressure of 0.15 mm., a temperature 1.5 above absolute zero was obtained.

The fact that this new gaseous element occurred in certain minerals was considered very remarkable. A new light was thrown on this subject by the discovery of radioactivity. Radioactive substances are known to emit spontaneously electrons, or particles, as they are now termed. As these particles are emited the substance changes into a new and different element; this is known as the disintegration theory of radioactivity. In looking for a disintegration product, the presence of helium is noteworthy, for helium is found in minerals containing uranium or thorium. Rutherford and Soddy suggested that helium might be a product of disintegration. Ramsay and Soddy obtained thirty milligrams of radium bromid and dissolved it in water. Radium bromid produces hydrogen and oxygen, so these gases were drawn off and there remained a small bubble of residue gas, which was introducd into a vacuum tube and showed the characteristic lines of helium. When a very old sample of radium bromid was



Condenser Method for Measuring Quick Changes in the Contact Potential. The Electrometer, E, Can Be Connected by Means of Suitable Clips, Either to the Gauze, G, the Selenium Plate, Se, or the Copper Plate, C. As Shown in the Diagram the Connections Are Such That, by Means of the Potentiometer, P, the Deflection of the Electrometer Which Occurs When Light Falls on the Selenium Plate Thru the Gauze, Can Be Made Zero, and the Change in Contact Potential Determined. Proper Precautions Are Taken, of Course, to Secure Proper Electrostatic Screening.

used, the residue bubble gave the complete spectra of helium. This experiment showed that helium was produced by radium. Helium is also produced from active forms of *actinium.* This shows also that helium ought to be a common product of both substances.

Radium, owing to its property of giving forth particles, gives forth certain particles which are called alpha particles. In old radioactive material there is a large collection of helium which goes to prove that the alpha particle is connected with helium or rather that an alpha particle is a helium atom. An estimate of the rate of production of helium from radium has been made by Ramsay and Soddy. 1 gram of radium produces daily 0.499 cu. mm. helium gas.

Investigation seems to show that the alpha particles from actinium and thorium are also atoms of helium; therefore we may regard these elements as compounds of helium and some unknown element. It appears that helium plays an important role in the formation of the radioactive elements. It may be that helium, like hydrogen, plays a part as one of the elementary elements of which the heavier atoms are built.

It is supposed that at the center or rather in the depths of the earth, where the pressure is great and the temperature high, radioactive elements are being formed and the deposits of radio-elements now on the earth's surface were thrown up from below ages ago.

CARD INDEXING THE "E.E."

I have a little stunt which I thought might be of interest to other readers, as follows:

I took a small card index that is sold for a recipe file and sold for $1.00 anywhere, and as I read my ELECTRICAL EXPERIMENTER each month, I note on the cards all those things that may be of future use to me, in this way:

Antenna Switch-Exp., Jan., 1917, page 658; then at any time that I want to make anything, I look at the cards and all articles in my stack of magazines are listed there, which saves hunting thru a stack of several dozen magazines for something you have seen, but cannot find.

Contributed by F. C. BROWN.

High Frequency Apparatus and Experiments

By HUBERT A. McILVAINE

MANY experimenters either do not realize the vastness of the high frequency field, or think that they have not money enough to buy the necessary apparatus. It is the purpose of this article to explain the manner of constructing a few simple instruments, and the method of carrying out some simple experiments.

In the first place, a high frequency transformer must be constructed. An Oudin coil will be the best for all-around work, and it may be made in the following simple manner: Procure an ordinary pasteboard mailing tube, about 2½ inches in diameter and 10 inches long, and cover it with a thin coat of white shellac. While this is still wet, wind the tube with fine copper wire, spacing the turns far enough apart to ensure proper insulation. (Enough wire may be found in an old telephone ringing magnet.) Glue this tube upright to a base and fasten three posts on the base. The primary coil may be made of 6 turns of No. 14 copper wire, connected as in the diagram, Fig. 1.

A condenser can be made by coating both sides of old photographic plates with tinfoil, and placing them in a cigar box, to hold them in an upright position. A spark gap of most any type will answer. A 1½ inch spark coil should be used.

When the above instruments are constructed, they should be connected up as shown in diagram, and the apparatus is ready. When the spark coil is operated, a brush discharge of purple light should appear around the free end of the secondary, upper end of coil, with sparks about 2 or 3 inches in length. If a piece of metal is held in the hand, a very long spark can be drawn from the secondary wire, without the slightest shock. If, however, the spark is drawn directly into the hand, a severe sting may result. On the other hand, if a pane of glass is held between the secondary wire and the hand, a spark may be received directly into the hand without pain; the spark, being dispersed or spread out while passing over the glass.

If a person insulated from the ground grasps the free terminal of the secondary, a match may be lighted from any part of the body. A Geissler tube will light up brightly, when brought near the body. This is also a good way in which to treat heart and nervous diseases. If there is any local trouble, a grounded metallic object should be brought near the point to be treated, thus taking out the induced current at this point.

An interesting experiment is to produce an artificial Aurora Borealis. This may be accomplished with a large electric bulb (a 100 watt, burned out one will do), covering the tip with tin-foil. Insulate the bulb

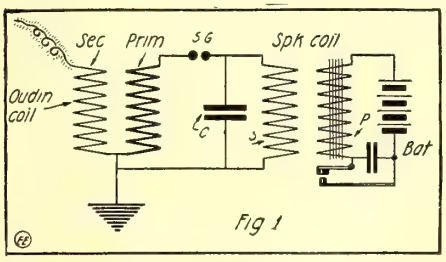


Fig. 1. Proper Connections for Small "Oudin" High Frequency Coil Excited by a Spark Coil or Step-up A. C. Transformer.

from the ground and fasten the screw end to the secondary wire. Place a strong permanent magnet on each side and start the coil. A beautiful auroral effect will form

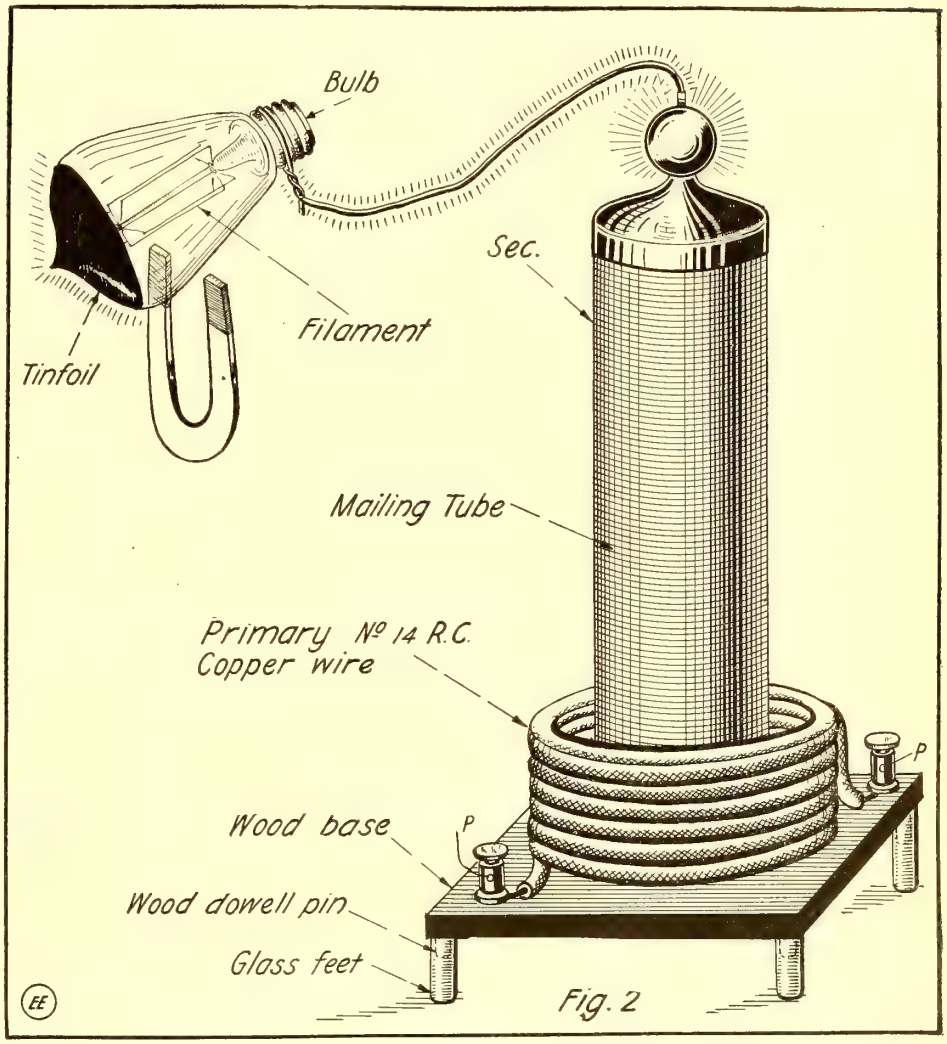


Fig. 2. Manner of Constructing Small "Oudin" Type High Frequency Coil for Carrying on a Series of Interesting Experiments. One of These Is the Artificial "Aurora Borealis," Which Is Produced with the Aid of an Incandescent Lamp Bulb, Having Its Tip Portion Coated with Tinfoil, and Connected as Shown.

inside the bulb. Also, if there are any loose pieces of filament, these will begin to revolve rapidly about the inside of the bulb and will continue to do so for some time after the current is shut off, and each time they touch the glass a shower of sparks will fly in all directions.

A by-product of high tension electrical stress in the air is *ozone*. Ozone is merely electrified oxygen. When a high voltage discharge takes place in air or pure oxygen gas, the atoms of oxygen are "torn apart" and exist in what is known as a nascent state. In this state each atom combines with one other atom, and the chemical affinity of these two atoms is such that, as there is nothing with which they can combine, these atoms pull to themselves and combine with a third atom of oxygen. Thus it is that a new gas is formed. This gas is much denser than oxygen and is many times as active. The smell of ozone is very strong and there seems to be a slight difference in the smell of ozone produced with a static machine and the ozone produced with high frequency current. Ozone is an excellent "germ killer," as it kills all kinds of disease germs on contact. If it is administered properly, and in time, it will cure consumption.

The electric stress about the coil is so great, that immense quantities of ozone are constantly being generated. In order to treat diseases obtain a box which is large enough to contain the coil and still leave enough space (about 4 inches) on each side to prevent the coil from "grounding." Run the coil wires through the box and leave the free end of the secondary about six inches long, so as to obtain good radiation surface. Place a hose in the top of the box and another in the lower part of one side. Paraffin the box to prevent leakage, and put a small window in one side so that the coil action may be viewed. Either air or pure oxygen is taken in thru the lower hose and the ozone is inhaled, or otherwise applied from the upper hose. In fumigation, treatment of coughs, pneumonia, colds, and for many other medical uses, besides oxidation of certain materials, bleaching flour and cloth, experimenting with its use in welding and many other commercial uses, ozone is a most valuable agent.

Taking the high frequency field as a whole, it is well worth while for more experimenters to work with it. High frequency current has the properties of both static and galvanic electricity, besides many properties which neither of the above possess. It will pass over ordinary insulators, such as glass, almost as easily as low frequency current will pass thru copper. It travels over the surface of a conductor and seldom thru it. Its oscillations are

(*Continued on page* 154)

The Problem of Using The Energy in Sunlight

By Prof. I. Thornton Osmond

A RESEARCH PROBLEM AND OUTLINED SOLUTION.

SUPPOSE all the electrical energy used in the world for power, heat and light to be obtained for nothing. How the world would be changed. Energy in electrical form, of limitless amount and absolutely free, is falling over a world provided with apparatus and appliances for the use of electric energy. But the world does not use this constant, exhaustless flood of free energy; it digs coal out of the earth and depends on that for its power, heat and light.

The greatest discovery any experimenter can seek is the *direct utilization of solar energy* as the source of power for the world's work.

The following outline of experimental research may enable some so circumstanced that they can make the investigations, to make this discovery. In this work I seek to obtain energy from solar radiation by causing it to produce ordered acceleration of electrons about, and in, a conductor — electric current.

Problem: — To Obtain Electrical Energy "Directly" from Solar Radiation.

1°. The solution here proposed is based on the following principles: 1. The solar radiation is electro-magnetic. 2. The flow of energy is in the direction of propagation, sun to earth. 3. The periodic action, vibration, is at right angles to the propagation, and is cyclic variation of two vector magnitudes, electric force and magnetic force. 4. Solar radiation produces acceleration in electrons in its path that have a component of motion in a certain relation to it. 5. Acceleration of an electron produces an (opposite) acceleration of surrounding electrons.

2°. The experimental solution is rendered difficult by the great complexity of the solar radiation. Take a small area in a plane at right angles to the solar beam. At every instant there are passing thru this waves of millions of different lengths and periods, and at every instant they are in millions of different phases, and the electric and magnetic vectors in these waves at any instant are in millions of different directions and continually changing at every point.

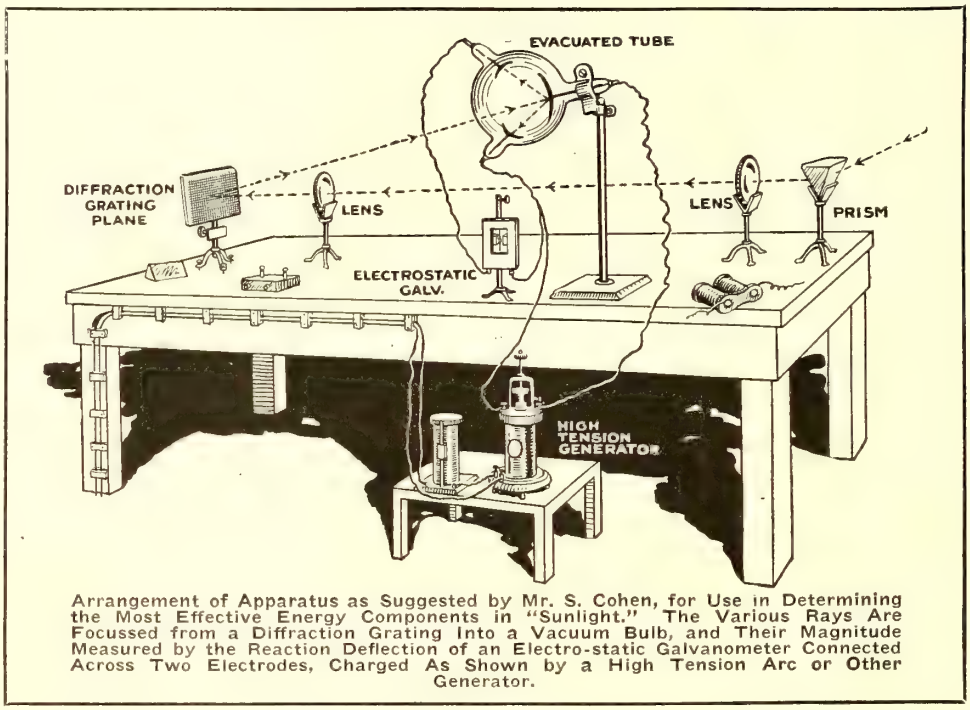
3°. A beam of one wave length or period approximately may be obtained by the use of a prism or a grating, preferably a grating.

4°. A beam with the electric vector confined to one direction may be obtained by the use of a polarizing mirror or a pile of plates; or to two directions, giving elliptic resultant by an additional mirror or a rhomb.

5°. A complex beam, a beam of one wave length, or a beam of one wave length and one direction of electric vector, may be concentrated to a small area, circular or linear, in which, at any given instant, there is but one phase in the focus of a lens, spherical or cylindrical, all waves (of a given length) are in the same phase at any instant.

6°. Two parts of a complex beam, of a one wave length beam, or of a one wave length and one electric vector beam may be made to traverse the same space by the use of a biprism or a mirror in such a way that the intensity at various places at any instant has values that vary from zero to four times that of the single beam.

7°. Take a vessel with walls readily traversed by the solar radiation and that may be exhausted to high vacuum if desired, and produce in it an abundant supply of electrons (as by a filament or wire heated by a current) and bring into this vessel electrodes to receive the radiant energy treated as in 3, 4, 5, 6, and send it thru an external circuit, containing such capacity, induction, and resistance as may be required, and some form of indicator, as a galvanometer, telephone, or wave detector. (The vessel, vacuum and ionizer may not be necessary; possibly the energy of the treated beams can be taken by the electrodes without these.)



Arrangement of Apparatus as Suggested by Mr. S. Cohen, for Use in Determining the Most Effective Energy Components in "Sunlight." The Various Rays Are Focussed from a Diffraction Grating Into a Vacuum Bulb, and Their Magnitude Measured by the Reaction Deflection of an Electro-static Galvanometer Connected Across Two Electrodes, Charged As Shown by a High Tension Arc or Other Generator.

8°. By the various combinations of apparatus, in 10-below, using solar radiation, produce in the vessel the linear focus, or foci, of the different character beams of 3 and 4 above; or produce within it the space variations of intensity of 6 above, with any of the kinds of beams named. Try various relations of variously formed electrodes to the focus, or foci, and to the regions of different intensity; with various ionizing current, as direct, high frequency alternating, or spark discharges of coil or condenser, and various inductances, resistances and capacities in the external, or receiving, circuit—using one or another of the indicators named above.

9°. Apparatus for Proposed Experimental Solution.—1. *Lens* of sulfur, paraffin or synthetic resin, cylindrical, 27 cm., chord, 40 cm. long, 50 cm. focal length; two others, each 22 cm. chord, 40 cm. long, 50 cm. focal length. 2. *Grating,* plane, 34 elements, a+b=1.2 cm., 40x41 cm. inside of frame. Also a curved, cylindrical grating, 100 cm. radius, 32 elements, a+b=1.5 cm. 3. *Fresnel Mirrors,* one 40x40 cm., the other 40x60 cm.; the latter serving for a Lloyd single mirror, if wanted. 4. *Biprism,* sulfur, 25 cm. wide, 40 cm. long; small angles 7°, large angle 166°. 5. *Polarizers,* reflecting metal plate, pile of plates, glass or sulfur; *fine* grating; Fresnel rhomb. 6. The transferring, or receiving, apparatus described in 7 above (which may not be necessary). 7. *Accessory* apparatus, as capacity, resistance, inductance, and indicating instruments.

Wherever wave length enters into the design of these pieces of apparatus it is taken as from 0.6cm., to 1.2cm., as being near the lower limit of waves well above the longest heat waves, *i.e.,* waves producing molecular motion. Greater wave lengths, with corresponding changes in design may be found to give better results.

10°. Apparatus Combined for Experiments, giving various kinds of radiation beams.—1. Grating and Lens, or Lenses; or Lens and Curved Grating. 2. Grating and Polarizer. 3. Grating, Polarizer and Lens, or Lenses. 4. Grating, Polarizer and Ellipsizer. 5. Grating, Polarizer, Ellipsizer and Lens. 6. Lens and Biprism or Lens and Mirror. 7. Grating, Lens and Biprism and Mirror. 8. Grating, Polarizer, Lens and Biprism.

For this work it would be desirable, perhaps necessary, to have a completely metal (iron) inclosed container of the instruments. If a room of this kind is not available, an iron case 2.4 meter (m.) long 0.5m. wide, 0.8m. high will contain any of the combinations of apparatus given above and the transferring, or receiving, apparatus. The mounting of the combination of apparatus should permit following the sun or directing to any point within 90° of it.

An electrolytic process of deoxidation has been patented in the United States by Pascal Marino of London. The object to be treated is made the cathode in an electrolyte containing phosphoric acid. In addition to its normal function of carrying the current, this acid acts as a solvent upon rust without attacking the steel or iron body beneath. It is in this last detail that its chief availability lies, since nitric, sulfuric or hydrochloric acids would not display such moderation. Finally, the phosphoric acid is beneficial in preventing subsequent further rusting.

The electrolyte is made by adding ten parts of phosphoric acid to ninety parts of water, or by adding 10% o the acid to a 10% solution of sodium phosfate.

Due to the advent of the war, we are particularly desirous of obtaining manuscripts describing original and practical "Electrical Experiments." We shall continue to publish Radio articles, but what we need is snappy "Electrical" articles. Be on guard for the enemy—Repetition!

HOW TO MAKE IT

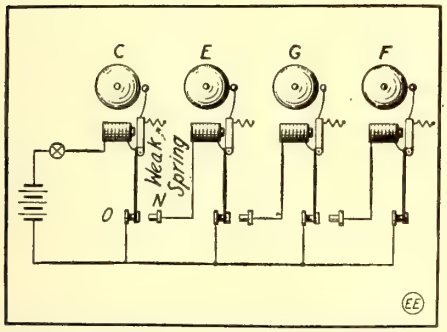


This department will award the following monthly prizes: **First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.**
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

A NOVEL ELECTRIC CHIME.

The accompanying illustration shows an electric chime which I have used in place of an ordinary vibrating bell.



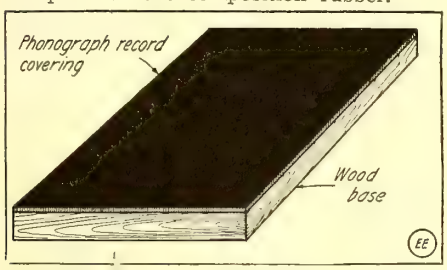
When the First Gong Strikes, Its Dependent Armature Closes the Circuit Thru the Second Gong Magnet "E", Etc.

The bell armature should be lengthened and two contact points soldered to the end. When a button is pushed the armature of bell C is drawn over, striking the bell once. The lower contact then strikes N and throws bell E in circuit. The armatures stay over against the magnet as each successive bell is put in circuit, thus keeping the circuit thru lower contacts complete. When bell F is rung, the battery circuit is broken, and all the armatures fly back. Thus the operation is repeated. The gongs should have different tones to give a pleasing chime effect, and as many bells can be used as desired.

Contributed by A. G. CORKRAN.

"HARD RUBBER" BASES FROM "VICTROLA RECORDS."

Wishing to make a detector and not having a suitable base I procured a piece of oak (any wood will do) and an old phonograph record. I cut the wood and record to the desired size. I then put a thin layer of shellac on the wood and prest the piece of record on it, and left it for a few hours. When it was dry I sandpapered the edges and polished the composition rubber.



Do You Want a Hard-Rubber Instrument Base? Just Cut a Piece of a "Victrola" Record and Glue It to a Wooden Sub-Base.

If the above directions are followed very neat bases can be made by the amateur. If the hole in the record does not allow a large base to be made, cut a circular piece of the composition rubber and plug it up.

Use records that have one side blank.

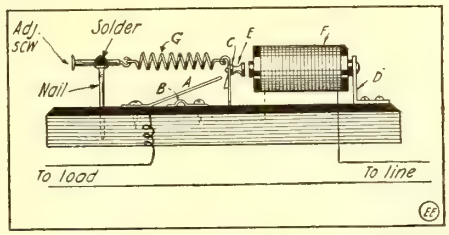
Contributed by HYMAN R. WALLIN.

SECOND PRIZE, $2.00

SIMPLE AUTOMATIC CIRCUIT BREAKER.

The circuit breaker described below is giving efficient service on the switchboard in my laboratory. The pieces A, B, C and D are brass strips; E, is a soft iron screw with two nuts to fasten it to the trigger C. F is an electro-magnet wound with No. 12 silk insulated magnet wire. The core of this magnet was obtained from an electric bell. The spring G, and the adjusting screw are used to regulate the instrument. The connections are as shown. The breaker is used on 110 volt A.C. or D.C. lighting circuit. When the contact A touches the contact B, it is held there by the trigger C. The magnet F is always magnetized to a certain extent but an overload or short-circuit causes the magnet to attract the armature C, releasing the contact A, which breaks the circuit. It is to be manually reset.

Contributed by ALGIE RIGGS.



In this Circuit-Breaker the Armature Normally Holds the Spring "A" Down; an Overload Causes the Magnet to Attract "E", Thus Opening the Circuit.

WALNUT STAIN.

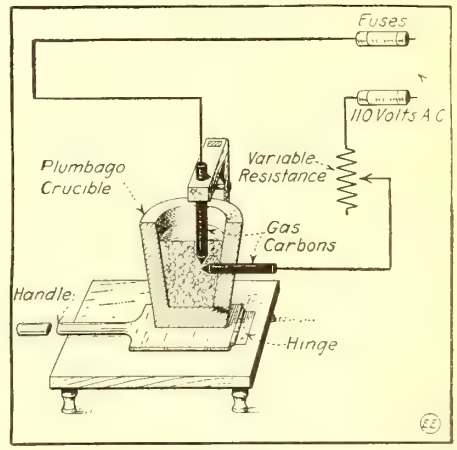
The following stain is excellently adapted to the finishing of wireless and electrical cabinets and instruments, and for various other wooden articles which is desired to have a uniform coloring or finish.

Prepare a solution of 6 ounces of a solution of potassium permanganate, and 6 ounces of sulfate of magnesia in 2 quarts of hot water. The solution is applied with a brush and the application should be repeated. In contact with wood the potassium permanganate decomposes, and a lasting walnut color results. If small pieces of wood are to be thus stained, a very dilute bath is prepared according to the above description, then the wooden pieces are immersed and left in the solution for from 1 to 5 minutes, according to whether a lighter or darker color is desired.

Contributed by ALBERT W. WILSDON.

ELECTRIC FURNACE MADE FROM PLUMBAGO CRUCIBLE.

An interesting and practical electrical furnace can be made of a plumbago crucible (used by jewelers) and two gas carbons. One of the carbons can be inserted in a hole drilled about 1½" from the bottom of the crucible, and the other held in a clamp. But some method must be devised to start the arc—that is, to bring the carbons together and draw them apart. A simple way is to place the crucible on a long board, to be used as a lever, fastened to the base by a hinge of leather. An interesting experiment can be performed by filling the crucible with ground glass up to the lower carbon rod. An arc may be started between the two gas carbons, and this will heat the glass to redness. An arc will then be formed with the carbon rod and the hot glass as electrodes.



A Simple "Arc" Furnace Made From Two Carbon Rods and a Plumbago Crucible.

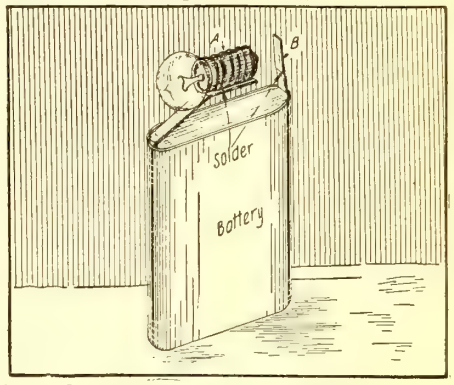
The eyes should always be shielded from the intense light of the arc by dark glasses.

Contributed by TOM RIEBE.

THIRD PRIZE, $1.00

THE SIMPLEST FLASHLIGHT.

Here's the simplest flashlight one can make: A flashlight bulb, A, and battery,

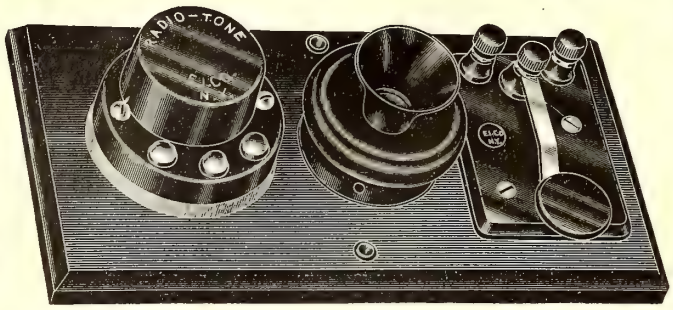


Hats Off to Mr. Peterson—Inventor of the "Simplest" Electric Flashlight. Can You Beat It?

and in some cases a strip of brass, B, soldered to the small battery terminal if it is not long enough. The lamp bulb is carefully soldered to the longer terminal strip. The lamp is lighted by holding battery in hand and pressing with thumb on strip B. A reflector (a nickel-plated thimble will do) may be fixt to the bulb if desired.

Contributed by ERWIN PETERSON.

"ELECTRO"



AMATEURS! ATTENTION!!

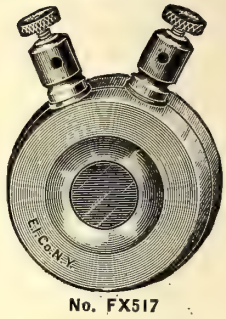
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The **Radiotone Codegraph** is positively the only instrument made that will send such an unbelievably close imitation of a high pitch Radio Station, that it has baffled experts. The outfit replaces the old-fashioned learner's outfit, consisting of key and sounder. The **Radiotone Codegraph** comprises our famous Radiotone High Frequency Silent Buzzer, a special loud talking receiver with horn, and a key all mounted on a base. Operated on one or two dry cells, the phone will emit the characteristic high pitch sound, which while not harsh, is heard all over the room. With little trouble you can learn the code correctly in 30 days—

AND THAT IS NOT ALL:

Connect two of these outfits together for intercommunication work and you and your friend five or fifteen blocks distant can converse over a NO. 36 WIRE, so fine that no one will see it. Or you can use instead of the wire, a metallic fence and the ground. **Or you can communicate over your 110 lighting line,** using no extra wire, only the ground. Full directions how to do this are furnished with the instrument. **DEALERS:** This is the 20th Century instrument that will sell like WILDFIRE. 600 sold in New York in 10 days. Get our proposition today!

Radiotone Codegraph complete as described, each, **$1.75**
IMMEDIATE SHIPMENTS



No. FX517

Selenium Cells

Everybody has read about the experiments of telephotography (sending photographs over a wire hundreds of miles) made by Professor Korn and others. It is also known that if the problem of tele-vision is ever solved, the selenium cell will play an important role. At present we are the only concern in the United States selling these cells. They are the most sensitive ones made.

Better send for a cell today and try making an electric dog that will follow a lamp, or an electric burglar alarm. It's very instructive and great fun. (See November, 1916, issue **"Electrical Experimenter."**)

No. FX517 Selenium Cell, each **$6.00**
Shipping Wght., 4 oz.
IMMEDIATE SHIPMENTS



BOYS!

Here Are the Stars and Stripes in All Their Glory

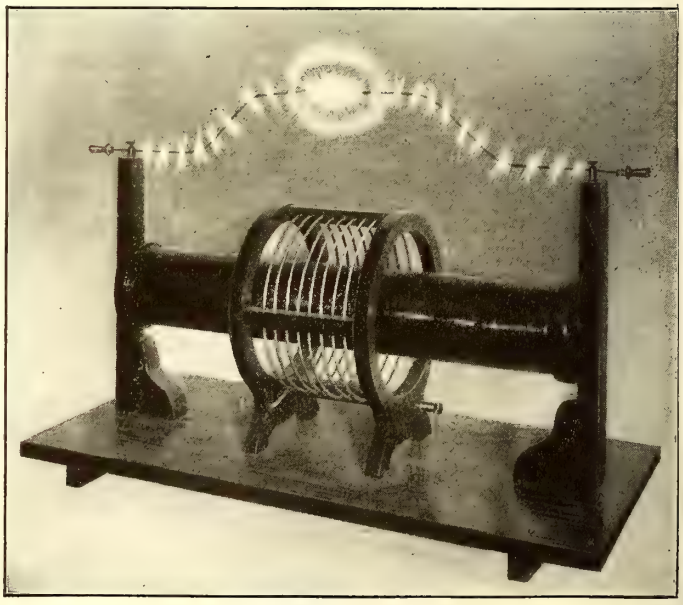
Be the first one in your town to wear this patriotic emblem. Think of it: An electrically illuminated boutonnière worn in the lapel hole of your coat.

It illuminates our National Flag in the original colors with a brilliant electric light. Just insert Flag in button-hole of your coat, put flashlight case in vest or coat pocket and every time you press the button, the flag in your button-hole flashes up with a beautiful color effect.

Illuminated flag, cord and **plug** (to be connected to any 2 cell flashlight), **$.60** (postage 10 cents).

Illuminated flag, flashlight case and **battery, cord** and **plug,** complete as per illustration, **$1.10** (postage 15c).

DEALERS: Write for our proposition today.
IMMEDIATE SHIPMENTS



"ELECTRO" TESLA COILS

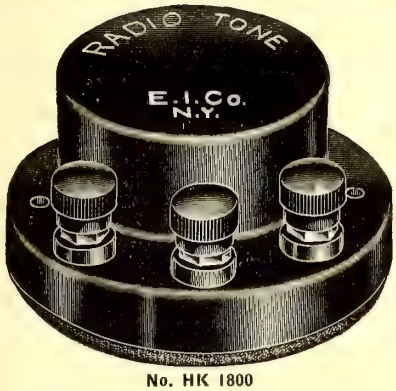
This photograph shows a seven (7) inch spark

Tesla Coil, made by us in our shops for a well-known institution. We build hundreds of special Tesla Coils for schools, universities, for stage purposes, etc. Spark lengths from two inches to fifteen inches and over.

We are known for careful workmanship and correct designing. The Tesla Coil, shown above (7" spark), without condensers or spark gap, sells for **$40.00.** Send for our quotations for special coils.

THE ELECTRO IMPORTING CO.

NEWS



No. HK 1800

The "Electro" Radiotone

HIGH FREQUENCY SILENT TEST BUZZER

The RADIOTONE is NOT a mere test buzzer, it is infinitely more. Mr. H. Gernsback who designed this instrument labored incessantly to produce an instrument which would imitate the sound of a high power Wireless station as heard in a set of phones. This actually has been achieved in the RADIOTONE. This instrument gives a wonderful high pitched MUSICAL NOTE in the receivers, impossible to obtain with the ordinary test buzzer. The RADIOTONE is built along entirely new lines; it is NOT an ordinary buzzer, reconstructed in some manner. The RADIOTONE has a single fine steel reed vibrating at a remarkably high speed, adjusted to its most efficient frequency at the factory. Hard silver contacts are used to make the instrument last practically forever.

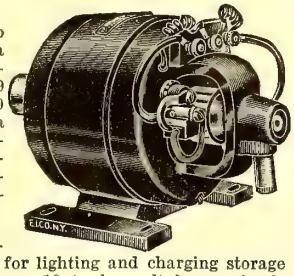
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You will be astounded at the wonderfully clear, 500 cycle note, sounding sharply in your receivers, when operated on one dry cell. **To learn the codes, there is absolutely nothing like it.** With the radiotone, a key and one dry cell and ANY telephone, a fine learner's set is had. Two or more such sets in series will afford no end of pleasure for intercommunication work. Particularly now that we cannot use our Wireless sets, the **Radiotone** is already in wonderful demand. All the interesting things as described with our **Radiotone Codegraph**, elsewhere on this page, can be performed with the **Radiotone,** a key, a dry cell and a phone.

Radiotone as described.....each **$.90**

IMMEDIATE SHIPMENTS

HERCULES DYNAMO



The Electro Hercules is a dynamo generating 12 Volts, 9 Amperes (100 Watts) and a marvel of electrical or mechanical efficiency and simplicity.

It is especially designed for lighting and charging storage batteries; will run 18 twelve volt lamps simultaneously. Can also be used as a powerful motor developing nearly ⅛ H.P. Machine is shunt wound; size 7 in. high, by 11⅜ in. long and 6½ in. wide. It is the cheapest Dynamo for its output on the market.

No. AGEK 1209. Electric Hercules Dynamo; shipping weight, 40 lbs. Price....**$17.50**

We carry these machines always in stock and can make immediate shipment.

The "Electro" Rheostat-Regulator

(Porcelain Base)

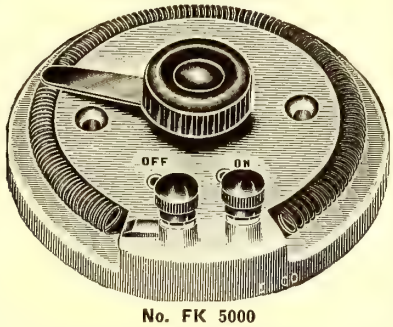
This illustration represents our little current regulator which is used everywhere to regulate battery current. It will prevent the burning out of your battery lamps, or will regulate the speed of your small motors, and scores of other uses.

It makes an excellent automobile lamp dimmer, where it can be used to cut down the glare of the headlights. This little instrument is impossible to get out of order. It is constructed **ENTIRELY OF PORCELAIN,** metal and hard rubber.

The resistance of our Rheostat is 10 ohms, the capacity 3 amperes continually, size is 4 inches in diameter; thickness of **porcelain** base is 13/16 ins.

No. FK5000 Rheostat Regulator. Price **$.60**
Shipping weight, 2 lbs.

IMMEDIATE SHIPMENTS



No. FK 5000

"Electro" Pony Receiver



No. EK 1024

Our Pony receiver is without doubt the best article for the money to-day.

Points of superiority: Hard rubber composition shell beautifully polished. Powerful permanent steel magnet, soft iron core, fibre coil heads, very thin diaphragm, brass posts inside. Hanger can be unscrewed and receiver will then fit our No. AX8077 headbands.

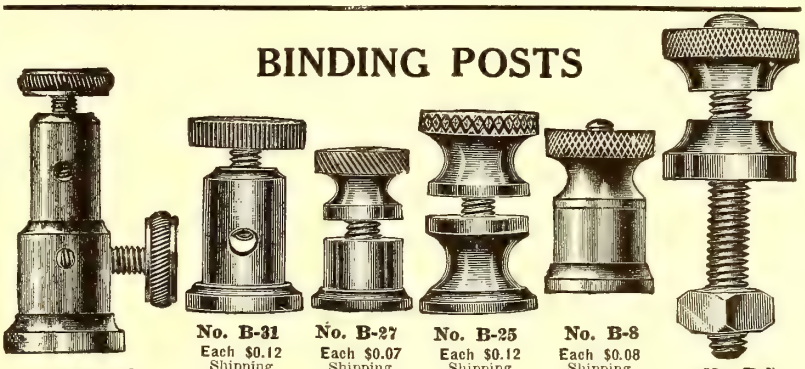
SOME USES.—For all telephone work. Also for making the small testing outfits for repair men in circuit with only one dry cell or flashlight battery. When connected in parallel with your house telephone receiver, you have a double receiver, an invaluable acquisition to those who phone in noisy places or to people hard of hearing. It can also be used for wireless though its low resistance won't permit of such good results as a higher resistance phone.

This receiver is single pole; 2¼x1⅛ inches; wgt. 4 oz.; resistance, 75 ohms. IF TWO OF THESE RECEIVERS ARE USED, IT IS POSSIBLE TO SPEAK AT A DISTANCE OF 150 FEET WITHOUT USING BATTERIES, ONE WIRE BEING SUFFICIENT IF GROUND IS USED.

No. EK1024 Pony Receiver, 75 ohms....**$0.50**

IMMEDIATE SHIPMENTS

BINDING POSTS



No. B-2 Each $0.15 Shipping Weight 2 lbs. per doz.

No. B-31 Each $0.12 Shipping Weight 1 lb. per 12.

No. B-27 Each $0.07 Shipping Weight 1 lb. per 12.

No. B-25 Each $0.12 Shipping Weight 1 lb. per 12.

No. B-8 Each $0.08 Shipping Weight 1 lb. per 12.

No. B-7 Each $0.10 Shipping Weight 2 lbs. per 12.

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"THE LIVEST CATALOG IN AMERICA"

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THE ELECTRO IMPORTING CO.
231 Fulton Street, New York City,



231 FULTON ST., NEW YORK, N.Y.

"ELECTRO" NEWS



AMATEURS! ATTENTION!!

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Shipping Wght, 4 oz.

IMMEDIATE SHIPMENTS

Patents:

No. 842,950 Feb 5, 1907

No. 902,069 Oct 27, 1908

No. 948,275 Feb 1. 1910

No. 951,788 Mar. 8, 1910

No. 961,855 June 21. 1910

No. 978,999 Dec 20, 1910

No 988,456 April 4. 1911

No 988,767 April 4. 1911

No 1,016,138 Jan 30. 1912

No 1,033,095 July 23. 1912

No 1,057,820 April 1. 1913

No 1,12 4,413 Jan 12. 1915

No 94,990 Jan 20. 1914

8 Patents Pending in Patent Office



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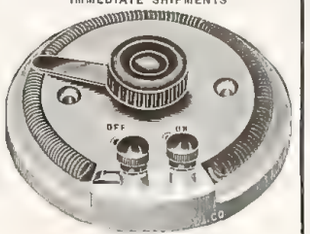
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Shipping weight, 2 lbs.

IMMEDIATE SHIPMENTS



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SOME USES. For all telephone work. Also for making the small testing outfits for repair men in circuit with only one dry cell or flashlight batteries. When connected in parallel with your house telephone receiver, you have a double receiver, an invaluable acquisition to those who phone in noisy places or to people hard of hearing. It can also be used for wireless though its low resistance won't permit of such good results as a higher resistance phone.

This receiver is single pole 2¾x1¾ inches wgt 4 oz. resistance 75 ohms. IF TWO OF THESE RECEIVERS ARE USED IT IS POSSIBLE TO SPEAK AT A DISTANCE OF 15 FEET WITH OUT USING BATTERIES ONLY WIRE BEING SUFFICIENT IF GROUND IS USED. **$0.50**

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IMMEDIATE SHIPMENTS



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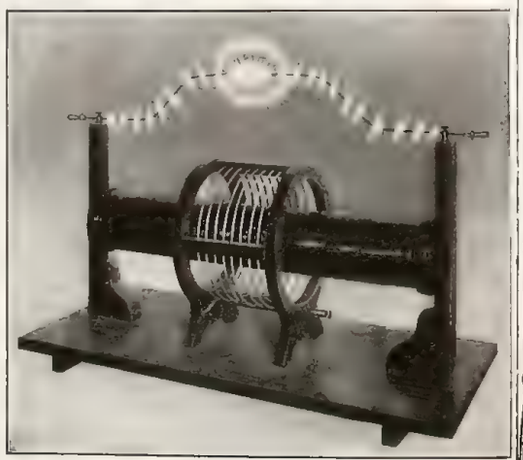
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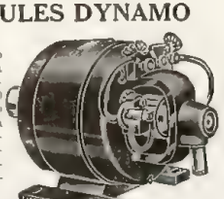
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HERCULES DYNAMO



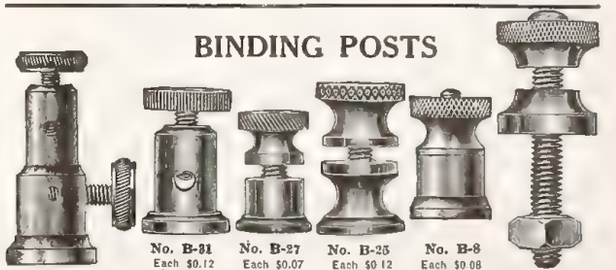
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BINDING POSTS



No. B-2	No. B-31	No. B-27	No. B-25	No. B-8	No. B-7
Each $0.15	Each $0.12	Each $0.07	Each $0.12	Each $0.08	Each $0.10
Shipping Weight 2 lbs per doz	Shipping Weight 1 lb per 12	Shipping Weight 1 lb per 12	Shipping Weight 1 lb per 12	Shipping Weight 1 lb per 12	Shipping Weight 2 lbs per 12

IMMEDIATE SHIPMENTS

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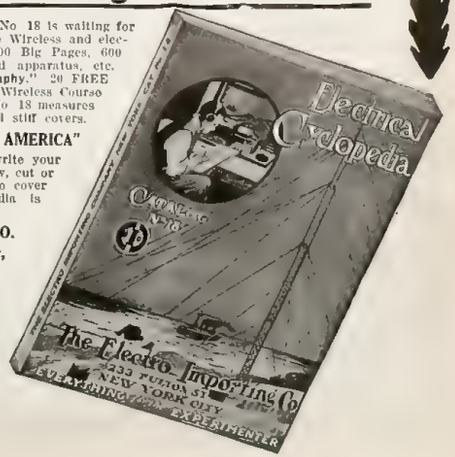
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"THE LIVEST CATALOG IN AMERICA"

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THE ELECTRO IMPORTING CO.
231 Fulton Street, New York City,

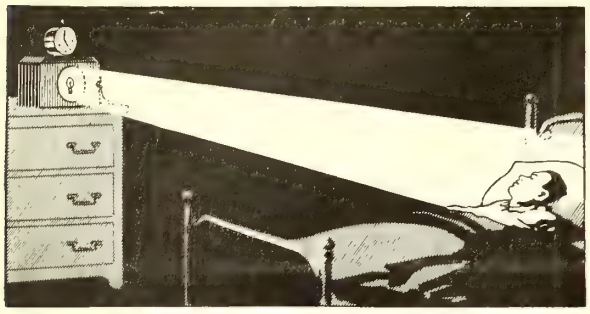


THE ELECTRO IMPORTING CO. 231 FULTON ST., NEW YORK, N.Y.

A NOISELESS "ALARM" CLOCK.

By K. M. Coggeshall.

Have you ever stopt to wonder what your friend in the next room thinks when your discordant alarm clock rings each morning? Have you ever wisht you had some method of waking yourself without disturbing your neighbors? Perhaps you may arise at five-thirty in the morning while the rest of the household do not find the necessity of opening their eyes until six-thirty. Perhaps some one may be ill and you wish to awake during the night to give him medicine, and yet do not like to disturb anyone else who may be asleep. Again you may be looking forward to a before-dawn start on a fishing expedition but out of respect to others you dislike to resort to the alarm clock to awaken you.



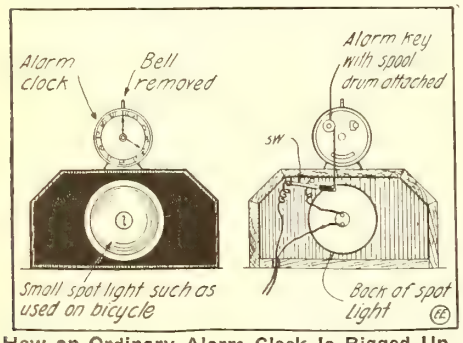
Did You Ever Hear of a "Silent" Alarm Clock?—Well, Here's One. It Awakens You by Flashing a Beam of Light on Your Face. Try It.

To overcome these objections to the ordinary alarm clock, the following apparatus was designed to awaken one sleeper without disturbing the rest of the household.

A box-like, wooden sub-base was built as shown in the sketch. In its face a round hole was cut and into this was fitted an ordinary bicycle spot light. A single pole, single throw knife switch was screwed to the upper inside surface of the sub-base. The lamp was then connected, thru the switch, to a battery of sufficient capacity to utilize its full candle-power. If the sub-base is made large enough the battery may be enclosed and the entire outfit made compact and portable.

The bell, as well as the striker, was removed from an alarm clock. A thread spool was attached to the alarm winding key to serve as a drum on which the cord to operate the switch was to wind. This switching device was very simple. A strong cord was attached to the handle of the knife switch, brought up thru a hole in the base and attached to the spool on the winding key.

The mechanical operation of this device can well be imagined. The apparatus is set on the mantel or dresser in the bedroom.



How an Ordinary Alarm Clock Is Rigged Up So as to Close the Lamp Circuit of the "Silent Alarm."

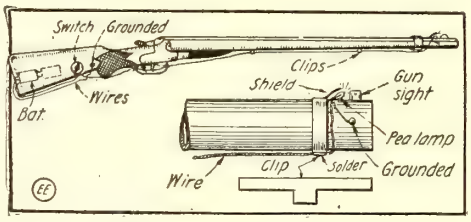
The spot light is then so adjusted that the full power of the light ray will concentrate on the face of the sleeper. The alarm should be wound and adjusted as usual.

When the predetermined hour has arrived, the alarm mechanism operates, turning the drum, thus winding in the cord, which in turn closes the switch and lights the lamp. All this will be accomplished noiselessly. No one can sleep with a bright beam of light suddenly directed onto the face. Furthermore, it is impossible to snatch a few catnaps before getting up with this light in the eyes. It is therefore imperative that the awakened person arise and open the controlling switch—and once out of bed there is little danger of dropping off to sleep again.

ELECTRIC LIGHT FOR GUN SIGHTS AT NIGHT.

As every hunter knows, it is extremely difficult to aim correctly at night, even tho the game can be seen, for the simple reason that the gun sights on the barrel cannot be accurately viewed.

The accompanying illustration shows how a small, frosted, flashlight bulb may be placed just behind the forward sight, with a metallic shield over it, so as not to throw a glare in the gunner's eyes. It is a simple matter to bore a hole in the wooden stock of the gun with an ordinary carpenter's brace and bit, in which to mount a cell or two from a flashlight battery, the size of these individual cells being about 1¼"x7/16" in diameter. Also the cells may be placed in a brass or fibre tube secured under the fore-arm section of the gun frame. A switch, of unobtrusive proportions, will serve to light the lamp bulb when wanted.



A Tiny Electric Light Fixt Just Back of the Forward Sight Proves a Boon to the Hunter at Night.

H. G.

GOOD INK FORMULAE.

These two formulae obtained thru original experiments, have been found to produce excellent inks. The ingredients are easily obtained and at little expense. Rain water may be used in place of distilled water thus removing the need of having any chemical apparatus. The resulting inks are each of a beautiful color, make a permanent record, flow easily, and do not corrode the pens. The blue ink can be used successfully and safely in the most delicate of fountain pens.

Blue Ink: Dissolve one ounce of soluble prussian blue in one quart of cold distilled (rain) water. Add to this solution, 5 grams of oxalic acid. Then filter the solution thru filter or blotting paper.

Black Ink: Dissolve one ounce of extract of logwood in one quart of boiling water. When cold, add one-fourth ounce of potassium bichromate and one gram of sodium carbonate. The addition of one-fourth ounce of prussian blue improves the solution. This ink will cost about 5 cents.

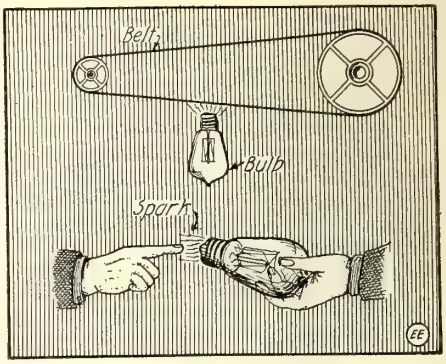
Contributed by

CLARENCE S. LEVINE.

STATIC EXPERIMENTS WITH LAMP BULB.

Materials needed—1 or more burned-out electric light bulbs.

Experiment—Take the bulb and hold it near a rapidly moving belt, connected with machinery which is not grounded. Hold the brass end of the bulb close to the belt and sparks will usually jump from the belt to the brass cap.



Hold an Incandescent Lamp Bulb Near a Rapidly Moving Belt—Usually Sufficient Static Electricity Will Pass to Charge the Lamp as a Condenser. It Will Give Powerful Shocks.

Charge in this manner for about five minutes, then take it away. Offer it to someone, holding the bulb by the glass end always. When the person goes to touch the brass end a nice hot spark will jump to him, giving a considerable shock.

Contributed by R. G. DEVANEY.

KNICK-KNACKS FOR "RADIO-BUGS."

By placing one of the E. I. Co.'s loading coils against the end of a small loose coupler, I have been able to catch stations, using up to 6,000 meters, this being done without additional inductance in the secondary, built for only 800 meters.

Most loose couplers have the primary tube placed in grooves cut in the heads and by turning it, a new surface is obtained for the slider. Clean the path of the slider occasionally with a rubber pencil or ink eraser.

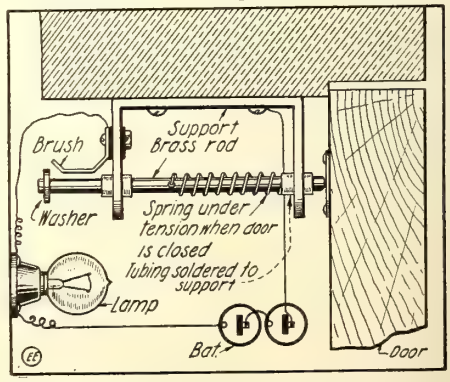
Use *Solderall* on the next loose coupler you build and you will use no other.

Contributed by ASA S. KELLER.

AUTOMATIC LIGHT SWITCH FOR CLOSETS.

Herewith is a drawing of a little device I made from scrap materials and which has proved very efficient.

It is intended to automatically close an electrical circuit on opening the door of a dark closet or unlighted room, and by means of a small battery and lamp illuminate the interior.



A Reliable Automatic Switch for Closet Light. When Door Opens the Switch Rod Is Moved Forward by the Spiral Spring as Becomes Evident, and Vice-versa.

As the illustration shows, the materials and construction are exceedingly simple.

Contributed by H. W. WALTER.

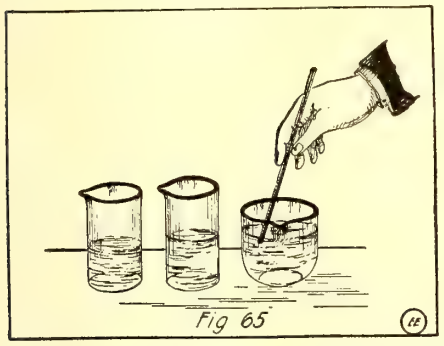
Experimental Chemistry

By ALBERT W. WILSDON
Thirteenth Lesson

ACIDS, BASES AND SALTS.

(*Continued*)

As stated in the previous installment, the basicity of acids are determined by the number of hydrogen atoms [replaceable by a metal] in its molecule. Thus: Mono-basic acids contain one hydrogen atom, as Hydrochloric acid [HCl], from which only one replacement is possible. Di-basic acids contain two hydrogen atoms, as, Sulfuric acid [H_2SO_4], from which two replacements are possible. Tri-basic acids contain three hydrogen atoms, as Phosphoric acid [H_3PO_4], from which three replacements are possible. Tetra-basic acids contain four hydrogen atoms, as, Normal Silicic acid [H_4SiO_4]. [Note: Normal Silicic acid readily parts with half of its water, leaving H_2SiO_3, also called Silicic Acid], from which four replacements are possible. Penta-basic acids contain five hydrogen atoms, as Periodic acid [H_5IO_6], from which five replacements are possible.



It Is Always Best to Stir Solutions with a Glass Rod. Have a Clean Vessel for Each Acid if You Would Achieve Satisfactory Results.

The higher the basicity of the acid the greater the variety of salts it can yield.

If we take the base Potassium Hydroxid to illustrate the replacement of the hydrogen of the acids, we find that Nitric acid or Hydrochloric acid can form but one salt with Potassium Hydroxid, the reactions being:—

$$\underset{\text{Potassium Hydroxid}}{KOH} + \underset{\text{Nitric Acid}}{HNO_3} = \underset{\text{Potassium Nitrat}}{KNO_3} + \underset{\text{Water}}{H_2O}$$

and

$$\underset{\text{Potassium Hydroxid}}{KOH} + \underset{\text{Hydrochloric Acid}}{HCl} = \underset{\text{Potassium Chlorid}}{KCl} + \underset{\text{Water}}{H_2O}$$

Other acids have the power to form two or more salts with the same base.

If only half the quantity of base that is required to neutralize the acid is added, half the acid remains unchanged, and on evaporating the solution, the excess acid will pass off. If only half the quantity of acid that is required to neutralize the base is added, half the base will remain unchanged. Sulfuric acid [H_2SO_4] has been found to have the power to form two salts with Potassium Hydroxid [KOH], in one of which there is twice the amount of the metal as in the other. The reactions being:

$$\underset{\text{Potassium Hydroxid}}{KOH} + \underset{\text{Sulfuric Acid [acid]}}{H_2SO_4} = \underset{\text{Potassium Sulfate}}{KHSO_4} + \underset{\text{Water}}{H_2O}$$

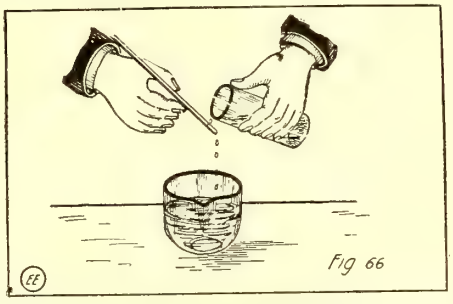
and again:—

$$\underset{\text{Potassium Hydroxid}}{2KOH} + \underset{\text{Sulfuric Acid}}{H_2SO_4} = \underset{\text{Potassium Sulfate}}{K_2SO_4} + \underset{\text{Water}}{H_2O}$$

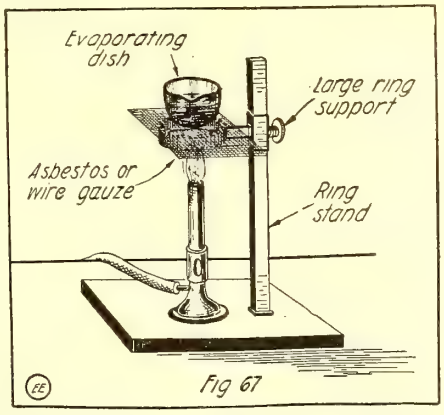
If to a certain quantity of Sulfuric acid only half the quantity of Potassium Hydroxid that is required to neutralize it is added, the first reaction takes place; but if twice as much Potassium Hydroxid is used, the second takes place. An acid of this kind can, further, form one salt with two bases, in which one metal is substituted for one of the hydrogen atoms of the acid and a second metal for the other.

As aforementioned, in the molecule of Hydrochloric acid [HCl] as in Nitric acid [HNO_3], there is but one atom of hydrogen. If, therefore, the act of neutralization takes place in each molecule it is complete, and the salt is known as a *neutral* or *normal salt*. In Sulfuric acid [H_2SO_4] there are two atoms of hydrogen in each molecule, and either one or both of these atoms may be replaced. If only one is replaced a salt having the general formula, $MHSO_4$, is obtained. This is still an acid, while it is also partly a salt. This is known as an *Acid Salt*.

It may be difficult for some readers to associate the names Monobasic, Dibasic, Tribasic, Tetrabasic, etc., with the basicity of the acids, but as these names represent the number of hydrogen atoms in the molecule, it may be well to memorize the following:



Method of Pouring Small Quantities of Acid onto a Glass Rod so That They Drop into a Beaker or Other Dish Easily.



Correct Manner in Which to Place "Evaporating Dish," Wire Gauze and Bunsen Burner.

The	prefix	*Mono—*	means	one
"	"	*Di—*	"	two
"	"	*Tri—*	"	three
"	"	*Tetra—*	"	four
"	"	*Penta—*	"	five

Thus, when speaking on monobasic acids, by remembering that mono— means one, and when associated with the basicity of an acid, mono— meaning one, and the basicity being the number of hydrogen atoms, we can thus see that monobasic means one hydrogen atom.

EXPERIMENT NO. 54—

Have two small-lipt beakers, or two test tubes, one of which will contain 10 cc. of a solution of Sodium Hydroxid [NaOH] and the other an equal quantity of Hydrochloric acid [HCl]. Pour 5 cc. of the Sodium Hydroxid solution in an evaporating dish, and immerse in it a piece of blue litmus paper, allowing it to remain in the solution. Pour small quantities of Hydrochloric acid from the beaker onto a glass rod, allowing it to drop into the evaporating dish, in the manner shown by Fig. 66, stirring the mixture.

It will be noticed that the litmus paper will probably turn red, owing to the fact that the solution has too much acid contained in it. If such is the case, add a little more Sodium Hydroxid, by allowing to drop from a stirring rod in the same manner as described for the acid. If too much of the Hydroxid is added the litmus paper might again turn to a blue color, and if this happens, add a little more of the acid, drop by drop, till the liquid becomes neutral to the litmus paper. It may be necessary to keep adding either the Acid or the Hydroxid. Introduce another piece of red litmus when you think the solution is neutral, and if it is unaffected, immerse another piece of blue litmus paper in it, and then if the solution does not affect either the red or blue paper it is neutral. If the solution is not clear after it has been neutralized, filter it, and throw away all but about 15 cc. of it.

Place the 15 cc. of the solution obtained into an evaporating dish, and place on either a piece of fine meshed iron gauze or a piece of asbestos pad, as shown in Fig. 67. Apply a light to the Bunsen burner under the evaporating dish, and allow the liquid to evaporate [boil] till a white solid is formed, or in other words till all the water has been driven from the original solution.

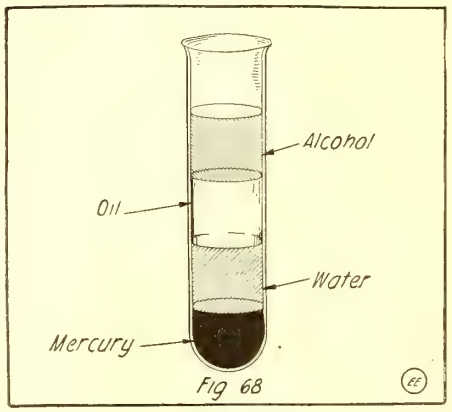
The equation of the reaction which took place between the Sodium Hydroxid and the Hydrochloric acid when neutralized was:—

$$\underset{\text{Sodium Hydroxid}}{NaOH} + \underset{\text{Hydrochloric Acid}}{HCl} = \underset{\text{Sodium Chlorid}}{NaCl} + \underset{\text{Water}}{H_2O}$$

We perceive from this equation, that the hydrochloric acid no longer is contained in the solution, and that the Sodium [Na] of the base exchanged, or replaced the hydrogen of the acid, forming a salt and water.

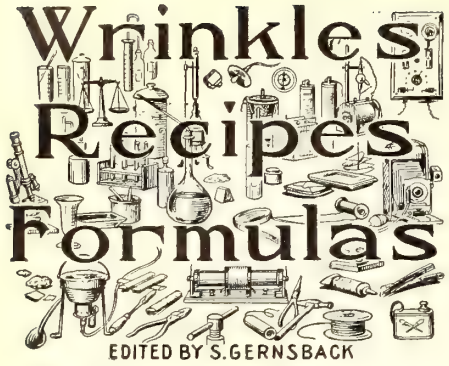
EXPERIMENT NO. 55—

In the same manner as described in the preceding experiment, prepare a solution of both Potassium Hydroxid and Hydro-



If Two or More Liquids Which Have Different Densities and Will Not Mix Are Poured into a Jar, They Will Come to Rest in the Order of Their Densities, with the Surfaces of Each Separating Them Horizontally. Mercury, Water, Oil and Alcohol, When Poured in a Test Tube, Will Come to Rest in the Order Named.

(*Continued on page* 127)



Under this heading we will publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

FREEZING MIXTURES.

When ice or snow are not to be had and for those of us who do not have an up-to-date laboratory that is provided with agencies of cooling power, I am sure the following mixtures will prove most convenient.

1. Nitrat of ammonia, carbonat of soda and water, equal parts by weight; the thermometer sinks 57°.

2. Phosfate of soda, 9 parts; nitrat of ammonia, 6 parts; dilute nitric acid (acid 1 part, water 2 parts), 4 parts. Reduces the temperature from 50° to 21°.

3. Sal-ammoniac, 5 parts; nitrat of potash, 5 parts; sulfate of soda, 8 parts; water, 16 parts. Reduces the temperature 46° or from 70° to 24°. This latter is very cheap and easily procured.

If you have ice and wish to reduce the temperature still further, use the following:

1. Finely pounded ice, 2 parts; salt, 1 part. This is a very common recipe.

2. Finely pounded ice, 2 parts; crystallized chlorid of calcium, 3 parts.

3. Finely pounded ice, 7 parts; dilute nitric acid, 4 parts. This reduces the temperature from 32° to 30°. The temperatures given are Fahrenheit. The materials should be kept as cool as possible.

Contributed by MINARD ROTE.

SOLUTION FOR MAKING WORK TABLE IMPERVIOUS TO ACID AND ALKALI SOLUTIONS.

Doubtless, many experimenters, especially those working with the various chemical reagents, desire some coating for the work table that is impervious to both acid and alkali solutions. The writer has used the following method in his laboratory with decided success, and heartily recommends it to those who desire a similar formula.

Two solutions are to be made:

Solution 1. Iron sulfate, 4 parts; copper sulfate, 4 parts; potassium permanganate, 8 parts; water, 100 parts.

Solution 2. Aniline, 12 parts; hydrochloric acid, 18 parts; water, 100 parts, or aniline hydrochlorat, 15 parts; water, 100 parts.

Apply two coats of solution No. 1, while hot, applying the second coat as soon as the first has dried. After solution No. 1 has dried, the excess of solution which has dried upon the surface of the wood is thoroly rubbed off before the application of solution No. 2.

Next, two coats of solution No. 2 are applied, and the wood permitted to dry thoroly. The black color does not appear at once, but requires a few hours before turning to a rich ebony-black color. Later a coat of raw linseed oil is to be applied with a cloth.

The tables are cleaned very easily by washing with water or suds after any work is finished, and the application of another coat of oil puts them in excellent order for another experiment.

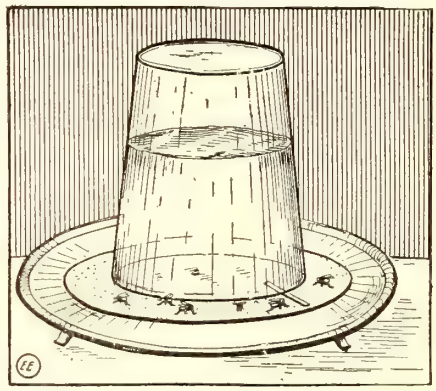
Contributed by ALBERT W. WILSDON.

RECIPES FOR KILLING FLIES.

The United States Government makes the following suggestion for the destruction of house flies: Formaldehyde and sodium salicylate are the two best fly poisons. Both are superior to arsenic. They have their advantages for household use. They are not a poison to children; they are convenient to handle; their dilutions are simple, and they attract the flies.

Preparation of Solutions:—A formaldehyde solution of approximately the correct strength may be made by adding 3 teaspoonfuls of the concentrated formaldehyde solution, commercially known as formalin, to a pint of water. Similarly, the proper concentration of sodium salicylate may be obtained by dissolving 3 teaspoonfuls of the pure chemical (a powder) to a pint of water.

A container such as shown below has been found convenient for automatically keeping the solution always available for flies to drink. An ordinary, thin-walled drinking glass is filled or partially filled with the solution. A saucer, or small plate, in which is placed a piece of *white* blotting paper cut the size of the dish, is put bottom up over the glass. The whole is then quickly inverted, a match placed under the edge of the glass, and the container is



Now That the "Fly Season" Is With Us, the Non-Poisonous (to Humans) Wet Blotter Fly Annihilator Shown, Which Is Recommended by the U. S. Government, Should Prove Particularly Valuable.

ready for use. As the solution dries out of the saucer the liquid seal at the edge of the glass is broken and more liquid flows into the lower receptacle. Thus the paper is always kept moist.

Other Simple Preventives:—Any odor pleasing to man is offensive to the fly and *vice versa*, and will drive them away.

Take five cents' worth of oil of lavender, mix it with the same quantity of water, put it in a common glass atomizer and spray it around the rooms where flies are. In the dining-room spray it lavishly *even on the table linen*. The odor is very disagreeable to flies but refreshing to most people.

Geranium, mignonette, heliotrope and white clover are *offensive* to flies. They especially *dislike* the odor of honeysuckle and hop blossoms.

According to a French scientist, flies have intense hatred for the color *blue*. *Rooms decorated in blue will help to keep out the flies.*

Mix together one tablespoonful of cream, one of ground black pepper and one of brown sugar. This mixture is poisonous to flies. Put in a saucer, darken the room except one window and in that set the saucer.

To clear the house of flies, burn pyrethrum powder. This stupefies the flies, but they must be SWEPT UP and BURNED.

Receipes for Stables, Barns and Out-of-doors:—Borax is especially valuable around farms and out-of-doors. One pound of borax to twelve bushels of manure will be found desirable as a poison without injuring its manurial qualities on farm stock. Scatter the borax over the manure and sprinkle with water.

Lye, chlorid of lime, or copperas (sulfate of iron) dissolved in water, crude carbolic acid, or any kind of disinfectant may be used in vaults.

HEKTOGRAPHS.

What are they, do you ask? The Century Dictionary defines it as follows: "A copying process in which the writing or drawing to be copied is made on smooth paper in aniline ink, and is then prest upon a slab coated with gelatin, to which a part of the ink is thus transferred, and from which a number of duplicate impressions can be made; also, the special appliances, collectively, by means of which this is done." The chance, however, is that you do not want any definition, but might like some directions for simplifying the process, which some teachers and students who want a number of copies of text or drawing, are using successfully. Agreeable to this contingency, we have:

Receipt No. 1.—Soak an ounce of fish glue in cold water. Drain off the water; put the softened glue into a double boiler and melt it, but *do not* bring it to a boil. Obtain six ounces of glycerin, warm it and add it to the melted glue. Add a few drops of carbolic acid. Mix thoroly and pour into your pan. A caramel pan is best.

Receipt No. 2.—Add 3 ounces of water to 1½ ounces of white glue. Heat in a double boiler until glue is melted. Then add six ounces glycerin and pour into pan. If too hard, add glycerin. If too soft, add glue.

Receipt No. 3.—Dissolve 4 ounces of gelatin in one pint of cold water; then add one pint of glycerin. Pour into a double boiler, and when it comes to a boil pour into your pan.

If bubbles appear on the surface, gently draw an edge of a sheet of writing paper over the surface before it cools. This will remove them.

General directions for use.—Use nothing but unglazed paper, which can be purchased at any store where typewriter paper is sold. In ordering, be sure to state that you wish to use it for hektography.

Use *hektograph ink* and a coarse stub pen. See that every stroke of the pen leaves a metallic luster when dry, else the work will not *take*.

When the ink is dry, lay the face of the sheet which you have written or drawn, down on the hektograph; press gently over the whole surface with the hand or soft cloth. After from two to five minutes (according to how many copies are desired) gently peel the paper off.

From the impression thus made, reproduce all the copies desired, laying one sheet on the hektograph at a time.

Hektograph ink all prepared may be bought, or your druggist will put it up for you. The following is the receipt:

Ink—Dissolve one dram of purple aniline in one ounce of water.

The hektograph solves the supplementary reading question. Each teacher, or any one who desires a number of copies of any text or drawing, can thus prepare as many as needed, at a very small cost.

Contributed by F. H. SWEET.

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U. S. PATENT OFFICE

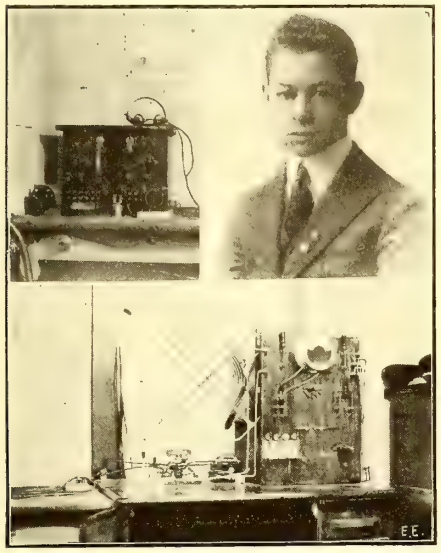
WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

AMATEUR RADIO STATION CONTEST
Monthly Prize, $3.00.
This month's prize-winner.

CEDRIC E. HART'S EXCELLENT RADIO OUTFIT.

The switch panel and cabinet, etc., shown in the accompanying photo have all been



Cedric E. Hart's Radio Station at Salt Lake City, Utah, with Which He Obtained Highly Efficient Results.

designed and built by myself, and with this cabinet I have no difficulty in receiving all of the coast stations and the amateurs within a fair distance of here. I also hear Guam, Honolulu, Alaska, Panama, etc., quite regularly. I have a license and my call is 6SL. My receiving set comprises the following: Navy 'phones, Blitzen tuner, Blitzen variable, Clapp-Eastham tubular fixt condenser, Turney variable condenser, and an Audion cabinet.

My transmitting outfit comprises a 1K.W. Thordarson transformer, K.B. preventer, commercial key, home-made condenser, Halcun rotary spark gap, home-made Telefunken type oscillation transformer and a Blitzen hot-wire meter. The switches on the panel control the transformer, power, meter, condenser and inductance.

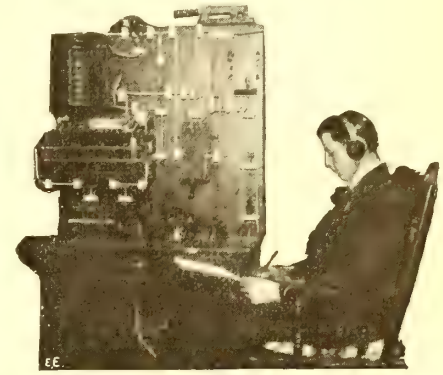
This set, so far, has proven very efficient and, being as the panel has not been completed two weeks yet, I think that Evanston, Wyo., is a pretty good distance to transmit for the short time I have had it. Here's wishing the EXPERIMENTER prosperity in its chosen path.

CEDRIC E. HART.
Salt Lake City, Utah.

H. L. SCOTT TO RENEW HIS RADIO ACTIVITIES.

Just recently I bought a copy of THE ELECTRICAL EXPERIMENTER, the January number, and on reading it thru it has brought back pleasant memories of the days when I operated my station. In fact it has thrilled me so much that I am going to renew my operations with the old vigor. (*Not until after the War—Ed.*)

It was when I lived at 158 Hamilton Street, East Providence, R.I., in 1909 and 1910, that I had my best outfit. About that



Herbert L. Scott and His Radio Outfit, Which Has Done Good Work.

time I believe I bought a detector from the Electro Importing Co.

I am sending you a photo of my apparatus I used in 1910, which I still have in storage. I hope you will find space in the columns of your magazine to reproduce this photo. For sending I used a three inch spark coil, run by six V. 60 A.H. storage batteries. The coil may be seen behind the loose coupler on the table; over the coil on the board is a plate glass condenser; above that is the spark gap and then the helix; to the right is an anchor gap. The sending key may be seen on the extreme right of the table; the contact points are two dimes.

For receiving I had a loose coupler of my own make, a Murdock tuning coil and a detector stand in which I used silicon, together with a pair of 3,000 ohm receivers, potentiometer, fixt condenser and Massie sealed-point electrolytic detector with double pole switch to throw in either system. I have heard Key West with this station.

HERBERT L. SCOTT.
Blackstone, Mass.

(*All radio men should read the notice in "Radio Dept." and on opposite page—Ed.*)

THE MONTANA WIRELESS STATION OF HOWARD PASCOE.

I offer herewith a photograph of "The Montana Wireless Station" which consists of 1 K.W. Packard transformer, run on (110 volts A.C.) and a stationary spark gap.

The receiving set consists of a loose coupler designed to receive up to 20,000 meters and a loading coil for 4,000 meters.

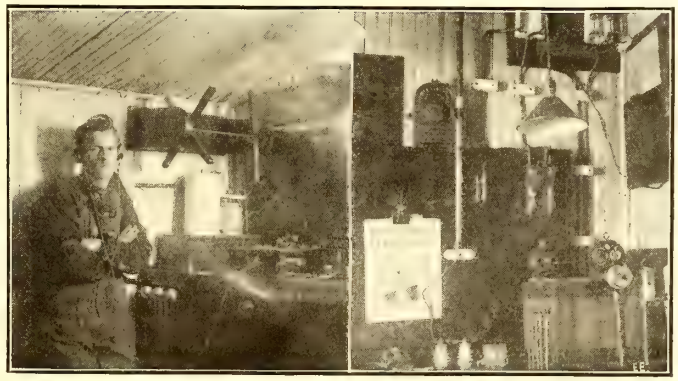
One (type D) receiving set of Marconi Wireless Telegraph Co. make which has a range of 2,000 to 4,000 meters or more. One pair of E. I. Co. Republic receivers, Standard wave meter, silicon and Audion detectors (Type R J 9).

With this receiving set I am able to hear all the coast stations such as NPE, NPC, and the amateurs 7ZC, 7JN and many others.

I have a little sub-station up in the mountains, 6,355 feet above sea-level. All my wiring is run in conduit. On account of the small space, the station had to be photographed twice.

I read THE ELECTRICAL EXPERIMENTER. It is a fine magazine for the "Wireless Bugs." I will be glad to correspond or exchange photos of my station with other amateurs.

HOWARD PASCOE.
Butte, Montana (1129 East Galena)



Uncle Sam May Find the Amateur Radio Station of Howard Pascoe, at Butte, Montana, of Valuable Assistance.

ATTENTION!!!

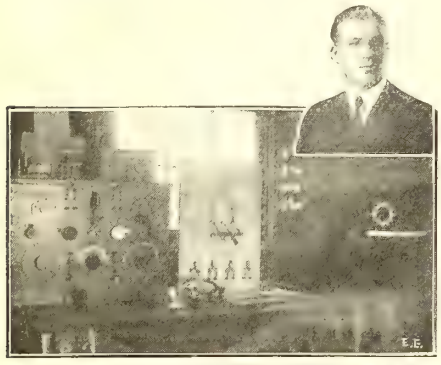
Has your station photo appeared in "The Electrical Experimenter"? Why not purchase the electrotype and have some "real" stationery printed with your station picture on it? All of the "regular radio-bugs" are doing it.

"NO MORE 'E.E.'"

says the newsdealer. "All sold out!" Did he tell YOU so last time? MORAL: Ask him to order a copy for you every month. *Costs you nothing to do so.* The tremendous cost of paper does not allow excess printing, so we furnish dealers only with a sufficient amount of copies to supply their *regular* customers. If you are one, be sure to tell your newsdealer so, and give him your name and address, so he'll notify you by postal if you forget to call.

A PROGRESSIVE CHICAGO RADIO EXPERIMENTER.

My sending set included a ¼ K.W. Blitzen transmitter with rotary spark gap, operated on 110 volts A.C. with a lamp bank in series with gap motor. Receiving set is result of reading *Modern Electrics* and THE ELECTRICAL EXPERIMENTER for over 2½ years and is home-made



One of the Honor Sets Among Chicago Radio Amateurs Was that of Mr. A. R. Gates. Mr. Gates Is One of the "Old Guard Boys," Having Been a Reader of "Modern Electrics."

The receiving transformer is designed for 3,000 meters with two variable condensers: one across secondary and one shunted across 'phones. I have two crystal detectors, Ferron and galena, operated with a three point switch. Also a three element vacuum detector for long range work. The two D.P.D.T. switches on each side of Audion make a complete switch-over from crystal to Audion apparatus. Also to amplify weak signals there is a Multi-Audi-Fone and 2,000 'phones. Station call 9NV.

Chicago, Ill. ARTHUR R. GATES.

AMATEUR HEARS SPY RADIO CODE.

Federal authorities hope to locate the sender of aerial instructions to German spies thru the disobedience recently of Malcolm Ronberg, who has (or had) an amateur radio plant at his home, 6220 University Avenue, Chicago, Ill.

Ronberg failed to obey the government mandate to dismantle radio stations. He decided to "listen in" before complying.

There was no sound for several minutes, then a peculiar unfamiliar call, repeated over and over again. Then there followed an even stranger grouping of letters, a code message.

Ronberg hurried to the federal building, confest he had been listening and turned over the message. It was sent to federal operators at Great Lakes station. They, too, failed to decipher it. But the fact that Ronberg received it in his small amateur station has helped the searchers to trace it.

Ronberg was thanked, instructed to dismantle his plant by midnight or go to jail, and a squad of detectives was hurried out under orders of John C. Dillon, chief radio inspector of Chicago.

Young chickens treated with electricity by a London experimenter grow more rapidly than those raised without treatment.

DE FOREST GIVES $5,000 TO AMERICAN DEFENSE SOCIETY.

Dr. Lee de Forest, the wireless inventor, has offered the American Defense Society $5,000 as the nucleus of a preparedness fund.

A RADIO ECHO FROM LARCHMONT MANOR, N.Y.

Herewith is a photo of my radio station. The sending set is composed of a 1 inch Bull-Dog spark coil, a sending condenser, spark gap, key and transformer. In my receiving set there are three loading coils, two fixt condensers, a double slide loose-coupler, a silicon detector and a de Forest Audion. I have two 1,500 ohm 'phones and one 500 ohm 'phone.



Clarence de Witt Rogers, Jr., a Rising Radio Student, of Larchmont Manor, N. Y.

CLARENCE de WITT ROGERS, JR.
Larchmont Manor, N.Y.

Amateur News

Fort Wayne Radio Association of Indiana.

The Fort Wayne Radio Association of Indiana began the New Year with the installation of the following new officers: G. Carter, President; R. Parvin, Vice-president; D. W. May, Secretary and F. Hall, Treasurer.

We have had some very successful meetings during the winter months. Our best and most-lookt for speeches are given by Mr. Carter, who, besides giving good talks, has formulas worked out, which enables us to see if we are getting the most out of our transmitters.

In an effort to lessen interference, we have a "QRM Committee" to report at our meetings every two weeks.

Several of our members have some fine long-distance work to their credit. They are 9 P C, 9 W F, 9 V Y, 9 T A, 9 K G and 9 U H.

We will be glad to correspond with other clubs so as to exchange ideas. Address communications to D. W. May (9 U H), 3021 Hoagland Avenue, Fort Wayne, Ind.

Alpena, Mich., Has a Radio Club.

The Alpena Radio Club of Alpena, Mich., has been formed for the advancement of wireless telegraphy. Meetings are held every Thursday evening at the home of the President, 516 State Street. The officers are: President, W. A. Potter; Vice-president, Hugo Sorenson; Secretary and Treasurer, P. B. Alger; and Consulting Engineer, Mr. J. Mulavey. All communications should be addrest to the Secretary, P. B. Alger, 119 State Street, Alpena, Michigan.

Allentown, Pa., Radio Men Reorganize.

The Inter-City Radio Association of Allentown, Pa., organized October 28, 1915, recently reorganized under a new name to be known henceforth as The Y. M. C. A. Radio Association of Allentown.

The art of field signaling and code receiving are now being taught to the members by the Chief Operator, Harvey Zinger. The following are the new officers of the Association: D. H. Goodling, President; Stanton Nadig, Vice-president; Blair Cunningham, Secretary; Arthur Breisch, Treasurer; Harvey Zinzer, Chief Operator. Correspondence with similar organizations will be appreciated. Address all communications to D. H. Goodling, 330 N. Madison Street, Allentown, Pa.

Radio Activities in Kansas City, Kansas.

The Kaw Valley Radio Association has been formed by the amateurs of this city. The club to date has seventeen members with officers as follows: Ralph Rehm, President; Parker Wiggin, Vice-president; Harlow Eppert, Secretary; Joe Harlan, Treasurer.

The club is progressing rapidly and is certain to obtain more members in the near future. As yet we have no set but expect to obtain one soon. Regular meetings are held every Thursday night at 7:30. All communications should be sent to Harlow Eppert, 841 State Avenue, Kansas City, Kansas.

Y. M. C. A. Wireless of Salesburg, Ill., Sends Basketball Scores.

The wireless club of the Y. M. C. A. recently sent out the scores of the basketball tournament. These scores were sent out three times a day, at the close of each session, 12:00 o'clock noon, 6:00 o'clock after the afternoon session and at 10:00 o'clock after the night session. The towns which were connected with Thursday night were Rock Island, Peoria, Springfield, Cambridge, Genesee and Monmouth.

Roy S. Landon had charge of this work, and under his supervision the boys are showing an unusual amount of interest. Recently the boys received and sent messages to the University of Iowa station.

ALL RADIO AMATEURS ATTENTION!

As all of you know the United States is now in a state of war with Germany, and as true-blood American citizens, we are, each and every one of us, duty bound to obey the mandates of the U. S. Government officials. The Navy Department has been delegated by our President to close all amateur or experimental radio stations, no matter whether equipt for transmitting or receiving, licensed or unlicensed, and therefore we shall all have to abide by this decree, whether we like it or not.

Therefore, beginning with the next issue of "THE ELECTRICAL EXPERIMENTER," we will endeavor to feature the Electrical Laboratories in preference to any radio stations in the awarding of the monthly prize of $3.00 in this department. Now is the time to get busy and freshen up your electrical apparatus, and incidentally improve your understanding of electrical matters, which perhaps you have unwittingly slighted to a large degree in your pursuit of radio-telegraphy. Let her go, boys!

Worcester Tech. Wireless Club is Busy.

The Wireless Club of Worcester Tech., elected Warren B. Burgess, '16, of Hyde Park, chief operator in charge of the maintenance of the Tech. station. Twelve new members were voted in and plans were discust for a series of talks to be given by Instructor Carleton D. Haigis of the physics department on the theory of electric waves and other subjects interesting to wireless students. The president was empowered to appoint a committee to draw up plans of a new antenna to be erected this year.

Hoboken, N. J., Wireless Amateurs Secure Clubrooms.

The Hudson City Radio Association has secured rooms, at 541 Central Avenue, Jersey City, where they have erected a large aerial and a sensitive receiving outfit. Code practise is given every night to those who desire it.

Election of permanent officers was held with the following results: President, Joseph F. Grece; Vice-president, William Biedenkapp; Financial Secretary, Frank V. Bremer; Recording Secretary, Clarence Maves; treasurer, William S. Davidson.

All amateurs in Hudson County are invited to join the association. Address Clarence Maves, Secretary, 90 Ferry Street, Jersey City, N.J., for an application blank.

Waterbury Radio Club of Waterbury, Conn.

The Waterbury Radio Club was formally organized recently by 15 local young men who are interested in wireless telegraphy. King Sam, the Chinese young man who is probably the only Chinese wireless operator in New England, took the initiative in banding the local operators together and the meeting was held in the wireless room at the Boys' Club. E. C. Glavin, an inventor and a pioneer in wireless telegraphy study, attended the meeting and was named as honorary chairman. The other officers are Robert W. Culbert, Jr., Chairman; Clinton A. Fitch (operator of the Boys' Club wireless set), Secretary and Treasurer. The membership of the club is 15 just now and it is planned to increase it to 25 later.

The publicity secretary for the club is King Sam. He stated that it is the purpose of the organization "to further advance and foster the art of wireless telegraphy in this city."

EXPERIMENTAL CHEMISTRY.

(*Continued from page* 123)

chloric acid, and proceed to neutralize them in the same manner. After they are neutraiized, and after applying the litmus tests, place in a clean evaporating dish and evaporate the solution to dryness. The equation for this reaction is practically the same except that Potassium is substituted

TABLE OF VALENCE.

TABLE NO. 1.

Metals and Positive Radicals.				Non-Metal and Negative Radicals.			
Monad.	Dyad.	Triad.	Tetrad.	Monad.	Dyad.	Triad.	Tetrad.
H	Mg	As	Pt	F	O	N	C
Na	Ca	Sb	Sn	Cl	S	P	Si
K	Sr	Bi		Br	SO_3	B	SiO_4
Ag	Ba	An		I	SO_4	PO_3	
Hg	Pb	Fe		NO_2	CO_3	PO_4	
NH_4	Cu	Cr		NO_3	C_2O_4	AsO_3	
CH_3	Cd	Al		ClO	$C_2H_4O_6$	AsO_4	
C_2H_5	Zn			ClO_2			
	Co			ClO_3			
	Ni			ClO_4			
	Hg			BrO_3			
	Sr			IO_3			
	Fe			$C_2H_3O_2$			

As we have been constantly referring to metals, non-metals, positive radicals and negative radicals, the above table is given now, before the study of valence is taken up, so that readers may refer to it when metallic and non-metallic elements are mentioned.

for the Sodium, as:—

KOH + HCl = KCl + H_2O
Potassium Hydroxid + Hydrochloric Acid = Potassium Chlorid + Water

EXPERIMENT NO. 56—

Dilute 1 part of Sulfuric acid with three or four parts of water, and place in a small-lipt beaker or test tube as in the preceding experiments, and neutralize. When neutral, filter, and place in an evaporating dish and evaporate to dryness. Either one of the following equations will take place:—

KOH + H_2SO_4 = $KHSO_4$ + H_2O
Potassium Hydroxid + Sulfuric Acid = Potassium [Acid] Sulfate + Water

or

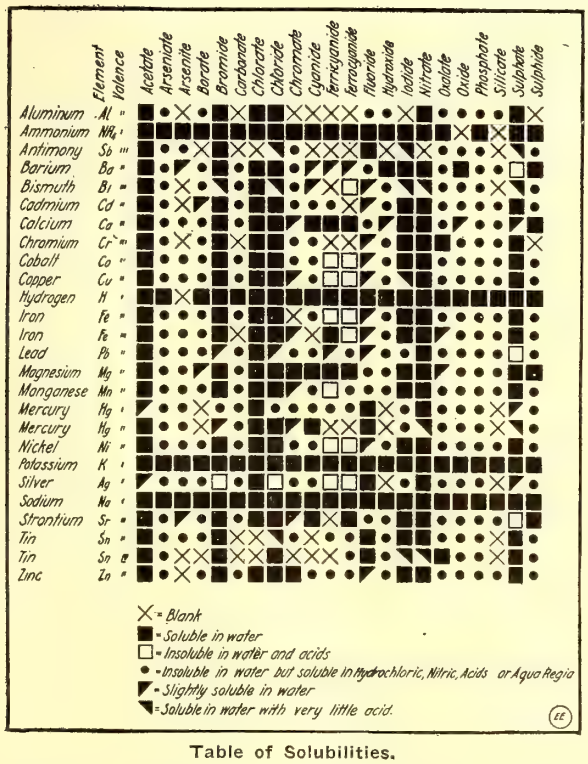


Table of Solubilities.

2KOH + H_2SO_4 = K_2SO_4 + H_2O
Potassium Hydroxid + Sulfuric Acid = Potassium Sulfate + Water

The reasons that two equations of reaction which may take place is more fully explained in the opening of this article.

If desired Sodium Sulfate [Na_2SO_4] can be prepared in the same manner as above.

EXPERIMENT NO. 57—

Neutralize Ammonium Hydroxid [NH_4OH] by the preceding methods, and Nitric Acid [HNO_3]. Make the tests with the red and blue litmus papers. Evaporate as before. The product of this neutralization cannot be evaporated to complete dryness, owing to the fact that the nitrat breaks up.

NH_4OH + HNO_3 = NH_4NO_3 + H_2O
Ammonium Hydroxid + Nitric acid = Ammonium Nitrat + Water

The above salts which were prepared by the neutralization of acids and bases, are *soluble* salts.

Salts can also be produced by the action of acids on metals; below are given methods of preparing chlorids, sulfats and nitrats.

EXPERIMENT NO. 58—

Put into a clean test tube about 5 grams of zinc and pour over it about 10 cc. of dilute hydrochloric acid. It will be remembered that this experiment was performed in a previous installment, [Hydrogen, Experimental; January, 1917, issue Electrical Experimenter]. Apply a lighted splint to the mouth of the tube and notice any familiar action. After the action stops pour the liquid upon a filter; then evaporate the *Filtrat* [the solution obtained after filtering] in an evaporating dish, and note what is left.

The reaction for this experiment is:

Zn + 2HCl = $ZnCl_2$ + H_2
Zinc + Hydrochloric Acid = Zinc Chlorid + Hydrogen

The gas which escapes from the tube is hydrogen, and by applying a lighted splint to the mouth a slight explosion should be caused to occur. The product obtained in this experiment is Zinc Chlorid [$ZnCl_2$].

EXPERIMENT NO. 59—

Pour about 10 cc. of dilute Sulfuric acid [H_2SO_4] made by pouring 3 or 4 cc. of strong Sulfuric acid *to* the water, about 10 cc., stirring the liquid constantly, and adding the acid in small quantities. [Never add the water to the acid], on about 5 grams of scrap iron. It may be necessary to heat the mixture over the Bunsen burner in order to produce better action. After the action has proceeded for some time remove from the flame, and add about 5 or 10 cc., [after the liquid has been filtered]. After the water has been added to the solution, place in an evaporating dish and proceed to evaporate. The reaction for this experiment is:

Fe + H_2SO_4 = $FeSO_4$ + H_2
Iron + Sulfuric Acid = Ferrous Sulfate + Hydrogen

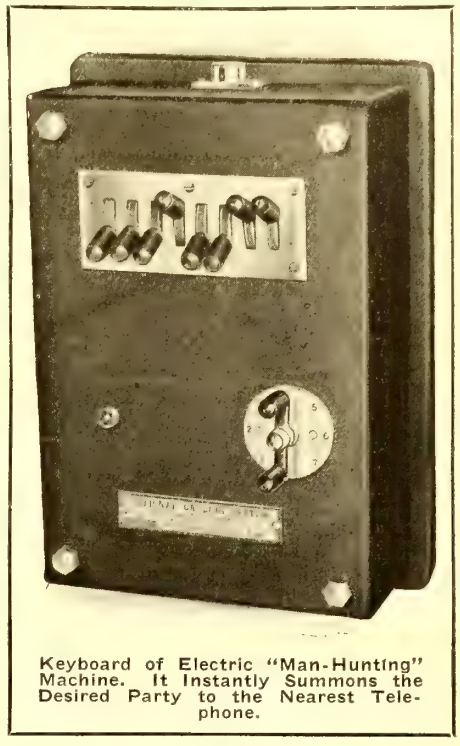
EXPERIMENT NO. 60—

Mix 5 cc. of water with about 5 cc. of Nitric acid [HNO_3]. Place about 5 grams of copper scraps in a test tube and add the 10 cc. of Nitric acid, prepared as above. If action does not take place, heat gently over a Bunsen burner. A deep green solution will form, and after the action has stopt, add about 5 or 10 cc. of water and slowly evaporate, as before. If the evaporation is carried to dryness the nitrat will break up into the insoluble oxid, which will manifest a black color. To avoid this action the liquid need not be completely evaporated, but it may

(*Continued on page* 154)

"MAN-HUNTING" WITH THE ELECTRIC CALLING SYSTEM.

One, two, three—pause—one, two = 32 on the electric calling system here illus-



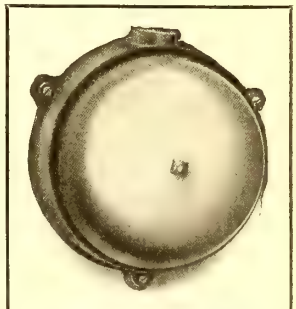
Keyboard of Electric "Man-Hunting" Machine. It Instantly Summons the Desired Party to the Nearest Telephone.

trated. It is the prince of man-hunters, serving as it does to quickly summon any particular individual to the nearest telephone, no matter in what part of the plant or shop he may be at the moment.

The Electric Calling System is primarily the operating instrument, which is connected by wiring to a line of signals consisting of either bells, horns, buzzers, lights or whatever other electrical devices it is desired to use. These signals are distributed thruout the establishment in such a manner that every foot of floor-space is within the sound radius of at least one signal.

The Calling System has no direct connection with the telephone, but is usually located, for convenience, near the telephone central station, within easy reach of the operator's hand. The operating instrument may, however, be placed anywhere on the circuit.

This System operates on a voltage of either 110 or 220, A. C. or D. C. It is always in service and there are no batteries to cause trouble or to be recharged. The consumption of current is most economical.



One of the Single Stroke Call Bells.

The instrument is made in one universal model, which has a calling capacity of 45 different code numbers. There is no limit to the number of signaling devices which the instrument will control, provided sufficient current is let into the line to operate them.

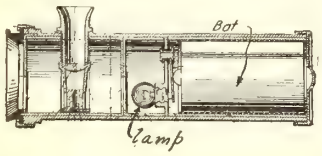
The signals are controlled by eight small levers which form the number combinations.

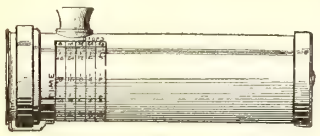
LATEST PATENTS

An Electric Photometer

(No. 1,218,946; issued to Clayton Laing.)

This device embodies a clever electrically operated photometer for use by photographers in accurately calculating the proper exposure for



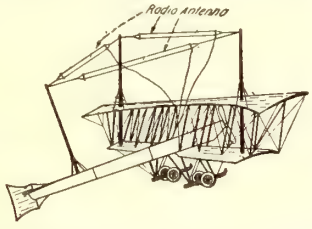


any strength of light and any size lens opening. The instrument comprises a suitable light filter and co-operating shutters, so that ordinary daylight may be properly compared with a standard of light incorporated in the photometer. The light standard is composed of a small electric bulb, and a dry battery with suitable switch. When equal amounts of light penetrate two special translucent blocks, they appear as one block; the two halves of the block perfectly balancing, so that natural and artificial rays are of equal intensity.

Antenna for Aeroplanes

(No. 1,219,550; issued to Walter Hahnemann.)

An improvement in design of wireless antennae for aeroplanes comprising a bamboo or other mast

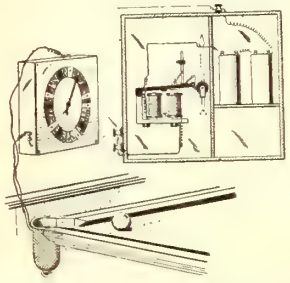


supporting one or more insulated flat-top aerials. The "ground" element is compensated for by utilizing the metallic aeroplane structure; the "aerial" element being cared for by the special antenna here shown. The inventor has paid particular attention to the correct design of aeroplane antennae, with respect to the proper maintenance of the stability and operating characteristics of the aeroplane itself and claims that the addition of his antenna to an aeroplane will not cause it to be unbalanced in flight or in maneuvering.

Pool Table Register

(No. 1,220,420; issued to William H. Heffley.)

An interesting and practical elec-

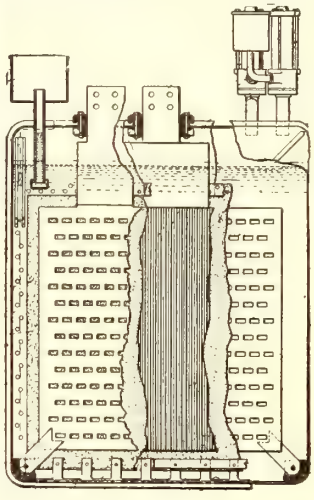


tro-mechanical device for registering the results of a game of pool, etc., whereby the pool ball as it falls into a pocket, closes an electrical contact. This causes a set of magnets to operate a pawl and ratchet connecting with the indicating needle in the manner shown, and the dial may be marked off in any suitable style and colors. The device can be attached to any pool table without altering or damaging it, and each table pocket is connected up to the electrical scoreboard.

Electrolytic Gas-Generator

(No. 1,219,966; issued to Isaac H. Levin.)

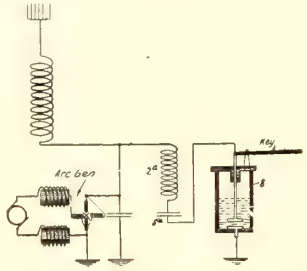
Electrolytic apparatus designed to produce hydrogen and oxygen gases by subjecting water containing a small quantity of a suitable electrolyte, such, for example, as potassium hydroxid, sulfuric acid, etc., to the action of an electric current, which



is caused to flow there-thru from one electrode to another, both electrodes being submerged in water. The solution is decomposed in the well-known electrolytic manner, oxygen being liberated at the positive electrode and hydrogen at the negative electrode. This invention relates particularly to an electrolytic gas generator in which the liquid acted upon is contained in a suitable receptacle, having two sets of insulated electrodes entirely independent of the receptacle proper.

Radio Arc Transmitter

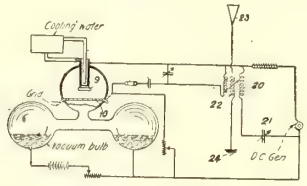
(No. 1,220,072; issued to Louis Cohen.)



Instead of utilizing the "compensation wave" method of radiating telegraphic signals by means of a radio arc type transmitter, the inventor has developed a novel scheme which operates as follows: With the Poulsen system, energy is continuously transmitted, but with this arrangement energy is radiated only as the dots and dashes are sent out. During the "space" periods no current is radiated from the aerial, the high frequency oscillations being shunted thru a variable resistance key 8, condenser 5-a and inductance 2-a. This does not affect the operation of the arc and no appreciable sparking occurs. When the variable resistance key 8, is closed, the loop circuit will have less resistance than the antenna circuit, as it is closed and practically all of the high frequency oscillations produced will flow in this circuit. When the key is opened, the arc oscillations will charge the aerial instead.

Oscillating-Current Generator

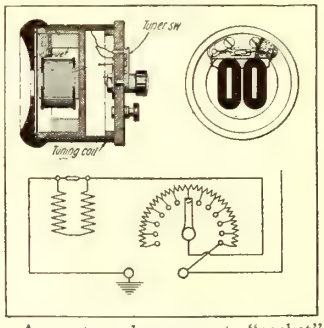
(No. 1,221,034; issued to Lee de Forest.)



An improved method of developing powerful high frequency oscillations with a vacuum tube generator suitably associated with one or more oscillatory circuits. The inventor provides an evacuated bulb containing mercury electrodes, which produce a mercury vapor arc within the bulb. Two cold electrodes 9, and 10, are utilized, 9 being water cooled, and 10 being a bent hollow grid. An oscillating circuit is associated with the two cold electrodes 9 and 10. A second oscillatory circuit is provided thru inductance 20, and capacity 21. With this arrangement, the oscillations produced in the first oscillatory circuit are increased in intensity when the period of the second oscillatory circuit is made equal to that of the first. The output or "load" circuit comprises ground 24, inductance 22 and aerial 23.

Combination Radio Receiver and Detector

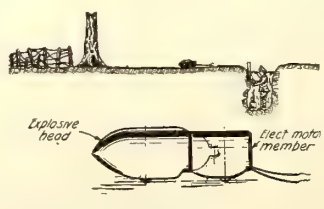
(No. 1,219,888; issued to Frank Wallberg.)



An extremely compact "pocket" wireless set, comprising a tuning inductance, crystal detector and telephone receiver, all in the space required for an ordinary watchcase telephone receiver. The telephone receiver and detector are connected in parallel, and this unit in series with the aerial, ground and tuning coil. The latter is adjustable by means of a switch; the tuning coil is wound about the shell of the receiver, and the detector is extremely small, being placed within the receiver-magnet chamber as shown. The device is held to the ear when in use, and the switch turned until the signals come in the loudest.

Electric Land-Torpedo

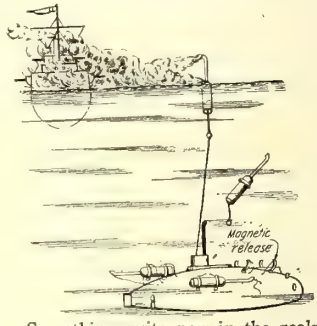
(No. 1,219,028; issued to Abraham Must.)



A novel invention comprising an electrically driven or propelled land-torpedo possessing several unique features. As shown in the illustration, the design comprises two sections; the forward compartment containing the charge of explosives and detonating means, while the pivoted rear unit contains the electric driving motor and necessary gears. The land-torpedo is dispatched from a trench, and is under constant control of a soldier in the trench. It should prove useful in destroying barbed wire, and other impediments, as when it has reached the desired spot, the operator simply pushes an electric button which detonates the explosive charge in the war-head of the torpedo, thus destroying the obstruction. The torpedo hauls its electric feed wires after it, as it ambles away from the trench.

Electric Gas Buoys for Submarine Warfare

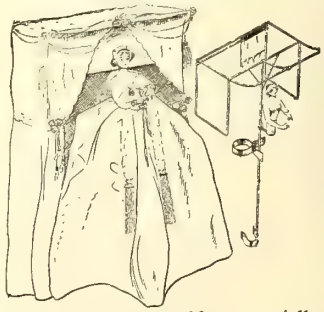
(No. 1,222,498; issued to Joseph A. Steinmetz.)



Something quite new in the realm of war machinery and comprising a series of highly charged poisonous "gas buoys," which may be attached to the exterior of the submarine, and which are held in clamps, electro-magnetically controlled from the interior of the submarine. The latter may submerge in proximity to a hostile war-ship and release one or more of the gas buoys. These float to the surface and even tho struck by shell-fire, they will proceed to liberate a cloud of deadly gas fumes, which are supposed to eventually overcome the crew of the war-ship. The gas buoys may be released and immediately cut free, or they may be maintained in position by a cable as shown, so that they will not drift away before their task is finished.

Hood for Concealing Telephone

(No. 1,221,919; issued to Lillian A. Strasburger.)



This invention provides a specially devised concealing hood for covering the telephone instruments in "My Lady's Boudoir," etc. As shown in the illustration, the device comprises a wire frame-work provided with a spring clip and a doll's head. The attachment is suitably drapt and at the rear it is provided with a sliding curtain. To use the telephone, it is but necessary to grasp the skirt of the figure and turn the whole outfit around 180 degrees, when the rear curtain can be slid sideways and the receiver moved from the hook.

COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c. EACH

Phoney Patents

Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for the entire universe.

We are revolutionizing the Patent business and OFFER YOU THREE DOLLARS! $3.00 FOR THE BEST PATENT. If you take your Phoney Patent to Washington, they charge you $20.00 for the initial fee and then you haven't a smell of the Patent yet. After they have allowed the Patent, you must pay another $20.00 as a final fee. That's $40.00 ! ! WE PAY YOU $3.00 and grant you a Phoney Patent in the bargain, so you save $43.00 ! ! When sending in your Phoney Patent application, be sure that it is as daffy as a lovesick bat. The daffier, the better. Simple sketches and a short description will help our staff of Phoney Patent examiners to issue a Phoney Patent on your invention in a jiffy.

Phoney Patent Offizz

No. $\left(\frac{2\frac{1}{4}\text{ V. A. C.}}{60^{\circ}\text{ S. G.}}\right)$

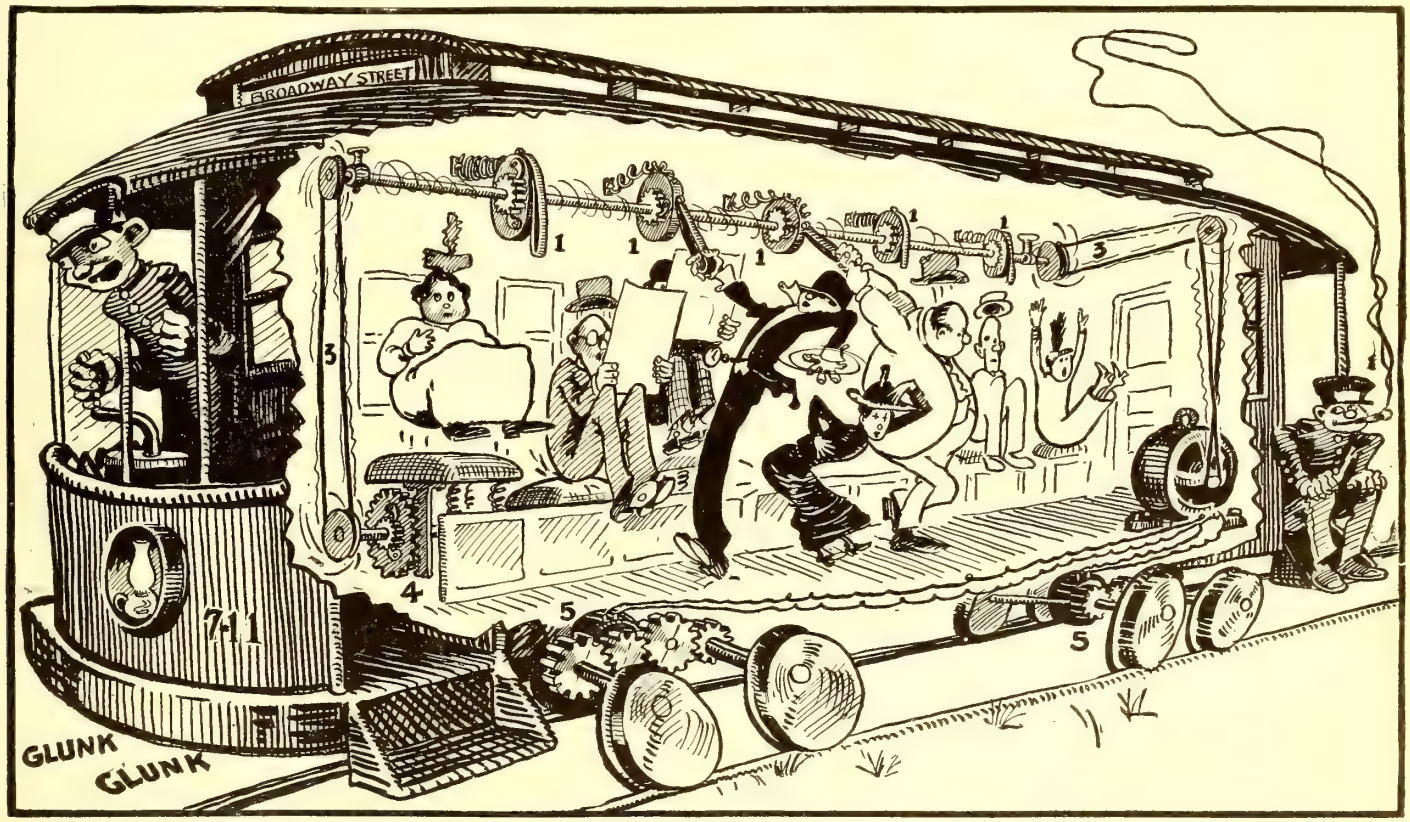
S. T. Raphangr of Rushour, D. T.

Patent Rattled

SELF PROPELLED TROLLEY

To Whomsever It Might Concert:

Be it knowed to all unknown and all other straphangers at large, as well as all those confined in solitary confinement thruout the world, that I Salomon Taddeus Raphangr of the City of Rushour in the State of Deliriumtremens, have devised, designed, designated and developed an invention of the most far reaching consequences to a long suffering traveling public.



Straphangers All Over the Universe As Well As Trolley Car Magnates Will Rejoice At This New Invention. Not Only Do the Swaying Passengers Now Propel the Car, But They Experience All the Variegated Experiences of a Sea Trip and All for a Nickel.

It is a well known, altho deplorable fact, that the modern trolley car for economic reasons of all traction companies are equipt with rather oval as well as "flat" wheels. The tracks too, are of the scenic railway type, fashioned after the camel's back, *i. e.*, hill and valley with 15 hills and 29 valleys to the running yard. These modern refinements are necessary to shake up and bump the cars vigorously, this action being required to pack the passengers tightly into the car and to jingle the passengers' nickles, so the latter can be extracted easier for the conductor's rake-off.

Having in mind these points and knowing that passengers always sway to and fro in all our trolleys in a truly alarming manner, I conceived the brilliant idea of utilizing this prodigious energy, now going to waste. In my researches I quickly found, that if you start the car on an incline, *no further power is required* to propel it, all the power and lots to spare besides, being furnished by the swaying straphangers themselves. The excess power can be used to light the car and charge a storage battery, which in turn may drive the car when traffic is light. But this is by no means all. By providing all seats with a spring attachment, the seated passengers will bump up and down nicely, and I found this to be far more pleasing than being bumped up and down on hard seats. It is also very healthy, for the digestion is greatly improved, especially after heavy meals. It will "settle" the heartiest meal wonderfully. If the public comes to realize this it will patronize my new self-propelling trolley in a manner undreamt of by the most voracious traction company shareholder. No power house nor trolley wires being required, the company will make enormous profits, and it will be able to issue a package of chewing gum and 10 trading stamps free with every nickel ride.

Referring to the patent drawing we find that 1 is the strap on which the straphanger navigates. Every time he sways he exerts a pull of about 150 lbs. on the strap, and by means of a pawl and ratchet arrangement mounted on a common shaft passing thru the length of the trolley, the shaft begins to rotate. The power is then conducted by belts 3 to dynamo which in turn drives the motors 5 under the car. The motors being geared to the axles drive the wheels of the car. The car wheels being off center, as observed, will give the trolley car a pitching motion like a ship in a swell. This greatly aids in more effectively swaying and bumping the passengers.

The seated passengers when rising up and down on their spring seats operate gears 4 and the resulting power is also conveyed to the belts 3, this furnishing additional power.

What I claim is:

1° A wireless trolley, operated solely by straphangers.

2° A self propelled fat reducing trolley stimulating digestion and preventing indigestion.

3° A trolley car giving passengers all the experiences of a sea trip for a nickel.

In consternation whereof, I have therefore resolved and caused to be appended and imprest hereunto and hereunder the crest of my family shoe tree with my left uppermost hind foot this 16th day after the "ad"vent of any deceased maiden aunt's German measles, in the presence of three witnesses.

S. T. RAPHANGR.

Wittynesses: *By his Attorney,*
A. W. Gowan, *Thomas W. Benson,*
I. M. Indutch, *Phila., Pa.*
C. U. Titout

QUESTION BOX

This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

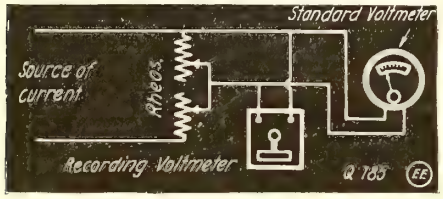
1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink; no penciled matter considered.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of **25 cents** is made for each question. If the question entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

RECORDING VOLTMETER.

(785.) J. Hassel, Baltimore, Md., asks:

Q. 1. What is a recording voltmeter?

A. 1. A recording voltmeter is an instrument which permanently records the potential that exists between points in an electric circuit during any definite period. It consists of nothing more than an ordinary voltmeter, the armature or moving element of which carries a small writing pen, that traces a curve on a moving strip of paper. The variation of the e.m.f. in the circuit is indicated by the variation of the traced curve. The strip of paper which receives the record is moved by a special clock mechanism.



Connections for Calibrating a Recording Voltmeter With the Aid of a Standard Voltmeter and Two Rheostats.

Q. 2. For what purpose are these instruments most adapted?

A. 2. They are generally employed in power-houses, where it is required to know the exact voltage conditions of the line during certain periods of the day.

Q. 3. Are these instruments sufficiently accurate to warrant their use in laboratory work? How are they calibrated?

A. 3. No. Most of them require a large correction factor. Their accuracy depends upon the degree of voltage variations, as the friction between the pen and paper is somewhat great when the moving element is caused to move frequently.

The wiring diagram herewith gives connections of a recording voltmeter for calibrating the same with a standard voltmeter.

IMPULSE EXCITATION.

(786.) Paul Magdale, Hackensack, N. J., desires to know:

Q. 1. What is meant by impulse excitation?

A. 1. Impulse excitation is a method of exciting the antenna by means of an oscillatory circuit which is highly damped and the coupled secondary or antenna circuit receiving an impact or shock from the primary circuit, and permitting this secondary circuit to oscillate with as little damping as possible. The primary oscillatory circuit is so adjusted or tuned that a *single impulse* is produced.

Q. 2. Is the quenched spark gap system operated on the impulse excitation principle?

A. 2. Yes; but it is not an ideal impulse excitation, since the primary of the circuit is not permitted to be highly damped. Furthermore, the oscillations of the primary are periodically cyclonic and not impulsive or semi-period oscillations, as that obtained from an ideal impulsive excitation transmitter.

RADIO BOOKS.

(787.) Andrew Colly, Oyster Bay, L. I., asks:

TO OUR FRIENDS.

Do you realize that not one day passes when we do not receive from 150 to 250 or more letters addrest to the "Question Box"? If we were to publish all the questions and answers we would require a monthly magazine five or six times the size of The Electrical Experimenter with no other matter but questions and answers! Of late the influx of letters has become so heavy that several of our associates have been forced to discontinue important editorial work, in order to answer the mail. This we are certain you do not wish. You do not want your magazine to lower its present high standard. You want the best, the very best, and you know we never have failed you yet.

Moreover the multitude of letters are wholly unnecessary. Most of the questions we are asked every day have been answered before in the Question Box. Therefore ere you sit down to write to us, look over your back numbers and nine times out of ten you will find the answer.

We strive hard to publish only such matter as has not appeared before in our columns, and for that reason only a small fraction of queries of those received by us are actually publisht.

Kindly note, therefore, that in the future we cannot, in your own interest, answer questions by mail, free of charge.

For questions requiring immediate answer our fee is 25c. for the first ordinary question and 25c. for each additional question. We will gladly advise fee for special questions entailing considerable calculations or research. Stamped and addrest envelope should be enclosed with the queries and, moreover, any sketches accompanying them should be made on separate sheets. And please be brief.

THE EDITORS.

Q. 1. Where can I buy wireless books describing in detail the complete theory of radio engineering, and also a text-book giving complete data as to the design and operation of radio apparatus?

A. 1. We would recommend the following books, which we believe will give you all the desired information: By J. A. Fleming, "The Principles of Electric Wave Telegraphy," $10.00; by J. Zenneck, "Wireless Telegraphy," $4.00; Eccles' "Wireless Telegraphy and Telephony," $3.50. We will send any of these books on receipt of price.

Q. 2. Are all the Radio Amateurs of this country to remove their aerials and apparatus in this present crisis?

A. 2. Orders have already been given to instruct all Amateurs thruout the country to remove their aerials. The instruments were not asked to be removed or confiscated by the authorities up to the present time.

WIRING DIAGRAM.

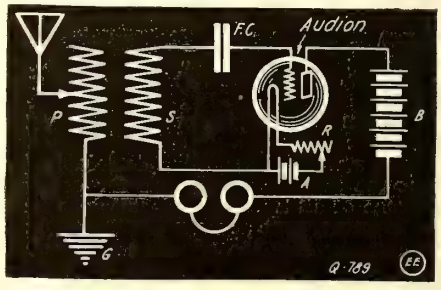
(789.) Peter Hancock, Toledo, O., wants:

Q. 1. A wiring diagram of a short wave regenerative Audion receiving outfit.

A. 1. The appended diagram gives the proper connections.

Q. 2. How can I eliminate the noises produced in the receiver when the Audion is in operation? This effect is even obtained when the receiving instruments are disconnected from both the aerial and ground.

A. 2. The noise which you are experiencing is due to a constant electrical charge on the grid of the Audion, which causes the grid condenser to charge and discharge unperiodically; consequently affecting the receivers. This trouble might be eliminated to a certain degree by shunting a high resistance "leak" path across the grid condenser. It must be a non-inductive leak and can be made very readily by marking upon a sheet of paper a pencil mark and connecting the ends of this line across the condenser. A little patience in making the proper thickness of line will be required before proper results can be obtained.



Hook-up for a Short Wave Regenerative Audion Radio Receiver.

WAVE LENGTH OF ANTENNA.

(790-A) Thomas Lowman, East Pittsburgh, Pa., inquires:

Q. 1. Can you give me the wave length of an antenna which consists of four wires 60 feet high, 100 feet long, and the wires separated 2 feet?

A. 1. The wave length of this antenna is 300 meters.

Q. 2. Suppose I desire to use this antenna with a transmitting station, which will comprise a 500 watt 60 cycle trans-

(*Continued on page* 137)

Who Gets $200,000,000 Tire Profits?

An amazing condition revealed in the tire business. Terrible waste shown by methods of selling automobile tires. How one tire man plans to cut the cost of tires to the consumer revealed

Tire Chain Stores Offer Solution of Problem

By M. E. PHILLIPS, "Staff Correspondent" (Home Magazine)

NOTE.—The following article, written by our staff representative, outlines plans for a giant chain of tire service stations and stores which it is predicted will greatly lower automobile upkeep costs. A unique co-operative plan which has been tested out and found successful. Output of splendid factory already secured, more to follow. The success of other chain stores and the tremendous growth of the automobile industry—consequently of the tire business—makes this one of the most attractive and interesting enterprises. We have made every effort to verify the statements made here and to the best of our knowledge the statements are accurate and the estimates conservative.—(Publisher Home Magazine.)

Who gets the $200,000,000.00 A YEAR TIRE PROFITS?

Do you know that the cost of producing a tire is possibly ONE-THIRD of the price you have to pay? That a small tire you pay $15.00 for costs about $5.00 to manufacture? That the tire costing about $20.00 to build *has to retail for about* $60.00?

Do you know that the tire manufacturer is satisfied to sell his tires for very little over the cost, and at only a fraction of the retail price?

Where does the balance go?

Who then gets this enormous "cut in" on the tires you buy?

DO YOU? Of course not.

Who, then?

Well, the JOBBER gets a BIG slice.

The WHOLESALER gets another BIG slice.

The RETAILER gets HIS SHARE.

The rest goes into advertising, dealer's helps, adjustments, etc.

Meanwhile YOU, Mr. Tire Buyer, pay the 100 per cent price and worry about the high price of upkeep of your motor car.

WILL CUT TIRE COSTS

A clever tire man, a man with intimate knowledge of the tire industry, a man with breadth of vision and economic principles, has seen this enormous WASTAGE in the tire business and has evolved a PLAN that will revolutionize the tire selling business.



The Famous Philadelphia Experimental Tire Service Store that Proved to President Feist of the National Rubber Company the Practical Possibilities of Tire Chain Stores, Located at the Corner of North and Broad Streets.

He argues that TIRES COST THE CONSUMER TOO MUCH.

He says there is no reason on earth why the tire buyer should have to pay this enormous burden of profits and selling costs. If tires can be made for ONE-THIRD of the actual retail prices they can be sold FOR LESS than prices now charged for them and still pay legitimate profits. LARGE PROFITS, because of the volume of business a company offering such savings is bound to achieve.

This far-sighted man is a PRACTICAL TIRE MAN. As a manufacturer he has MADE GOOD. He is a PRACTICAL BUSINESS MAN, with all a practical man's dislike for waste. He has proved his genius for organization and big things.

This man is Mr. J. G. Feist, President of the National Rubber Company of New York.

PLANS CHAIN OF STORES

Mr. Feist's plan is to establish a chain of tire service and store stations from Maine to California, and Canada to the Gulf of Mexico.

The National Rubber Company of New York has been organized with strong men behind it and it has already secured the output of one entire factory as the nucleus of this chain store plan. More factories will be added as the chain extends and the need of more tires becomes evident. The first factory whose product has been acquired is the National Rubber Company of Pottstown, Pa., manufacturers of the famous National Speedway Tires and National Red Tubes.

The NATIONAL SPEEDWAY REDWALL TIRES are so GOOD that they are sold under the strongest GUARANTEE to be had.

The company agrees to replace FREE any tire that does not outlast and outwear any tire of any make or price of the same size tested under the same conditions.

This company now has a production of 1,000 tires and tubes a day and is being enlarged to a much greater capacity. When the distribution exceeds the capacity of this plant, new plants will be started or bought in different sections of the country, or their outputs contracted for in order to bring up the production to the necessary number of tires.

Mr. Feist proposes to sell tires at a MUCH LOWER PRICE than is now being charged for good tires elsewhere.

He plans to give SUPERIOR SERVICE to tire buyers.

He will give them a BETTER TIRE. He anticipates that in doing this his company *will prove the greatest profit maker in the country.*

EXPERIMENTAL PLANT A SUCCESS

Mr. Feist is not building his company's future on imagination or theory. Before maturing his plans he opened in Philadelphia



Boston Service Store of National Rubber Company, Located at 557 Columbus Avenue.

a station such as he proposes to establish elsewhere.

This is what his Philadelphia service station and store does:

It sells tires below the average price of high-class tires of equal size and quality.

It delivers tires PUT ON YOUR CAR.

You phone in that you need a 34x4 tire and give your address. A mechanic picks up the required tire, puts it in the carrier of a motorcycle and speeds off to your address. On arrival he takes off your old tire and puts on the new one. No trouble, no mess.

If you want your old tire repaired he takes it back with him and it is delivered as soon as repairs are made.

You have saved time, labor, worry and *money*.

The success of this first service station PROVES what REASONABLE PRICES, HIGH QUALITY GOODS, EFFICIENT SERVICE will accomplish. Profits are large because of volume. The Philadelphia service station already has 11,000 CUSTOMERS. (Not tire sales, but CUSTOMERS.)

With this established PROOF of the value of this new departure service, Mr. Feist has organized a company to establish National Rubber Company SERVICE STATIONS and stores all over the country. His plan provides for opening 500 stores the first year, if possible, and more stores year by year as the company grows.

OFFERS GREAT OPPORTUNITIES

The OPPORTUNITIES offered by this chain of tire service stores are self-evident.

CHAIN STORES of all kinds have been enormously successful. They have built up some of the greatest fortunes in the country. They have made original investors enormously rich. And this in spite of the fact that most chain stores have dealt only in articles selling for a very small sum. HOW MUCH GREATER should be the profits of a chain of stores selling a product whose every SINGLE SALE equals the sale of HUNDREDS of the articles sold in most chain stores?

The UNITED CIGAR STORES, selling cigars, cigarettes and tobacco, average LESS THAN 20 CENTS PER SALE. The National Rubber Company averages MORE THAN $20 PER SALE, with proportionate profits.

THE WOOLWORTH STORES sell 5 and 10 cent articles. Yet they have made many millions and the highest office building in the world was built out of these nickels and dimes.

The REGAL SHOE COMPANY with its chain of hundreds of shoe stores, has made its owners rich. So have the Walk-Over Shoe Stores, the W. L. Douglas Shoe Stores. All chain stores.

The TRULY WARNER Hat Store chain has accumulated wealth for its owners.

The Great Atlantic and Pacific Tea Stores, the Jewel Tea Stores, the Acme Tea Stores, all chain stores, have made millions.

The several chains of drug stores, of grocery stores, of cheap restaurants, have all made fortunes.

The reasons for this uniform success are numerous.

In the first place, operating a "chain of stores" of any kind reduces the cost operation—what is known as OVERHEAD EXPENSE—to the minimum.

Secondly, the purchasing power of the buyer who buys for hundreds of stores is so enormous that he can pretty nearly make his own price. He gets ROCK BOTTOM costs on everything. Woolworth can sell for 5 or 10 cents articles that often retail at from 25 to 50 cents because he buys outright entire factory productions. The manufacturer who sells his whole output to one man for cash, eliminates all selling expense, salesmen, advertising, collections, etc., and can sell for a quick turnover, and will yet make more profit in the end. That's how the chain store buyer can buy at such a low figure that he can sell goods that retail generally for 25 cents for 5 and 10 cents.

Then, the chain store man nearly always buys FOR CASH. That means he takes advantage of every cash discount and by paying cash he enables his manufacturer to buy for cash and get a similar benefit. So it becomes an endless chain of savings which benefits the ultimate consumer of the product.

ECONOMY OF CASH BUYING

The chain store man uses his cash to buy everything. He buys everything the same way. He buys his fixtures, his delivery wagons—if he uses them—his every necessity at the lowest bulk price, and bulk with the chain store man means tremendous bulk.

If these chain stores, selling articles that retail for such a small price, can earn such fabulous dividends, what will a chain of tire service stores earn with the big sales it will make; sales averaging $20 apiece?

It doesn't take a prophet to look into the future and see the magnificent accumulations of dividends that should accrue from such an enterprise.

It isn't hard to foresee what the earnings of such a chain of stores can pay in say ten years from today. By that time the chain should extend to every city of any importance in the country. This may mean thousands of such stores, because there are in the United States 1,442 towns of 5,000 or more inhabitants and over 100 cities having a population of 55,000 or over. The small towns, say the towns under 10,000, would require only one such service station, while the larger towns would require a number of them.

THOUSANDS OF CHAIN STORES

To give you an idea of how many stores some of the big chains have, it is enough to mention the Great Atlantic and Pacific Tea Company, with over 1,500 retail stores; the United Cigar Stores, with over 1,000 retail stores; the Woolworth Company, with over 1,000 stores, etc.

The tremendous growth of the automobile industry—a growth that is gathering size and importance every day—makes this projected chain of tire service stores all the more important.

At the beginning of 1917 there were approximately THREE MILLION autos in use in the United States. According to last United States census, there were in 1910 (date of last census) 91,972,266 inhabitants in the U. S. It is calculated that there are now at least 120,000,000 people in the U. S. At this rate, there is one auto in the U. S. for every 40 people. In many of the states, the ratio is higher than one for every 16 people. This means that THERE IS A TREMENDOUS POSSIBILITY FOR MORE MACHINES.

According to the best informed automobile authorities, it is calculated that there will be added at least 1,000,000 auto users during the year 1917, bringing up the total close on to *FOUR MILLION AUTOS in actual use in the U. S.* With such an *enormous* distribution of cars, and all the automobile factories of any account way behind in deliveries, an enormous supply of tires will be required to keep these autos running.

24,000,000 TIRES NEEDED

Very moderate estimates place the number of tires required on each car at EIGHT PER YEAR. Each auto MUST HAVE FIVE TIRES, four on the wheels and one spare tire. It is an ultra conservative estimate, therefore, that places the required number of tires to meet the needs of 1917 at SIX PER CAR. At this rate 4,000,000 automobiles will require 24,000,000 tires. This is truly AN AMAZING FIGURE for an industry that is only a little over a dozen years old.

The distribution of these cars is centered at present in certain sections. When the other sections have awakened to the advantages and uses of the automobile and its economy for travel and commercial purposes, it is more than likely that the distribution will be much more even.

It has been estimated by statisticians that there are *OVER TEN MILLION men in the U. S. who should be, and probably*



Chicago Store of National Rubber Company, the Third in the Chain.

soon will be, auto owners. These are men who, because of their business, their financial condition and their position, should become automobile owners.

There are upwards of seven million farmers in the U. S., and of these a large percentage will probably become owners of automobiles. Just now only about 7 per cent of the prosperous farmers own automobiles. The farmer is today the RICH MAN of the U. S. He has been getting the biggest prices ever paid for crops, he has by scientific farming increased the yield of his acres, and he has been fortunate in getting big crops when the price was highest.

For these reasons, THE FARMER IS USUALLY PROSPEROUS and he is putting some of his riches into the comforts and conveniences of an automobile.

With such prospects, with such a tremendous field to conquer, with the SUCCESS that has attended the FIRST UNIT of the National Rubber Company chain of service stores, it is not hard to visualize the ENORMOUS POSSIBLE PROFITS from this enterprise.



Officers and Officials of the National Rubber Company of New York. These Men Have Made the Making and Selling of Tires Their Life Work, Both as Manufacturers and Branch Managers. They are Pioneers in the Tire Business; They Have Watched the Tire Business Grow from the Experimental Stage. Today They are Large Factors in the Manufacturing of the Best Tire that Money Can Make. Mr. Walsh, Who Is Superintendent of the Plant, Has Been for 23 Years in Active Charge of the Making of the Best Known Tire in America. Mr. Sperry Was With the Deere Plow Co. as Agency Organizer. Mr. Dougherty Has Been a Tire Representative for Years, Formerly With the Lee Tire Co. H. A. Lamoree Has Also Been a Branch Tire Store Manager and General Tire Salesman With Several of the Big Companies.

HOW PROFITS PILE UP

Even a casual consideration of the subject makes the figures run into such amazing columns of profits that the very thought is staggering.

The great earnings of chain stores of all kinds has been in the aggregate.

When you take 1,000 stores and pile their profits in one great heap, you have a formidable aggregate—an aggregate which doesn't have to be very large in the individual case to make up this magnificent total.

Let us take into consideration one unit and then see how it works out.

Firstly, we must remember that these service stores are operated at a *minimum of expense.* Being administered from the central office, whose costs of operation are spread over the whole chain, the local stores require only inexpensive help. The man who operates a store of his own expects to make A GOOD LIVING out of it for himself AND A GOOD PROFIT besides; he has to pay for everything on the high price of individual purchases. He has to have efficient help, has to advertise and, of course, he has fixed charges for rent, light, taxes, insurance, etc.

CHAIN STORE SAVINGS

The chain store hires only the necessary help, it eliminates the owner's living and profits. It buys in enormous quantities at prices that make the prices the individual store owner pays seem preposterous; it pays the minimum for taxes, for insurance and the advertising expense of operating is carried in bulk by the parent company, and this is divided pro rata so that each individual store pays only a small sum as its share of the advertising expense.

Tires are bought at actual contract price from the manufacturer and so charged agains the store, much cheaper than the average tire store man can buy them.

We then have EXPENSES PARED DOWN TO THE BONE, probably HALF WHAT THEY WOULD BE UNDER ORDINARY CONDITIONS. And we have the most attractive kind of a proposition to offer to the tire buyer—THE BEST TIRE ON THE MARKET AT MUCH LESS than he would have to pay elsewhere; A SERVICE NO OTHER TIRE CONCERN GIVES or can give, GUARANTEED SATISFACTION backed up by a company operating a nation-wide chain of stores.

With so much to offer and with such splendid profit-making advantages it is not hard to look into the future and see every store paying a big profit and the company earning dazzling dividends.

What may one store earn, you may ask?

Let us do a little figuring:

Firstly, the ENTIRE FACTORY SELLING EXPENSE IS ELIMINATED—the entire output of the factory being sold to one customer—the chain store.

The saving of the traveling expense and salesman's salaries and commissions. The saving of advertising and promotion expense. The added office accounting and credit expense. All these are SAVED by the chain stores. In these items alone is found a selling cost of at least 20 per cent.

On top of that the JOBBERS' DISCOUNT OF 40 PER CENT IS WIPED OUT.

No thinking man or woman has to be told that the NET SUM the manufacturer receives ALONE CONTROLS THE QUALITY AND QUANTITY of materials used in making tires, because ONLY AND SOLELY from this NET SUM is the PROFIT derived.

Because of the TREMENDOUS OVERHEAD selling and distributing expense, the enormous discounts demanded by the jobber, the wholesaler and the retailer, if the manufacturing cost were TOO HIGH or even over his competitors, then added charges, as described here, increase out of proportion and the consumers' prices would be prohibitive.

Hence, in National Speedway Tires most of the factory selling cost is put in the tire in ADDED QUALITY AND QUANTITY, and the usual trade discounts are divided with the consumer.

PROFITS OF CHAIN STORES

We now come to the question of the profits of the chain stores of each unit and of the chain in the aggregate.

After a careful scrutiny of costs of manufacturing, of operating the chain store—each unit—and figuring a retail price on the tires at a sensible reduction over average price of tires of equal size and quality we find that there is still possible an average margin of $5 per tire. This is "AVERAGED" because some of the tires will pay more profit while some will pay less, but the average has been shown to be *about* $5 *per tire sold.*

This is evidently a CONSERVATIVE ESTIMATE.

If each chain store sells ONLY 10 TIRES PER DAY, we have each store earning a profit of $50 a day or $50,000 a day profit for 1,000 stores.

$50,000 profit per day for 365 days in the year—tire service stations are busier Sundays and holidays than other days—FIGURES OUT THE ENORMOUS TOTAL OF $18,250,000 A YEAR PROFITS.

You will realize that an estimate of only ten tires per day is very small. When you consider the tremendous advantages of dealing with the National Rubber Company service stores, the high class product, the low price, the good service given in the way of instant special deliveries, placing the tire on the car and taking away the injured tire for repairs, it is not hard to understand why these stores should do an enormous business.

Ten tires per day is a very low estimate of the possibilities, but to be even more conservative, let us cut down this estimate by half. Let us suppose that the stores only AVERAGE FIVE SALES PER DAY. Let us see how this figures out.

FIVE TIRES A DAY, showing an average profit of $25 per day per store, one thousand stores will, therefore, pay an estimated daily profit of $25,000. For 365 days in the year, THE ENORMOUS TOTAL WOULD BE $9,126,000, and it would be a mighty small store that couldn't sell five tires per day.

These figures are staggering when you analyze the accumulated profits of hundreds of stores all over the country, each contributing its quota of profits from many sources.

A GOLD MINE OF PROFITS

You will note that no estimate has been made of profits from sale of tubes and from the repair department, which should also be profitable.

It will, of course, take time to build up such a large chain of service stations, but in a few years, with the growth of the chain and the enormous increase in the automobile industry and number of cars in use, THIS CHAIN OF TIRE SERVICE STATIONS SHOULD BECOME A VERITABLE GOLD MINE OF PROFITS FOR EVERY STOCKHOLDER WHO BECOMES INTERESTED IN THIS COMPANY NOW, when its shares can be acquired at a low initial price.

The National Rubber Company, of New York, is incorporated under the laws of the State of Delaware, with a capitalization of 500,000 shares of the par value of $10 PER SHARE, ALL COMMON STOCK, SHARING EQUALLY IN PROFITS AND CARRYING FULL VOTING POWER.

THE STOCK IS FULL PAID AND NON-ASSESSABLE.

For the purpose of establishing the business on a right basis, the directors have set aside 100,000 SHARES OF THIS STOCK TO BE SOLD TO THE PUBLIC.

Their idea is that by obtaining a wide distribution for this stock, they will enlist local interest in the local distributing and service stations of the National Rubber Company.

UNDERWRITING STOCK OFFER

This UNDERWRITING SYNDICATE STOCK is offered in five different allotments.

The first allotment will be sold in lots of not less than TEN SHARES and not more than 100 shares at $5 per share, or half the par value of the stock.

This first allotment of 20,000 shares is the only stock of the UNDERWRITING allotment that will be sold at this low price. The next allotment will probably be sold at from 40 to 50 per cent advance in price as soon as the first allotment of 20,000 shares is disposed of. Further allotments at further increases as warranted.

It is desired—as nearly as possible—to place every share of this UNDERWRITING stock in the hands of owners, or prospective owners, of automobiles, who will become immediate patrons of the chain stores and who ARE ALSO OFFERED AN INDUCEMENT TO BECOME BOOSTERS FOR THE TIRE SERVICE STATIONS. THIS INDUCEMENT CONSISTS OF A CASH DISCOUNT OF 25 PER CENT UNDER THE STANDARD LIST PRICES FOR ALL TIRES SOLD BY THE NATIONAL RUBBER COMPANY TO ITS SHAREHOLDERS.

An automobile owner, therefore, has a double interest in buying this stock.

The saving alone in tire bills for a year should pay for this ten shares if he buys at this price and he will have, besides the savings in tire costs, and dividends which the company declares.

IS THIS INVESTMENT WORTH WHILE, you may ask?

WHAT THIS MEANS TO AUTOISTS

Let us study it over. $50 invested in ten shares of this underwriting stock will save the automobile owner 25 per cent on his tires. If his bill for tires runs to $200 a year, he will be saved, therefore, $50. That means that the stock will have paid him 100 per cent on his investment or 50 per cent on the par value of the stock, which, computed on a stock's ability to earn 5 per cent, will make his TEN SHARES REPRESENT AN INVESTMENT OF $1,000 FROM AN ORIGINAL INVESTMENT OF $50. Then if the company begins paying dividends, the stock should go to par and over if the dividends amount to more than 5 per cent.

When the company gets on a 10 per cent dividend basis, the stock he bought for $50 should represent an investment of $200. When it pays 50 per cent, it should have an INVESTMENT VALUE OF $1,000.



Section of Tire-making Department. Here a Small Army of Workmen Are Constantly Employed Putting the Finishing Touches to National Redwall Speedway Tires. These Workmen Are the High-skilled Labor and Their Rapidity and Efficiency Are Wonderful.

So when the company is in a position to pay 50 per cent dividends, this stock should represent an investment to the automobile owner of $2,000, figured on the basis of the dividends and savings it will give him on his tire purchases. And all from an original investment of $50.

When the company reaches its full development and its 1,000 or more stores begin piling up big profits, such as we have already figured on, profits that mean exceptional dividends, THIS ORIGINAL INVESTMENT WILL HAVE ACCUMULATED A PHENOMENAL VALUE.

NO AUTOMOBILE OWNER CAN AFFORD TO OVERLOOK SUCH AN OPPORTUNITY.

A blind man could see the possibilities presented in this underwriting offer, an offer so liberal that the directors had to confine it to a small amount of stock.

AN EXCEPTIONAL OFFER

The offer of the stock at $5 per share (par $10) is in itself a tremendous inducement, but when it is coupled with the offer of the company to extend *a discount of 25 per cent on all tire and tube purchases made* through the company, it becomes so extremely attractive a proposition that NONE CAN AFFORD TO IGNORE IT.

The savings in tire costs alone should pay for the stock of those who accept this offer.



The Splendid Modern Character of This Ideal Plant Is Shown Clearly in These Pictures, With Its Strong, Clear Light, Fine Equipment and Good Flooring. Ideal Conditions for Turning Out High-class Work.

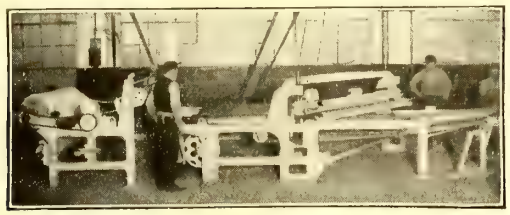
This, in itself, makes the proposition attractive. But when the future of this company is analyzed and the possibilities it offers are considered, the offer becomes immensely more attractive.

YOU NEED NOT NECESSARILY BE AN AUTOMOBILE OWNER today to accept this offer. Your stock in the National Rubber Company will entitle you to this 25 per cent discount on tires and tubes JUST AS LONG AS YOU REMAN A STOCKHOLDER. Later, when you buy an auto, you'll be able to buy tires at this great saving.

You often hear it said that if you had a chance to invest with Ford, or Willys, of Overland fame, with Goodrich or Fisk or Firestone; with Westinghouse or Bell, or some of the others, whose companies have earned fabulous dividends, and made stockholders rich, you would today be ON EASY STREET.

This is very true but the pitiful truth is YOU DID NOT HAVE THIS CHANCE. VERY FEW PEOPLE DID. These com-

panies were all close corporations with the stock held in the hands of a small group of men. These stocks were not offered to the public.



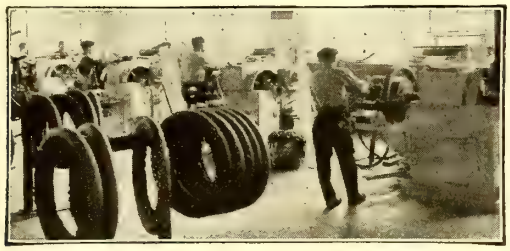
Tire Fabric Cutting Machine. This Machine Can Cut the Fabric for 1,000 Tires a Day, Doing the Work of 10 Men.

A CHANCE IN A MILLION

BUT HERE IS A CHANCE. Here is a company offering UNDERWRITING STOCK, stock that can now be bought at the ROCK BOTTOM PRICE, that should in time become enormously remunerative. Stock in a company that promises to have tremendous growth.

Woolworth and Whalen and the others, who have made tens of millions out of chain stores, never gave the public a chance to come in on the organization. They have sold stock since, lots of it to the general public, but it has been stock in the developed proposition, stock that has been sold on the market AT THE VALUE IT PRESENTS NOW, a value figured on the company's earning power.

LATER YOU MAY GET A CHANCE on the National Rubber Company stock on the open market but YOU'LL PAY THE PRICE OF DEVELOPED STOCK. If the company is earning 100 per cent on its capitalization, you'll pay for it at that rate, which, in that case, would be $2,000 for every $100 par value, or $200 a share for $10 shares.



Tire-Making Machines. A Busy Corner in This Department. These Four Machines Shown in the Picture Do the Work of 40 Men. This is the Most Modern Tire-making Machine Built.

THIS IS THE PENALTY THAT SHORT-SIGHTED PEOPLE PAY for not accepting opportunities that are offered them.

The poorhouse is FULL OF SUCH PEOPLE, "THE MIGHT-HAVE-BEENS."

They lacked the initiative and courage to back their belief with their money.

THOSE WHO HAD COURAGE

The others, those who are without fear, those who have the courage to back their judgment with their money, they are those you watch spinning past you on the boulevard in luxurious limousines, whose homes line the fashionable streets.

MONEY MAKES MONEY, but it takes an exceptional opportunity to bring you big returns from small investments. You read, for instance, that $500 invested in such-and-such stock has earned $250,000; that $500 invested in such other stock has paid $200,000; that $1,000 in Ford stock of the original company is now worth millions. THAT IS ALL TRUE, gospel truth, BUT did YOU ever get a chance to invest in the original $28,000 that started Ford on the highroad to his present millions? Did you get a chance to invest in the $33,000 that John N. Willys has built up into the tens of millions of the Overland Company? Did YOU get a chance to get in on Westinghouse, or Bell Telephone, or Western Union, or Welsbach Mantles stock? Of course not. And very few people did BECAUSE THESE STOCKS WERE NOT OFFERED TO THE PUBLIC when they were at a low price.

THERE'S A REASON

This stock is offered for a reason.

It is offered to the UNDERWRITERS of this company to start it with a nucleus of interested tire buyers and boosters in every locality.

The directors set A MINIMUM OF TEN SHARES AND A MAXIMUM OF 100 SHARES on this offer. It would doubtless be more profitable to the company if every subscription for this stock was for $50 (10 shares), par value $100, because that would mean that the greatest number of people possible would be holding the stock and boosting for the company.



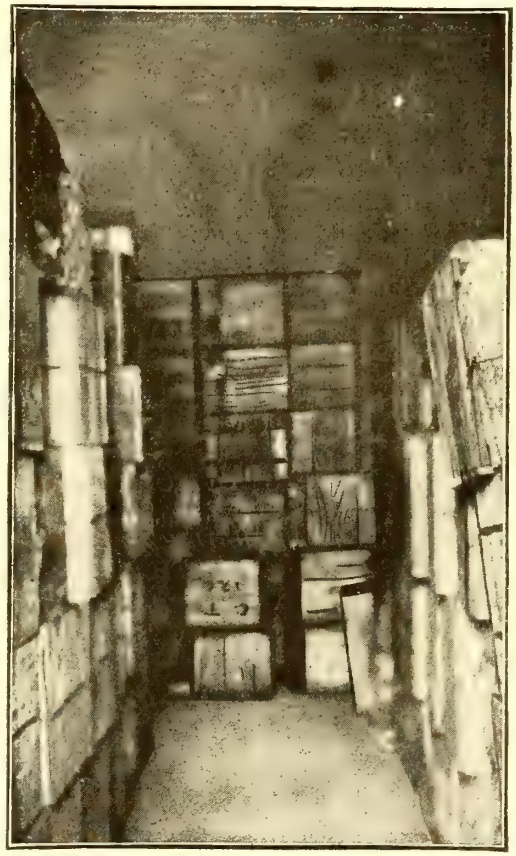
Vulcanizing Department of the Pottstown Plant. Here the National Speedway Tires Are Hardened to Stand Wear and Tear. This Department is Now Vulcanizing 1,000 Tires a Day.

Ten thousand holders of stock scattered throughout the country would mean a veritable army of boosters, helping build up the business IN WHICH EACH ONE HAS A SOLID, SUBSTANTIAL INTEREST.

Ten thousand boosters, working to popularize and make known the high quality of National SPEEDWAY RED-WALL TIRES and National Red Tubes—boosting this way because it is TO THEIR INTEREST to boost this way—would save the company tens of thousands of dollars per annum in advertising expense.

That's the principal REASON WHY THIS STOCK IS OFFERED TO YOU AND TO EVERYONE WHO BUYS TIRES OR EXPECTS TO BUY TIRES.

It is WORTH IT to the company to make you EVERY INDUCEMENT to buy this stock. AND IT IS CERTAINLY WORTH WHILE TO YOU TO BUY IT. Remember you profit immediately because as soon as you are a stockholder you can save 25 per cent on all the tires you buy.



Rubber Vault. In This Vault Are Stored Thousands and Thousands of Pounds of Uncured Rubber for Tire and Tube Making. It is Stored Here Just as It Comes from the Ships.

WAITING FOR A MIRACLE

Every man hopes, some day, that by some wonderful miracle he will be lifted out of the life of drudging toil he leads into one of affluence, comfort and independence. It is our nature to live in this HOPE. But the day of miracles is past. Good fairies do not run around with bags of gold and drop them into the laps of the worthy.

YOU'VE GOT TO HELP YOURSELF TO FORTUNE. You've got to save to get a nucleus of money to invest where



Tube-making Department. Here Are Made the Famous National Red Tubes. The Factory is Producing 1,000 Tires a Day.

the opportunities for profit are large. BUT YOU'VE GOT TO INVEST YOUR SAVINGS, if you want them to pay big returns.

One of the world's greatest bankers has said that NO MAN WILL EVER GET RICH FROM THE SAVINGS OUT OF A SALARY OR WAGES. He must accumulate wealth by PUTTING THESE SAVINGS TO WORK, INVESTING THEM TO ADVANTAGE.

Of course, it takes COURAGE to invest money that you have worked hard for, that has been slowly and laboriously accumulated by privations and sacrifices. But IT IS THE COURAGEOUS WHO WIN THE EARTH.

DON'T INVEST ALL YOUR SAVINGS. That wouldn't be the wise course. Keep a reserve of your savings for eventualities, for sickness or loss of position or unexpected calls, BUT INVEST PART OF YOUR SAVINGS WHERE THEY CAN EARN YOU SOMETHING WORTH WHILE.

INVEST FUTURE SAVINGS

Or better still, HERE IS A PLAN BY WHICH YOU CAN ACQUIRE THIS STOCK WITHOUT TOUCHING YOUR SAVINGS.

BUY WHAT YOU CAN AFFORD TO PAY FOR OUT OF YOUR NEXT SAVINGS

The directors have made it EASY FOR YOU TO GET THIS STOCK AND PAY FOR IT OUT OF YOUR FUTURE SAVINGS.

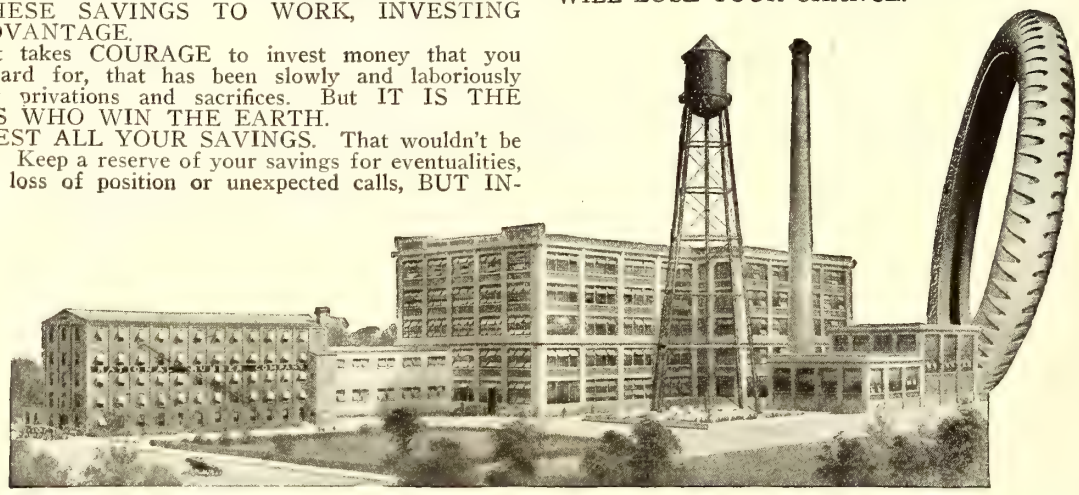
You can pay down $10 ON EVERY TEN SHARES OF STOCK YOU WANT AND PAY THE BALANCE IN FOUR EQUAL PAYMENTS OF $10 A MONTH for each 10 shares, making the total of $50 for the ten shares, par value $100.

This liberal plan makes it possible for you to buy this stock and pay for it WITHOUT TOUCHING THAT PRECIOUS CASH RESERVE you have been accumulating in the bank so carefully.

BUT WHATEVER YOU DO, DON'T OVERLOOK THIS OPPORTUNITY. You'll never get another such chance. This first allotment of 20,000 shares at $5 a share (par value $10 a share) will be snapped up so quickly that WE CONFIDENTLY EXPECT EVERY SHARE TO BE TAKEN UP WITHIN TEN DAYS from the publication of this announcement. After that, there will be no more $5 shares. The price will jump perhaps 40 or 50 per cent. SO ACT NOW.

Fill out the convenient coupon attached. Mail it with your first payment, which will RESERVE the stock you want at this LOW PRICE. Then you can take fifteen days to investigate, to make sure that all the facts are just exactly as represented to you. If you, for any reason whatever, are not satisfied, you can release your reservation and your money will be returned to you, but if you find out that you have invested wisely—as we are confident you will find out—then you can either pay the balance in full or you can take advantage of the easy method of paying for it, a little each month. Either plan is equally satisfactory to the directors of the National Rubber Company of New York.

IF YOU WANT ANY OF THIS UNDERWRITERS' STOCK, YOU'VE GOT TO WRITE NOW, at once, OR YOU WILL LOSE YOUR CHANCE.



The Magnificent Pottstown, Pa., Plant of the National Rubber Company, Where National Speedway Redwall Tires and National Red Tubes Are Made. Two Floors of This Big Building Are Completed and Occupied. This Is a Strictly Modern Steel, Concrete and Glass Construction Factory Building of the Highest Type. The Big Tire Coming Out of the Building is the National Speedway Redwall Tire, Best on the Market.

How You Can Buy This Stock

10 shares (par value $100)

$10 down, $10 a month for 4 months.....$50

15 shares (par value $150)

$15 down, $15 a month for 4 months.....$75

20 shares (par value $200)

$20 down, $20 a month for 4 months.....$100

30 shares (par value $300)

$30 down, $30 a month for 4 months.....$150

40 shares (par value $400)

$40 down, $40 a month for 4 months.....$200

50 shares (par value $500)

$50 down, $50 a month for 4 months.....$250

$100 shares (par value $1,000)

$100 down, $100 a month for 4 months.....$500

APPLICATION FOR UNDERWRITERS' SHARES

E. E.

NATIONAL RUBBER COMPANY OF N. Y., Pottstown, Pa.
Main Office: National Rubber Bldg., Broad and North Sts.
PHILADELPHIA, PENNA.

Date.....191....

The undersigned hereby subscribes for.....shares of the Common Stock of the National Rubber Company of New York, full paid and non-assessable, and tenders herewith.....
(Bank Check or Money Order)

to the order of National Rubber Company of New York for $....., at the rate of $5.00 per share {full / part} payment.

STOCKHOLDER'S DISCOUNT—It is understood that in consideration of this subscription as long as I remain a shareholder of record on the books of the Company, I am to receive a Net Cash Discount of not less than twenty-five Per Cent (25 per cent) from the Company's regular Printed Price List, on any goods listed therein which I may buy for my own use. I am to have 15 days from date in which to investigate all statements made by the Company.

Issue shares in the name of..... and forward to addres below:
(Print Name Plainly)

(Subscriber's Signature) .....

(Street Address) .....(Town and State) .....

QUESTION BOX.

(*Continued from page* 130)

former, having a secondary potential of 10,000 volts. This to charge a group of four Murdock block condensers that will be connected in parallel. The discharge to take place in a quenched spark gap linked to a primary of an inductive oscillation transformer. The secondary to be connected in the usual way to the antenna and ground terminals. What I desire to know is what size of capacity of condenser is required to reduce the wave length of my oscillating system so as to conform to the Government's 200 meter wave length regulation? What formula do you employ in determining this capacity?

A. 2. The required formula is:

$$C_1 = \frac{\lambda^2 C}{3552 L C - \lambda_1};$$

Where

C_1 is the capacity of the series ground condenser for reducing the wave length

λ_1 = wave length desired (here it is 200 meters)

C = Capacity of the antenna

L = Inductance of antenna

Having calculated the values of the capacity of the antenna .0004 mfd.; inductance 62,090 cm., we then determine the desired capacity by substituting in the above formula and we get:

$$C_1 = \frac{(200)^2 \times .0004}{3552 \times 62090 \times .0004 - (200)^2};$$

Solving, we get .003 micro-farad, the capacity of the condenser necessary to reduce the wave length of the antenna to 200 meters.

ELECTRON DISCHARGE.

(790.) Louis Bradenburg, Little Rock, Ark., wants to know:

Q. 1. Does the effect of light upon selenium crystal produce a purely electronic discharge?

A. 1. This question is still in the hands of some prominent physicists, and they have not come to any conclusions on this mysterious problem, and for this reason we are unable to give you an exact answer. We should recommend, however, that you read an article on selenium in this issue, written by two of the most prominent and able scientists on this subject.

Q. 2. I have had an idea for a number of years to make an electronic detector for converting high frequency currents to direct or pulsating currents, or in other words an instrument similar to the Fleming Valve and de Forest Audion. Now what I desire to know is, what chemical will produce an electronic field sufficiently strong for producing the same effect as that of the lighted filament? Also, was there any such device ever made?

A. 2. Dr. J. A. Fleming, the inventor of the Fleming Valve, has built electronic tubes employing an exhausted vessel in which an amalgam of Sodium and Potassium was placed in such a manner that it produced an electronic field when a beam of light was focussed upon its surface and in addition a secondary plate was placed within the focus of the electronic stream. The secondary and sodium-potassium plates were used for the rectifier circuit of the electronic tube.

The two most generally used of all the metals and alloys for the production of an electronic field are chemically pure and highly polished rubidium metal and an alloy composed equally of sodium and potassium metals.

TONE CIRCUIT.

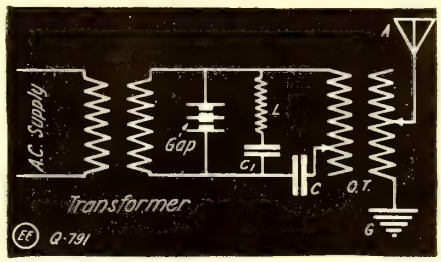
(791.) Roy Jansen, Houston, Tex., asks:

Q. 1. What does a "tone" circuit consist of and how is it connected to a radio transmitter?

A. 1. A tone circuit consists of nothing more than an oscillatory circuit shunted across the gap. This circuit is shown here and it is only used in an impulse exciting transmitter usually. The tone circuit is represented by the oscillatory circuit L C_1. A large capacity and a small inductance is used.

Q. 2. Is this circuit tunable? If so, how?

A. 2. The tone circuit is tuned to some multiple or sub-multiple of the impulse frequency. This is usually accomplished by varying the tone circuit condenser capacity. It should be kept in mind, that a tone circuit does not improve the tone emitted by the transmitter in every type of gap, as it was found by actual experiment that at times it is even detrimental to the tone. They are usually employed on low tension arc or spark transmitters such as the Von Lepel or Chaffee Arc.



Arrangement of Tone Circuit in the Von Lepel and Chaffee Arc Radio Transmitter.

MAGNETIC TELEPHONE.

(792.) William Olsen, Jamaica, L. I., desires to know:

Q. 1. What is the principle upon which two ordinary telephone receivers when connected together can transmit the human voice from one place to another by talking to the diafram of either of the two receivers?

A. 1. The principle of operation of such a telephone is identical to the production of electric current by a dynamo-electric machine, in that when a magnetic field is permitted to be interrupted by a wire near its field, a current of electricity is produced in that wire and the intensity of the generated current is dependent upon the rapidity with which the magnetic field is interrupted and the intensity of the field. It is identical with the magnetic telephone where the permanent magnet of the receiver furnishes the magnetic field, the coil of wire or electro-magnet represents the wire, while the interruption of the magnetic field is obtained in this case by the vibration of the magnetic diafram. When the diafram of the receiver is caused to vibrate by "talking," the magnetic flux is varied; generating a current in the coil which operated the distant receiver.

MEDICINE HAILS ELECTRICITY.

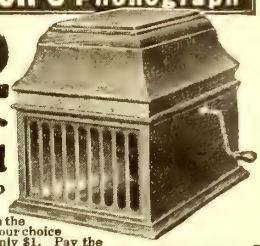
"The day of the howling dervish in electro-therapeutics is past," declared Dr. S. Solis Cohen in the meeting recently of the Philadelphia County Medical Society, "and the science now has a definite, dignified place in the estimation of the medical profession and of the public."

"We must confess with shame," said Dr. S. Lewis Ziegler, "that the greatest advances in the application of electricity to medicine have come thru laymen and not doctors."

Dr. A. B. Hirsh traced the history of electro-therapeutics, and declared that an astonishingly large number of diseases responded to electric treatment.

Mr. Edison's Wonderful Phonograph

Only $1.00 After Free Trial



Yes, you may keep this new Edison—Thomas A. Edison's great phonograph with the diamond stylus—and your choice of records, too, for only $1. Pay the balance at rate of only a few cents a day. Try the New Edison in your own home before you decide to buy. Send no money down. Entertain your friends with your favorite records.

Write Today For Our New Edison Book. Send your name and address for our new book and pictures of the New Edison phonographs. No obligations.

F. K. BABSON, *Edison Phonograph Distributors*
A744 Edison Block, Chicago, Illinois

Never Mind How STRONG You are—

What d'ye Know?



Today it's a battle of wits—and *brains win.* Muscle and brawn don't count so much as they used to.

The great question now is "What do you know?" It draws the line between failure and success.

What do *you* know? Have you special ability in any one line? Could *you* "make good" in a big job right now?

For 25 years the International Correspondence Schools have been helping men to get ready for better work and bigger salaries. They can do the same for YOU. No matter where you live, what hours you work, or how little your education—the I. C. S. can train you for a more important and better-paying position.

Mark and mail the attached coupon—it won't obligate you in the least—it won't cost you anything to find out how you can get this salary-raising ability right in your own home, during your spare time.

MARK THE COUPON NOW

TEAR OUT HERE

INTERNATIONAL CORRESPONDENCE SCHOOLS
BOX 5347, SCRANTON, PA.

Explain, without obligating me, how I can qualify for the position, or in the subject, *before* which I mark X.

☐ ELECTRICAL ENGINEER	☐ SALESMANSHIP
☐ Electric Lighting	☐ ADVERTISING
☐ Electric Railways	☐ Window Trimmer
☐ Electric Wiring	☐ Show Card Writer
☐ Telegraph Engineer	☐ Sign Painter
☐ Telephone Work	☐ Railroad Trainman
☐ MECHANICAL ENGINEER	☐ ILLUSTRATING
☐ Mechanical Draftsman	☐ Cartooning
☐ Machine Shop Practice	☐ BOOKKEEPER
☐ Gas Engine Operating	☐ Stenographer and Typist
☐ CIVIL ENGINEER	☐ Cert. Pub. Accountant
☐ Surveying and Mapping	☐ TRAFFIC MANAGER
☐ MINE FOREM'N OR ENG'R	☐ Railway Accountant
☐ Metallurgist or Prospector	☐ Commercial Law
☐ STATIONARY ENGINEER	☐ GOOD ENGLISH
☐ Marine Engineer	☐ Teacher
☐ ARCHITECT	☐ Common School Subjects
☐ Contractor and Builder	☐ Mathematics
☐ Architectural Draftsman	☐ CIVIL SERVICE
☐ Concrete Builder	☐ Railway Mail Clerk
☐ Structural Engineer	☐ AUTOMOBILE OPERATING
☐ PLUMBING AND HEATING	☐ Auto Repairing
☐ Sheet Metal Worker	☐ Navigation
☐ Textile Overseer or Supt.	☐ AGRICULTURE
☐ CHEMIST	☐ Poultry Raising

☐ Spanish ☐ German ☐ French ☐ Italian

Name_____

Present Occupation_____

Street and No._____

City_____ State_____



Save Dictating Time

USE THE DICTAFORM

If you are at present keeping one or more stenographers busy—you need the Dictaform. It will mean the saving of valuable time in the handling of your correspondence. Surprisingly few letters require special dictation. The Dictaform enables you to build a letter-writting system to fit your own business, and gives you stronger, more forceful letters.



SOME USERS

Carson Pirie & Scott — Bryant & Stratton
Addressograph Co. — Henry Bosch Co.
Wm. J. Wrigley, Jr. — Link Belt Co.
Kunstadter Bros. — Royal Tailors
Commonwealth Edison Co.

Banish Dictating Bother

The Dictaform places at instant reference paragraphs, phrases and arguments sparkling with your own individuality. You think out your strongest answers to a question, classifying the argument under its proper heading, and put it into the Dictaform. Through continuous use of these prearranged paragraphs and letters you will be able to get out, at a fraction of the former cost, ten times the volume of correspondence possible if each letter was dictated separately.

A Score of Other Features

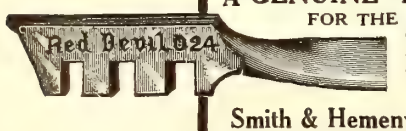
It makes an ideal tickler—on the back of the first thirty-one cards is our patent clip for the holding of memos., etc. The DICTAFORM also places before you your prices, sizes, weights, descriptions, ideas, campaign schedules, proofs of cuts, cost estimates, time tables, lists, addresses, phone numbers—in fact everything to which you have occasion to refer.

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HIGH FREQUENCY PHENOMENA.

(793.) S. Kohn, Brooklyn, N. Y., asks:

Q. 1. Can you explain the following phenomena which I recently observed during certain experiments which I have carried on with a Tesla high frequency coil?

A large primary of a loose coupler was located near the Tesla coil; this was about 3 feet away from the same, and it was not connected to anything. As the Tesla transformer was set in operation, I have noticed streaks of sparks escaping the winding of the isolated coil. If it is possible, I should like you to enlighten me on this phenomena.

A. 1. The phenomena which you have observed is due to the striking resonance effect existing between the Tesla coil and the primary coil; since the resonance was pronounced, due to the effect noticed, the electrical energy transformation between the produced oscillations of the high frequency coil and that of the isolated coil is at maximum; consequently, the discharge of sparks from the coil was produced. These resonance high tension and frequency experiments were carried out first by Nikola Tesla, and he was able to obtain sparks which reached in magnitude from five to six feet in length.

TRANSFORMER FORMULA.

(794.) L. Kennedy, Los Angeles, Cal., wants to know:

Q. 1. In the design of a radio transformer, what are the most important precautions that must be taken in order to build an efficient transformer?

A. 1. There are a few important steps that the designer must observe when designing a transformer, namely: the voltage transformation between the primary and secondary, the latter should be made to correspond with the proper sending condenser capacity, and this must be obtained beforehand; the proper arrangement of secondary pies, separated with proper insulation, and finally, the magnetic circuit in which great care must be exercised in designing the same, as 75 per cent of the efficiency will be in this magnetic circuit. The proper number of cubic inches of core is at first found; this is then split up into suitable form, the legs of which should correspond to the primary and of the secondary windings.

Q. 2. What is the relation existing between the primary winding and voltage of a transformer?

A. 2. The relation of the two factors is exprest by the following formula:

$$N_p = \frac{10^8 \times E_p}{\sqrt{2\pi}\, f\, B\, A_c}$$

Where

N_p = Number of turns on primary winding
E_p = Voltage across primary
f = Frequency.
B = Magnetic flux of core (per sq. cm. of cross-section of the iron core)
A_c = Area (express in square centimeters of the cross-section of the iron core)

Q. 3. What do you consider the best insulation material for covering the core when the winding is to be made?

A. 3. Empire cloth is very excellent for this work and it is universally employed for this purpose.

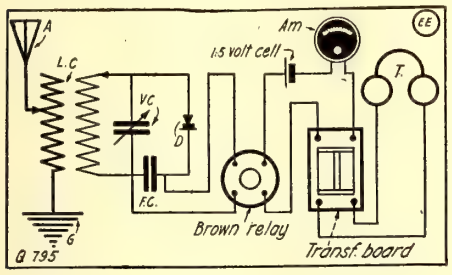
THE "BROWN" TELEPHONE RELAY.

(795.) Frank Vontair, Philadelphia, Pa., desires to know:

Q. 1. Is the "Brown" relay, which is used in England, a microphone device?

A. 1. This type of instrument is a

purely microphonic device and the microphone is controlled by a super-sensitive telephone relay. A more complete detail of this device was published in the August, 1915, issue of this journal.



Connection of the "Brown" Amplifying Relay in the Circuit of a Radio Receptor.

Q. 2. What is the binding post connections of this relay? How is it connected to a wireless receiving set?

A. 2. The accompanying diagram gives the connections.

Q. 3. Are these instruments used extensively in this country?

A. 3. No, they are mostly used abroad, especially in England.

MERCURY RECTIFIER.

(796.) Thomas Pierson, Richmond, Va., wants to know:

Q. 1. What is the efficiency of a mercury arc rectifier?

A. 1. The efficiency of this device varies with circumstances and depends largely upon the load voltage. There is a certain drop or lost voltage in the tube, usually 15 to 25 volts, which is practically independent of the load and the energy thus represented appears as light and heat. So if a set was delivering current at a potential of 15 to 25 volts, its efficiency under these conditions would be, roughly speaking, about 50 per cent. But this is rarely the case, and in most commercial installations of constant potential sets, the full-load efficiency is over 80 per cent and the efficiency of most constant current sets will be over 90 per cent at full load.

Q. 2. What is the life of a mercury rectifier tube?

A 2. The average life is about 700 hours, but many cases are known where the tubes have run much longer.

Q. 3. What is the power-factor of such a rectifying system?

A. 3. On a 50 light set the power-factor on the primary of the constant current transformer is about 65 per cent. On constant potential systems it may reach as high as 90 per cent.

MEASUREMENT OF IRREGULAR AREA.

(797.) Paul Andel, New Orleans, La., asks:

Q. 1. What are the principal methods for determining the area of an irregular plane surface such as those obtained from indicator cards, etc.?

A. 1. There are three general methods for obtaining the area value of irregular plane surfaces and the simplest of the three is by employing a "planimeter" instrument, a device which automatically figures out the area of the plane in question. Such an instrument consists of a wheel of definite circumference, which revolves when the lever attached to this wheel is caused to trace the perimeter of the irregular surface.

A second method is by forming a large number of small squares within the

(*Continued on page* 140)

BOOK REVIEW

THE SUBMARINE TORPEDO BOAT. By Allen Hoar. Cloth covers; size 8x5¾ inches; 212 pages, 84 illustrations and 4 folding plates. Price, $2.00. Publisht by D. Van Nostrand Co., New York City, 1916.

One of the most valuable and popular treatments of this all-important subject which is at the present time of interest to readers of all classes. Unlike a great many books of this nature dealing with such a specific and technical subject as the submarine torpedo boat, Mr. Hoar has given us a well-written and lucid description of this marvelous twentieth century war machine. The engineer and layman will both profit by perusing the interesting chapters of this authoritative writer, who is a junior member of the American Society of Civil Engineers. The various chapters take up the early history and development of the submarine torpedo boat, and contain some very interesting illustrations and photographs of practically every distinct type of submarine ever built. The succeeding chapters deal with the development of the present day submarine; its characteristics and requirements; types of submarines; the design of the submarine torpedo boat; the power plant; means of defense against submarine attack; tactical evolutions of the submarine; the torpedo; tenders and salvage ships; submarine mines, etc.

Some of the most interesting sections of the book deal with the approved manner of maneuvering a submarine in order to torpedo an enemy vessel, and also discuss authoritatively the various technical aspects developing in the general operation and handling of the submarine torpedo boat.

AMERICAN BOY'S BOOK OF ELECTRICITY. By Charles H. Seaver. Cloth covers; size 8x6 inches; 366 pages, 313 illustrations. Price, $1.50 net. Publisht by David McKay, Philadelphia, Pa.

The American boy is always interested in a good book treating on electrical experiments of a practical and interesting nature. There have been a great many books written in the past few years, intended for the electrically inclined youths of the land, but we do not remember seeing a more worthy volume in a long time than here presented by Mr. Seaver. The volume is profusely illustrated with clear-cut drawings, which can be readily understood by young boys of from ten to fourteen years, and all of the important fundamental magnetic and electrical laws with their accompanying actions and reactions have been cleverly and interestingly woven thru the experiments outlined.

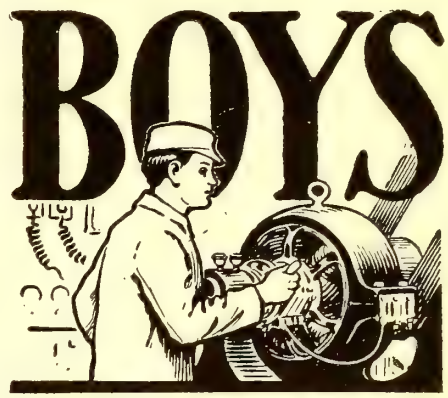
A number of excellent half-tone illustrations are inserted, showing modern electrical appliances, so that as the boy studies the different experiments and simply explained laws, he will also be given a clear understanding of the relation between such experimental apparatus and the commercial instruments and appliances. Mr. Seaver is to be congratulated upon the adaptness with which he has combined these two important fields of electrical endeavor, so that the young reader will not become confused or discouraged by his inability to understand the underlying theory of the apparatus described.

The book describes how to build substantial experimental apparatus such as small dynamos and motors; induction or spark coils; telephone and telegraph apparatus; a complete wireless station of improved design; how to do simple house wiring in accordance with the standard rules; how to wire ignition circuits on gasoline engines of the single and multiple cylinder type; how to build small transformers and the principles upon which they operate; how to build primary and storage batteries; the action of lightning discharges and how to protect buildings from them, and also a considerable number of electrical experiments in static electricity. We strongly recommend this book to the American boy.

EXAMPLES IN ALTERNATING CURRENTS. Vol. 1, Second Edition. By Prof. F. E. Austin, B.S., E.E. Flexible green leather covers, pocket style; size 7½x5 inches; 224 pages, 75 illustrations with numerous tables. Price, $2.40. Publisht by the Author at Hanover, N.H.

The second edition of this valuable treatment of alternating-currents contains a number of ad-





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☐ Electrical Draftsman	☐ RAILROADER
☐ Electric Machine Designer	☐ ILLUSTRATOR
☐ Telegraph Expert	☐ DESIGNER
☐ Practical Telephony	☐ BOOKKEEPER
☐ MECHANICAL ENGINEER	☐ Stenographer and Typist
☐ Mechanical Draftsman	☐ Cert. Pub. Accountant
☐ Machine Shop Practice	☐ Railway Accountant
☐ Gas Engineer	☐ Commercial Law
☐ CIVIL ENGINEER	☐ GOOD ENGLISH
☐ Surveying and Mapping	☐ Common School Subjects
☐ MINE FOREM'N OR ENG'R	☐ CIVIL SERVICE
☐ Metallurgist or Prospector	☐ Railway Mail Clerk
☐ STATIONARY ENGINEER	☐ Textile Overseer or Supt.
☐ ARCHITECT	☐ AGRICULTURE ☐ Spanish
☐ Architectural Draftsman	☐ Navigator ☐ German
☐ PLUMBING AND HEATING	☐ Poultry Raising ☐ French
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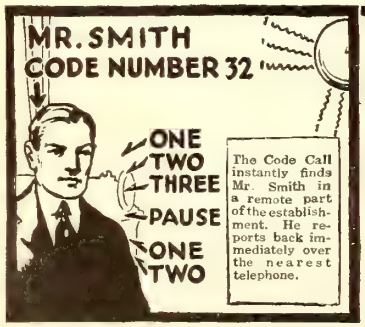
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ditions and revisions, and will be found extremely valuable to all students of this subject. Some of the more practical examples given in alternating-current calculations involve frequency, power factor, harmonics, induced A.C. pressures, and the various specific values of A.C. potential, such as the instantaneous and effective values, etc., etc.

Many practical problems are explained by means of examples, and in accordance with the best modern methods, covering such topics as the addition of sine pressures; the product of sine curves having the same frequency but different phase displacements; the calculation and measurement of inductance coils, including the simple measurements of this important factor by means of a volt meter, ammeter and frequency meter, and including the new inductance formula due to Brooks and Turner. Further sections of the work treat on the inductance of transmission lines and various current and voltage relations, etc., when two or more impedances are connected in series or in parallel. Also the method of computing capacity of condensers, and the current taken by them when connected to A.C. circuits. The work concludes with a number of valuable tables containing the products of 2 x pi x frequency, and modifications of this expression, which are used so frequently in alternating-current computations.

HOW TO MAKE LOW PRESSURE TRANSFORMERS. Third Edition, by Prof. F. E. Austin, B.S., E.E. Board covers; size 7¼x4¾ inches; 22 pages, 16 illustrations. Price 40 cents. Publisht by the author at Hanover, N.H.

Another addition of Prof. Austin's treatise on the design and construction of small, low-pressure transformers which has found considerable favor. The work takes up numerous practical operations to be followed in constructing step-down transformers for ringing bells, and for other operations, and also a design for a transformer giving as high as 174 volts when run on a 110 volt A.C. circuit. Data is given for these transformers for use also on 220 volts, 60 cycle A.C. circuit. The text matter is written in a clear manner which can be followed by any amateur and the illustrations are made in perspective so as to show explicitly just how the various iron core strips are assembled and clamped together, and also how the coil windings may be wound in sections to simplify the construction.

APPLIED ELECTRICITY FOR PRACTICAL MEN. By Prof. Arthur J. Rowland. Cloth covers; size 5x7½ inches, 375 pages, 323 illustrations. Price, $2.00. Publisht by the McGraw-Hill Book Co., New York City.

This book has been prepared by an author of wide experience in teaching practically and theoretically the subject to students, and he has incorporated many valuable ideas in the matter presented. We believe this work should prove extremely valuable to electricians of all classes, as it contains all the fundamental electrical principles which are discust in an approved yet somewhat new manner, and gradually the student is introduced to the principles and practical operating features of dynamos; motors; electric heating apparatus; the wiring of switchboards and power plants; principles of the electric trolley system; alternating-current systems, including the various types of commercial transformers, and just how they operate and why; poly-phase current principles; alternating-current motors; storage batteries; electric circuits and wires and wiring.

Unlike many volumes of this nature, the author has seen fit to not only explain each subject in simple language at the start, but also to give the elementary formulas governing the theory and operation of these various electrical apparatus and circuits. The general electrical student will find this work of distinct value, and to enhance the value of each lesson he has studied, there are a number of questions and problems given at the end of each chapter which the student can work out.

THE SCIENCE OF MUSICAL SOUNDS. By Prof. Dayton Clarence Miller, D.Sc. Cloth covers; size 8¾x6 inches, 286 pages, 187 illustrations. Price, $2.50. Publisht by the MacMillan Co., New York City, 1916.

This work by Prof. Miller treating on the science of musical sounds is one of the most pretentious science works that we have ever reviewed. A vast array of sound producing and analyzing apparatus of both simple and complicated structure are described and illustrated. The text matter is exceedingly clear, and can be readily understood by any student of music or physics. The author starts off with the definition of sound, and proceeds to give many illuminating details that the average physics student will find both new and interesting.

Every conceivable form of tuning fork and siren for producing sounds of any pitch or frequency is profusely illustrated and described. Among the subjects discust in a popular scientific manner, so that it may be enjoyed by the lay reader as well as the student of pure physics, are the action of organ pipes (including illustration of an organ pipe over 32 feet in length and giving sixteen vibrations per second), and such further practical considerations as standard tuning forks; the law of tone quality; the manometric capsule and revolving mirror, and also the use of the phonograph and Professor Miller's own invention, the "Phonodeik," by which apparatus it has become possible to intercept a sound wave such as a person's voice, and to project these, magnified many hundred times, upon a screen so that the voice fluctuations can be studied by a large body of students. The phonodeik is so remarkably sensitive to sound waves, that it will respond to a frequency of ten thousand complete vibrations per second.

The subject of harmonics has received special attention, and considerable discussion is given on the different types of harmonic analyzers, including the remarkable machine as used by the U.S. government for predicting the rise and fall of tides. Among other interesting subjects covered in this book, we find oscillogram curves of the voices of such famous singers as Signor Caruso and Amato. Also such an interesting subject as the influence of horns on sound, and the importance of diaframs in certain instruments. The principle of musical instruments, such as the piano, flute and violin are discust, and the music produced by them shown grafically by means of oscillogram curves. One of the most interesting chapters is that treating on synthetic vowels and words, and the relation of the art and science of music which is illustrated by many remarkable cuts of apparatus which have been developt for emitting vowel sounds.

A remarkable illustration is that showing the large group of organ pipes necessary, which when sounded simultaneously reproduce the vowel a, as in "mat," and still another illustration shows the vast number of organ pipes required to reproduce the principal vowels synthetically.

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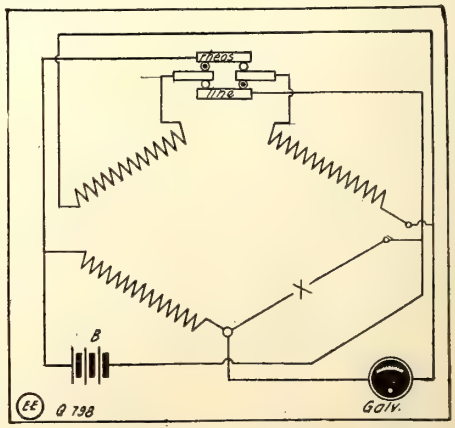
(*Continued from page* 139)

boundary of the plane surface, and determining the area of one of these squares, then multiplying the area of each by the total number of them within the surface. This will give an approximate area, since it is impossible to erect squares close enough to the irregular curves of the plane surface.

The third and most accurate method is by the use of higher mathematics: where a limiting value of the maximum and minimum peaks of the perimeter of the surface is obtained by actual measurement, and substituting this value in an integral equation as used in the Calculus. Some engineers weigh a sq. cm., or inch of the chart paper and then, by a simple calculation, compute the area of the irregular surface.

WHEATSTONE BRIDGE CIRCUIT.

(798.) John Brown, San Diego, Cal., wishes to know:



How a Reversing Key Is Connected in a Wheatstone Bridge.

Q. 1. How are the connections made of a Post Office type of Wheatstone bridge so that the resistance arms are reversed in the circuit? I understand this arrangement is used in eliminating errors in measurements which may be due to polarity interferences acted upon the galvanometer.

A. 1. The diagram herewith gives the proper connections of the instrument you mention. The reason for reversing the connections of resistance arms is to eliminate the errors produced by cross-currents in the circuit. By obtaining two sets of readings for both reversed positions of the arms, such errors are limited to a minimum.

ALUMINUM QUERIES.

(799.) Joseph Hassel, Boston, Mass., asks:

Q. 1. What are the ores used in the production of commercial aluminum?

A. 1. Aluminum oxid is the main source out of which aluminum is extracted. Bauxite, a hydrated oxid of aluminum, is extensively used.

Q. 2. How is the metallic aluminum obtained?

A. 2. The only process used at present for the extraction of aluminum is an electrolytic one. The electrolyte consists of a solution of aluminum oxid in melted cryolite. The cryolite is not decomposed, but serves as a solvent only. The mineral Bauxite is used to furnish the oxid. The cryolite is fused and kept liquid by the heat generated during the passage of the current; the dissolved aluminum oxid is separated into aluminum and oxygen by the current. The aluminum collects as a molten mass in the bottom of the melting pot; the oxygen is liberated at the anodes, which are oxydized by it. The weight of the anodes consumed about equals the weight of the aluminum liberated.

TELEVISION.

(800.) Thomas Jelinder, Hartford, Conn., asks:

Q. 1. Was television ever brought to a practical stage?

A. 1. No.

Q. 2. What method did Mr. Ernest Ruhmer of Berlin use for his television apparatus?

A. 2. He employed a large number of selenium cells placed before a similar number of lenses. Each of these cells corresponded to a "single eye," similar to the human eye, and the reflection of light from the object, the image of which was to be transmitted, was caused to fall upon the various selenium cells. These cells were connected to a corresponding number of electro-magnets which controlled a number of diaframs. These diaframs were set in operation in unison with their proper selenium cells at the transmitting station. A rectangular image was possible with this arrangement. It was used to transmit letters, as it was imperfect enough to be used to differentiate the actual colors of a photograph or image of a human countenance.

A number of suggestions have been made to develop a television scheme, but the inventors only went as far as making suggestions, but never went into the trouble of bringing out their ideas experimentally.

TRANS-PACIFIC RADIO COMMUNICATION SUSPENDED.

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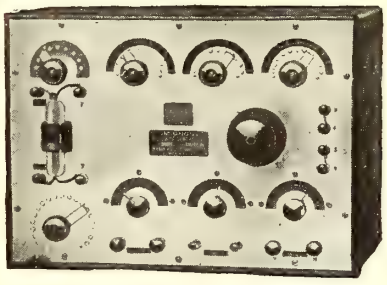
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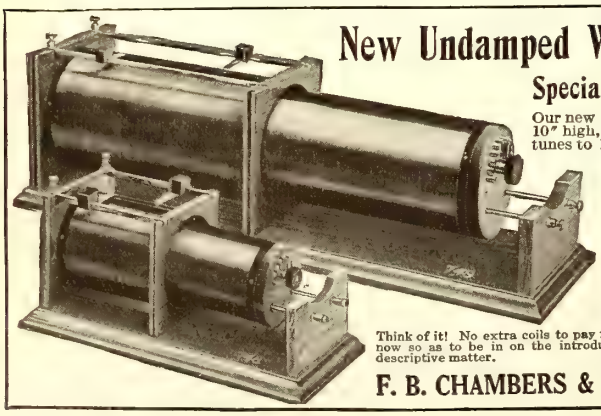
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Special Introductory Price, $18.00

Our new coupler No. 749 is 32" long, 9" wide, and 10" high, over all, and on an average-sized Antenna tunes to 15,000 meters. This coupler, used with the new CHAMBERS' SYSTEM or CIRCUIT, will bring in signals from domestic and foreign Arc Stations surprisingly loud and clear. Note the difference in size of our No. 748 and No. 749.

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CHANCES FOR ELECTRICIANS IN THE NAVY.

(*Continued from page* 86)

reciprocating steam engines, steam turbines, internal-combustion engines, magnetism and electricity, dynamos, motors, motor-generators, alternating currents, interior communication, lighting, batteries, etc. Members of the radio class are trained in all the duties of a radio operator and are given constant practice in the use of all the apparatus employed in radio and especially in receiving and sending by the systems employed in the Navy.

Enlistments in the Navy are for a period of four years. A man will not be advanced to chief electrician (with rank of chief petty officer) during his first enlistment, but he may be recommended for that position towards the completion of his first enlistment, with a view to advancement upon re-enlistment if any vacancy exists.

NEW METHOD OF MEASURING PRESSURE OF LIGHT.

(*Continued from page* 102)

The 32 c.p. lamp was enclosed in a metal box whose front face had been replaced by a glass screen covered with a few thin wires. Inasmuch as it is required that the radiation should be normally incident, the lamp was not brought too close to the tube, a calculation of the limiting approach having been previously made. The current passing thru the lamp was maintained at the same value thruout all the experiments. The reflecting and transmitting powers of the foils used were then tested. Gold and aluminum reflected 90 per cent of incident radiation.

Calculation of the Deflection of the Strip.—Since the foil reflects 90 per cent of the incident radiation, and since 7 per cent is reflected from the glass of the tube, the total pressure of the radiation is given by

$$E(1+0.07\times0.9)(1+0.9) \text{ or } 2.04E,$$

where E is the energy density of the incident beam.

A certain amount of radiation, however, strikes the back of the glass tube, and some of this is reflected to the back of the strip. For a strip three-quarters the width of the tube it is estimated that the normal component of this radiation is about 1 per cent of all that is incident on the strip. It is, therefore, necessary to substitute $2.02E$ for $2.04E$.

It can be shown that a uniform flexible strip when deflected by a small uniform pressure still remains straight. To a close degree of approximation, therefore, we may calculate the deflection of a strip such as that represented in Fig. 1 by taking moments about the axis of rotation. The details of apparatus used are given in the original paper, as well as the thermo-kinetic reaction and a table of results observed in succession.

ELECTROLYSIS SURVEY PROPOSED IN MONTGOMERY, ALA.

The Bureau of Standards has been asked to make an electrolysis survey in Montgomery, Ala

DENVER WIRELESS STATION WINS PRIZE LOVING CUP.

(*Continued from page* 107)

the good times they used to have while working on the several relays which we have run for their benefit.

Next month we will start by giving some gossip about the famous *Washington's Birthday Relay*, and also give the first installment of a complete set of instructions about how to make a *Hall Wireless Relay*, as this instrument was shown in this magazine some time ago, under the list of patents issued; and as the writer has received a great number of inquiries concerning it, we believe that you will all be interested in reading about this instrument, which is very simple in construction, and which all of you may make, with just such tools and material as is always at hand in a radio laboratory.

The war will not last forever, Amateurs. Now is the time to make efficient instruments to be used after the war and to "brush up" on all Radio Matters.

DO YOU

own a wireless station, either for sending or receiving? If you do, don't fail to join the greatest Wireless Association in the country: THE RADIO LEAGUE OF AMERICA. If you believe in the preparedness of your country, if you wish to help Uncle Sam, if you wish to have your station **officially** recognized, join the LEAGUE, a national, non-money-making organization. Beautiful engraved and sealed certificate, FREE to all members. NO DUES OR FEES WHATSOEVER.

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L. Berman, 8 ML, Cincinnati
Scott High School, 8 ZL, Toledo
Merle Sager, 8 ASW, Tiffin
N. Thomas, 8 FX, Marietta
M. B. West, 8 AEZ, Lima
J. F. Eckel, 8 PL, Cincinnati
J. O. Hibbett, 1113, Ottawa
L. M. Clausing, 8 YL, Lima

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PENNSYLVANIA

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Chris. M. Bowman, 3 PC, Lancaster
High School Station, 8 JS, Bellefonte
L. & H. Alexander, 8 ALE, Grove City
R. R. Goodwin, No call, Roulette
M. H. Mandelkern, 3 MR, Philadelphia
Peabody High School, 8 YZ, Pittsburgh
W. & S. Shoop, RS, Vandergrift
F. J. Anderson, 3 QD, Reading
F. H. Brian, Smithport
C. H. Stewart, 3 ZS, St. David's
Nassau Bros., 3 CT, Philadelphia
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TEXAS

B. Emerson, 5 DU, Dallas
R. Corlett, 5 ZC, Dallas
J. L. Antry, 3 ED, Houston
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J. E. Krone, 3 TY, Newport News
A. N. Johnson, 3 TY, Newport News

WEST VIRGINIA

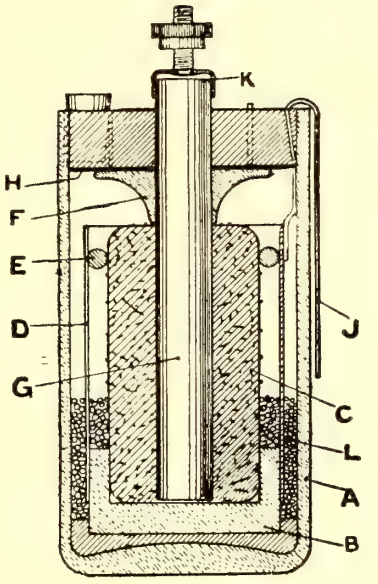
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TO RECHARGE THIS CELL—FILL WITH WATER.

The "H_2O" Cell, as it is termed by its English sponsors, was introduced to meet



New English Type of Primary Cell Which Is Recharged by Simply Filling It With Water. It Is Known As the "H_2O" Cell.

the demand for a wet cell smaller and more compact than the "Leclanché," and in this respect it appears to have gained its advantage. This cell may be stored for any length of time and in any climate without any deterioration. It is not liable to creeping or evaporation while in use. Its internal resistance is low, and it does not polarize in use so quickly as wet batteries of the "Leclanché" type, it is claimed.

The addition of water only is needed for charging, and its active life is equal to any high-grade cell of similar size. If the cell is required for instant use, it is recommended that the cell be filled with warm water; distilled water being used, if possible, as this tends to prolong the life of the cell by reason of the absence of iron or lime impurities, which are frequently found in hydrant water.

In order that the condition of the zinc electrode and the interior parts of the cell may be examined, the container consists of

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3—¼H.P. D. C., 110 volts, each $19.00; list price, $24.00. 3—⅛H.P., D. C., 110 volts, each $9.00; list price, $15.00. 1—½H.P., D. C., 110 volts, each $37.00; list price, $46.50. 1—1/16H.P., D. C., 110 volts, each $7.00; list price, $9.00.

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Remember, the War won't last forever, and when the ether is free once more for all, YOU want to be the first one to listen in with a REAL set.

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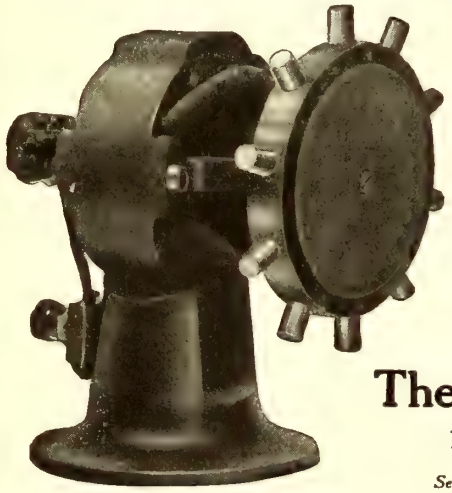
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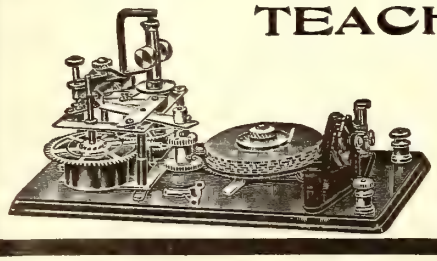
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a clear glass jar, A. (See diagram.) Into the bottom of this jar some bitumen is poured while in a hot condition. This serves to fix the porcelain base, B, in position. This base forms the support for the sack, C, keeping it in a central position, and also a support and spacer for the zinc cylinder, D, keeping it always the correct distance from the sack. It is this narrow space between the zinc and the sack which, to a large extent, makes the internal resistance of these cells so much less than Lechanché batteries. The top of the sack has a rubber ring, E, round it in order to further safeguard against the zinc cylinder touching the sack. Above the sack a specially shaped porcelain ring, F, is slipt over the carbon rod, G, and this serves as a support for a waxt cardboard disk, H, which supports the sealing compound. Two holes are arranged in the sealing compound and the cardboard washer; in one of these is a fiber tube. This tube forms the funnel thru which the water is poured when the cell is required for use, and is normally sealed with a cork. The other hole contains a small glass tube to allow the gases generated when the cell is in action to escape. A lead connection strip, J, is soldered to the zinc cylinder, and this is brought up at the side of the cardboard washer and thru the sealing compound. This lead strip is provided with a punched hole to allow of connection to an adjacent battery. A brass cap, K, is forced on to the carbon rod, and the nut for wire connections screws on to a pin riveted and soldered to the cap. The ammonium chlorid crystals, L, are placed in the cell at the time of manufacture; so that all that is necessary to make the cell ready for use is to remove the cork, fill the cell with water, and replace the cork.

POWERFUL HYDRO-ELECTRIC SALVAGE APPARATUS TO RAISE SUNKEN SHIPS.

(*Continued from page* 95)

may have gone ashore in shoal waters. Supposing that a vessel has become embedded in the sand. Upon arriving at the scene with one of the Linquist hydrostatic lifting units of the type already described, this is set up out in the deep water at a considerable distance, say one thousand to 1,500 feet from the vessel in distress, and a heavy cable is attached to the oceanward side of the vessel. In certain cases, and when necessary a line may be shot over the vessel to carry out this part of the operation. The cable which is secured to the stranded vessel is carried from the Linquist apparatus, and passes thru two large pulleys secured to a stationary truss on the base of the "fort," and in proximity to the vertical member of the lifting apparatus. The free end of the cable is secured to the top of the telescopic movable cylinder of the Linquist device, and this is made to rise by becoming more buoyant thru the agency of the electric pumps (supplied with electric power from the lines on shore), water being pumped out of the movable telescopic cylinder causing it to rise, and when this occurs a force of thousands of tons is brought into play, giving sufficient upward pull on the cable passing thru the stationary pulleys to haul the vessel off the shoal.

The inventor of this truly remarkable scheme for raising sunken boats, etc., says that if his device had been available at the time the U. S. Submarine F-4 sunk in the Honolulu harbor some time ago, that he could have raised the submarine in *four days* instead of taking four months, which was the time required by the only method available, when this deplorable accident

occurred. One of the divers who worked on the Submarine F-4 and who had negotiated depths of 306 feet (corresponding to a pressure of 135 pounds to the square inch) has seen the device and believes that Mr. Linquist's calculations as just cited are not only practical but feasible.

ELECTRICITY AND WATER TO RUN OUR AUTOS.

(*Continued from page* 88)

and air will eliminate all carbon deposits, and in so doing will add to the life and power of any motor, and that is not all, for we obtain our gas from water, which nature has provided abundantly, and so easy to secure that the cost is practically nothing.

Those interested in this electrolytic cell gas generator intended for a substitute for gasoline in driving automobiles will undoubtedly find interesting a U. S. patent on a similar cell, bearing the number 1,219,966 which is discust in the "Latest Patents" department on page 128 of this issue.

DECISION IN THE "HETERODYNE" RADIO RECEIVER CASE.

On April 2 Judge Mayer, of the United States District Court for the Southern District of New York, handed down an opinion in the suit of Samuel M. Kintner and Halsey M. Barrett, receivers of the National Electric Signaling Company, plaintiffs, vs. the Atlantic Communication Company, August Merckens, P. C. Schnitzler and K. G. Frank, defendants, in which he found for the plaintiffs. This suit was based upon a charge of infringement of United States letters patent 1,050,728 and 1,050,441, being respectively for the method and apparatus employed in a receiving station of a radio telegraph system. These patents, issued January 14, 1913, cover the invention known to the art generally as the "heterodyne" or beats method of receiving radio telegraph signals.

The court found that Reginald A. Fessenden, the inventor of this system, had produced an invention of great merit and entitled to a broad interpretation. He found that the prior art cited by the defendant as anticipating the Fessenden invention had failed to teach the art anything in respect to the use of beats and, at most, merely disclosed a local source for operating some particular form of receiver. He decided against the defendants' contention that the invention should be given a narrow construction, in view of an earlier patent of Fessenden.

The defendants' sole effort was directed towards securing a narrow construction of the patents. They contended that the Fessenden patents were not entitled to a broad interpretation but should be restricted to the use of the particular form of appliance shown in the issued patents. The court decided against this, holding the invention to be of such merit as to entitle it to a broad interpretation of equivalents.

The court also stated that Fessenden or his company, the National Electric Signaling Company, were the only ones to teach the art anything of value of this method of operation between the date of application of his original patent in 1902 and the date of applications for the patents in suit, 1905.

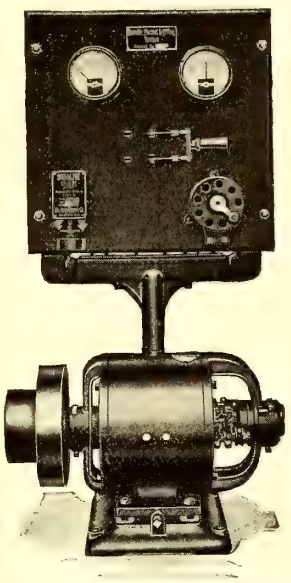
To overcome the difficulties of navigation in the Kara Sea the Russian Government has established three wireless stations that inform vessels of ice conditions.

A COMPACT FARM LIGHTING PLANT.

The farm lighting plant illustrated is rated at 1,000 watts and operates at 30 volts. In most cases a 2, 2½ or at most a 4-h.p. engine is required to run this system. The generator has a heavy flywheel pulley with tapered shaft.

A feature of this equipment is that regardless of variation in the number of lights being used, the generator will automatically furnish the current necessary for these lights, in addition to that which it has already been furnishing for charging the battery, thus allowing the battery to receive its normal charging rate automatically, regardless of the number of lights being turned on and off. An automatic electric governing winding is incorporated in the design which prevents the variation in the lighting load from affecting the amount of current going into the battery. Lights may be used at any time either direct from the generator, if the engine is running, or direct from the battery, if the engine is not running.

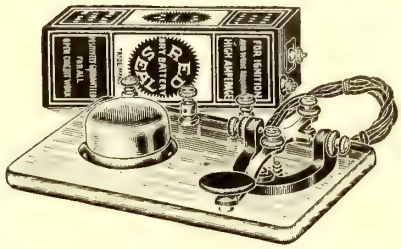
The manufacturer also claims that by using this self-regulating winding for starting duty, engines, regardless of their type, can be started without abnormal strain on the battery plates. This condition applies specifically to engines of 8 h.p. or less. Twice the starting torque with one-half the current is said to be produced by means of this winding. In a test recently made, this unit, with an 80-ampere current, easily started a 4-h.p. special electric engine. A shunt wound generator failed to start the same engine with the ammeter reading 140 amperes. This plant permits the lights to burn at practically the same brilliancy at all times. If the lights are being used direct from the generator and should the engine stop, the electrical connections will be changed automatically, so that the lights will then receive their energy from the storage battery. The switchboard is equipt with large scale instruments, an automatic reverse current circuit breaker and only one lighting switch. All internal connections are made at the factory. The batteries used with this plant are made in both the Faure and Plante types, assembled in either rubber or glass jars.



A New Compact Electric Generating Plant Having the Switch-board Mounted Rigidly on the Dynamo Frame.

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The Practice Set comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

The key and buzzer are mounted on a highly finished wood base, and three nickel plated binding posts are so connected that the set may be used for five different purposes, as illustrated on page 24.

For the beginner, the set is of exceptional value, for it may be used for individual code practice or for operation of a two party line, which is an excellent method of quickly learning the code. After the beginner has mastered the code, the set may be used in his wireless outfit for setting the detector in adjustment, and also the key may be used to control the spark coil.

Recommended for schools, as it gives excellent service for class instruction in code work. Full directions with each set.

The main object of the set is to enable the beginner to master the wireless code, and the buzzer reproduces the sound of the signals of the most modern wireless stations perfectly.

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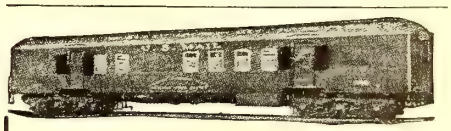
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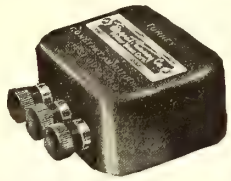
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It is made in one style only, for all powers up to 1-KW, and can be mounted in almost any position.

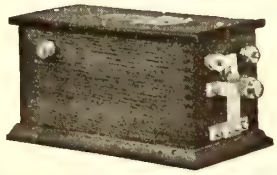
The gap is enclosed in a circular iron housing 8 inches in diameter and 2½ inches thick, with removable cover (for inspection). The adjustment can be as close as desired between sparking points.

Rotating disc is of brass with 12 projecting round brass arms (total diameter 6 inches), mounted on shaft running in bronze bearing and is belt driven by small motor giving a variety of tones depending upon the speed.

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SHIPS WHICH THE RADIO SAVED.

The U.S. Government cites the following marine disasters in which wireless figured during the period July 1 to December 31, 1916:

July 11.—Steamship *Ramos* foundered in a gale while en route from Philadelphia to Cartagena, Colombia. SOS calls were answered by the Miami land station and the steamships *Van Hogendorp* and *Illinois,* all but five persons on board being saved.

July 22.—Steamship *Matatua,* stranded on rocks seven miles south of St. Mary's Light, Cape Race. Vessel shot line to shore and passengers and crew were removed. The distress call was answered by the steamship *Stephano,* Red Cross Line, which stood by until passengers were safely removed.

September 15. — Steamship *Congress,* with 445 persons on board, caught fire off Coos Bay, Marshfield, Oreg. The vessel was headed toward shore. SOS calls being sent out continuously, which were received by the land stations at Marshfield, Oreg., Cape Blanco, Oreg., and Eureka, Cal., and the steamship *F. A. Kilburn.* Rescue vessels were dispatched by the Marshfield station, and all persons on board were saved.

September 23.—Steamship *Bay State* ran ashore off Cape Elizabeth, Me.; total loss. Distress calls were answered by the Coast Guard cutter *Ossipee* and the naval station at Cape Elizabeth, which dispatched the tugs *Portland* and *Cumberland.* All persons on board, approximately 200 in number, were saved.

October 7.—Steamship *Antilla,* with fifty-six persons aboard, caught fire off the Virginia Capes while en route from Guantanamo, Cuba, to New York. Approximately twenty-five vessels responded to the distress calls, and all persons were saved.

October 19.—Steamship *Araphoe* lost her rudder twenty-five miles north of Cape Lookout. SOS calls were answered by the steamship *Henry R. Mallory* and the Coast Guard cutters *Seminole* and *Tampa,* which towed the vessel to Norfolk.

October 28.—Steamship *Chicago,* with 265 passengers and crew, caught fire at sea and arrived safely at the Azores Islands. Communication was established with vessels, but assistance was not needed.

October 29.—Tug *Vigilant* disabled 150 miles off Irish coast. SOS call answered by the steamship *Ryndam,* which towed the tug to Queenstown.

November 25.—Steamship *Powhatan,* en route from Boston to Baltimore, caught fire off Block Island. Fire was controlled before arrival of Coast Guard cutters, which answered the distress call.

November 27.—Steamship *Niels Nielson* lost propeller in heavy gale. Distress calls were answered by several vessels, which assisted the disabled vessel to make port.

November 28.—Steamship *Coronado* lost propeller off Tillamook Head. Distress calls answered by Astoria, Oreg., station, which dispatched tug to assistance of disabled vessel.

December 3.—Steamship *Carolina,* Goodrich Transit Co., struck rocks off entrance to Sturgeon Bay Canal. Distress calls were received by the Manitowoc, Wis., station, which dispatched a tug to the assistance of the disabled vessel.

December 12.—Steamship *Sumner* grounded in fog off Barnegat, N.J. Six vessels responded to SOS calls, and all persons on board were saved.

December 14.—Steamship *Powhatan,* en route from Norfolk to Boston, sank in collision with unknown vessel on way to open sea. Several United States destroyers, Coast Guard cutters, and steamship *Jamestown* answered SOS calls. Crew transferred to Coast Guard vessels and passengers were taken to New York on the steamship *Jamestown.*

December 25. — Steamship *Maryland* sank at sea, position as given in SOS call 380 miles east of Sandy Hook, with crew of thirty-four. Distress calls answered by several Coast Guard cutters, but they were unable to locate the disabled vessel.

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By Albert W. Wilsdon.

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Apologies to "Casey Bee."

750,000 HORSEPOWER WASTED IN NEW YORK.

Electric power sufficient to turn every wheel and illuminate every dwelling and factory in New York State could be developed from the water power which is running to waste every day in the rivers, streams and canals of the State, Attorney General Woodbury declared in his annual report submitted to the State Legislature. He estimates a daily waste of 750,000 electric horsepower on the Long Sault Rapids and along the line of the barge canal. He urges the Legislature to establish a policy by which the State will reap some benefit from this stupendous resource, the value of which has been estimated by conservation experts at $250,000,000. Attorney General Woodbury points out that the Long Sault Rapids in the St. Lawrence River, control of which was recently regained by his office after a fight which was carried to the United States Supreme Court, could be harnessed to yield over 700,000 electric horsepower, while the dams and other structures along the course of the barge canal impound an excess of water over navigation requirements sufficient to generate 50,000 horsepower.

SPRAGUE DEFENDS ELECTRIC DRIVE FOR CRUISERS.

After consultation with Secretary of the Navy Daniels, Frank J. Sprague, Chairman of the Naval Consulting Board Committee on Electricity and Ship Construction, has come out strongly against the critics of electrical drive for the new battle cruisers.

In a letter to Senator Swanson, Chairman of the Senate Committee on Naval Affairs, Mr. Sprague says he has been reluctant hitherto to join in public discussion of the decision of the Navy Department to adopt electric drive.

"I feel that perhaps I am now justified in so doing," he adds, "in view of the fact that such discussion, which I assumed was begun from patriotic motives, seems to be taking on the nature of an active commercial propaganda, incidentally supported by a number of gentlemen, most of whom, however representative and endowed with experience along the lines of their individual professions, are utterly untrained in naval affairs, and hence are not possest of sufficient knowledge of this particular subject to indulge in the avalanche of criticisms which have been leveled at the department."

Referring to what he describes as "the successful installation of the electric drive on a comparatively small scale on the collier *Jupiter* and the adoption of similar power for three battleships," Mr. Sprague reminds Chairman Swanson that "the Navy Department, reinforced in their opinion by what had been done in electrical development in great power plants, decided upon electric drive also for the battle cruisers, each of which is to be equipt with engines of the large total of 180,000 horsepower.

"The wisdom of this decision," Mr. Sprague continues, "was challenged by Charles Curtis of the International Curtis Marine Turbine Company, which company would, if geared turbines were adopted instead of the electric drive, be a beneficiary by a large amount of royalties. It is, of course, difficult for one engaged in a commercial enterprise which may be seriously affected to be, even if unconsciously so unaffected in his judgment by personal interests, but I prefer to believe that Mr. Curtis was actuated by a desire that our cruisers should be the best afloat, even if I disagree somewhat with his methods and conclusions.

"Failing to get a reconsideration of the Navy Department's decision, a number of prominent engineers have been requested to write, and several have written, letters based on certain adverse information supplied them, some condemning without reserve the decision of the department and others urging that the matter be referred to the Naval Consulting Board or some other board of civilian engineers.

"Among those other than Mr. Curtis, who have been quoted as authorities are Dr. S. S. Wheeler, President of the Crocker-Wheeler Company, manufacturers of electrical machinery, who has been voluminous in his criticisms; Dr. Francis Crocker, an associate of Dr. Wheeler; George Gibbs, Consulting Engineer of the Pennsylvania Railroad; Dr. Michael Pupin, a distinguished scientist and inventor of a system for increasing the efficiency of the long-distance telephone; Isham Randolph, a well-known civil and railroad engineer; Prof. William H. Burr, a widely-known consulting engineer; President Falk of the Allis-Chalmers Company,

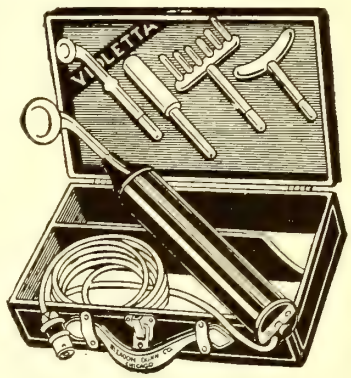


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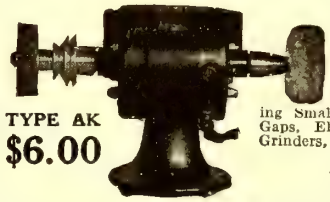
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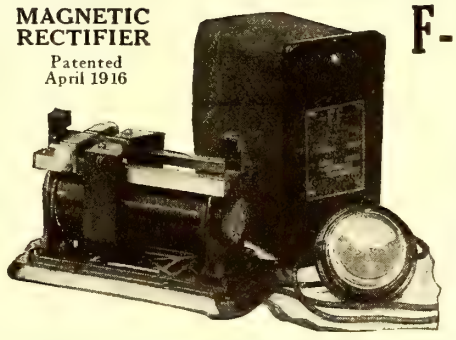
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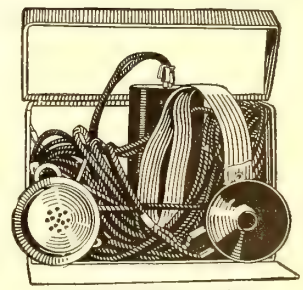
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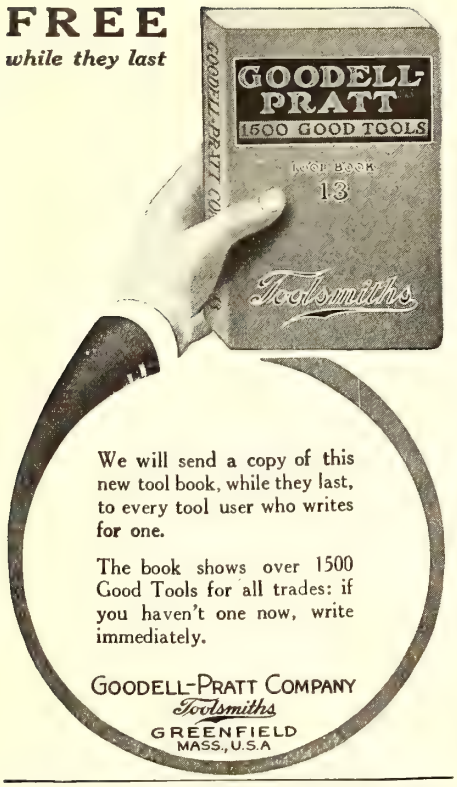
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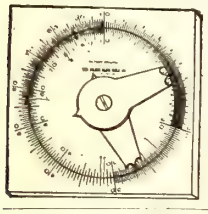
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manufacturers of electrical machinery; Luther Lovekin, Chief Engineer of the New York Shipbuilding Company, and Calvin Tomkins, former Dock Commissioner of New York."

Observing that this list "contains many names not only of men of prominence but of men standing high in their professions," Mr. Sprague says: "But the question may properly be asked to what extent are these gentlemen qualified to criticise, what is the training and experience which would warrant them to sit as judges in so vital a matter, and what is it they really seek to accomplish.

"The discussion," Mr. Sprague continues, "seems first to seek to condemn the adoption of electricity on the score of increased weight and cost, or impossibility of construction, or safety in operation, and second, a reference of the whole matter to the Naval Consulting or some other board.

"It is inconceivable," says Mr. Sprague, "that with all the known facts in hand the Navy department would or could surrender to outside advisers, directly or even inferentially, the selection between two known and accepted methods of drive, with their varying influence upon the distribution of weights, location of turrets and armor, size and disposition of compartments and the results of flooding, the distribution of fuel, the distances of machinery from the skin of the ship, provision against torpedo damage, the necessities of handling ships in emergencies and the results of failure of any parts."

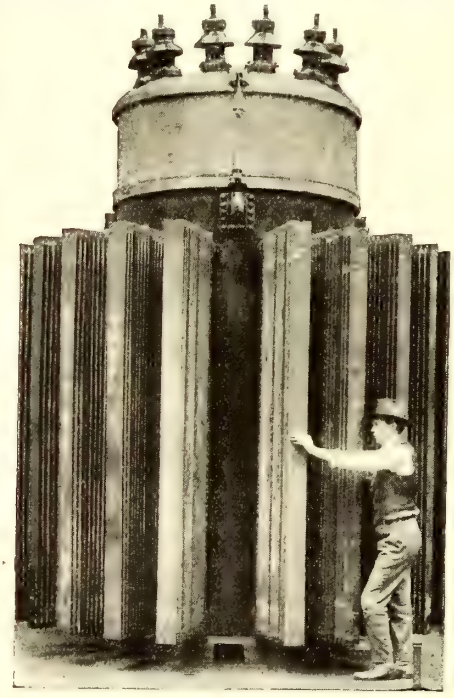
Mr. Sprague declares that generators and motors of the size indicated can be built, and that if necessary they can even be controlled by a push button from the bridge.

"I am," he says, "generally credited with being the pioneer of the modern electric railway and am certainly the creator of that system of train control, now used the world over, which makes it possible to aggregate any amount of power required under a single control."

One reason why Mr. Sprague was selected for the Naval Consulting Board was that he had served as President of four technical societies—the American Institute of Electrical Engineers, the American Institute of Consulting Engineers, the New York Electrical Society and the Inventors' Guild.

A PRESENT-DAY ELECTRIC GIANT.

While we may not have the human giants of old with us, their places are admirably



The Largest Self-control Induction, Feeder Voltage Regulator Ever Built.

filled by the gigantic mechanical and electrical apparatus that modern genius has evolved, as for instance, the device shown in the accompanying illustration. This picture shows the largest self-control induction, feeder voltage regulator that has ever been built. The regulator is of the oil-insulated, self-cooling type, and was built by a Pittsburgh concern. It is rated at 600 kva. (kilowatts) 3-phase, 60 cycles, 13,200 volts, with 10 and 20 per cent regulation at 262 and 131 amperes. It is designed for operation outdoors with full-automatic control self-contained.

This regulator was built for the Southern Power Company and is to be connected to the low voltage side of a 6000 kva. (kilowatt) bank of 44,000 to 13,000 volt transformers on the power company's line at Spray, N. C. By the use of this regulator the power from the line will be delivered to the Thread Mill Company mills owned by the Marshall-Field's interests, with the voltage maintained continuously at normal value.

JOHN J. CARTY, TELEPHONE ENGINEER, NOW MAJOR CARTY.

Mr. J. J. Carty, chief engineer of the American Telephone and Telegraph Company, New York City, and recognized as one of the foremost authorities in the world on wire communication, has been commissioned senior major of the Signal Officers' Reserve Corps, the reserve auxiliary of the Signal Corps, U. S. A. The addition of Mr. Carty to that organization will be a decided accession and one which will be widely applauded. It is believed other appointments will follow from the ranks of leading American engineers. The importance of the telephone system in any plan of national defense has been accepted by officials of the War Department.

The adaptability of the American telephone lines was thoroly proven last summer when the entire A. T. & T. Company's service was turned over to the Government for a test under hypothetical war conditions. In 45 seconds Secretary Daniels was in communication with the Pensacola, Fla., Navy Yard, and in 28 seconds more was talking with the navy yard at San Diego. The Secretary of the Navy later exprest his pleasure over the "wonderful success" of the experiment. When the country's National Guard was mobilized last summer a complete telephone exchange was established at Camp Whitman, in New York State, in less than 24 hours after the troops were called out, connecting Washington with Albany, N. Y., and all the vital points necessary to the movement. The commissioning of Mr. Carty as an officer in the Reserve Corps may be taken as a further step to have this important branch of the country's defensive system ready, not only in material, but in personnel.

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PATENT ADVICE

Edited by H. GERNSBACK

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

BELL SOFTENER.

(152) E. T. Jones, New Orleans, La., writes as follows:

"I, a subscriber to your wonderful magazine, would greatly appreciate your opinion on the following 'phone-attachment, printing same in your Patent Advice department in one of the following issues this year, as soon as possible.

"After reading over your article on patents wanted, I devised a scheme by which any tone desired can be had instead of using bells. I have drilled and tapt the armature knob of the ringer and screwed thereon a certain device; on a protruding stand, I have a mandolin string, which is adjustable (any note can be had); when the 'phone (rings) the device passes over the string and I have attained a dull, soft-pitcht tone which is audible three rooms away.

"I would appreciate your opinion on the above arrangement, and I highly recommend more suggestions on your part in a magazine which I and a million or so others cannot do without, as it is the *only live one* out to-day. I read it from cover to the last page and find old copies interesting even after they have been fully read."

Ans. The idea, while a very good one, does not seem very practical for the reason that the device would take up too much room. If an arrangement were obtained whereby the long string could be done away with, we think a more practical arrangement would be had, but we believe a patent can be obtained on the idea.

INVISIBLE PERISCOPE.

(153) Jose M. Moreira, Lowell, Mass., submits a design of a *glass* periscope, his idea being to make it invisible.

Ans. While this is a good idea on paper it does not work out in practise for two reasons, one of which is that glass is too dangerous a substance to be used for a periscope which has to stand enormous strains due to rushing thru the water as it speeds on. Furthermore a periscope sticking out of the water can never be invisible, that is, while the periscope itself may not be seen at a distance, it forms a white *wake* as it runs in the water, which is very noticeable. It is not the periscope itself that the enemy will see, but the water trail which the periscope leaves behind. As long as nothing is found to do away with this wake, it is useless to make the periscope itself invisible.

AUTOMATIC TUBE CLOSER.

(154) James D. Miller, Montreal, Quebec, Canada, submits to us several drawings of collapsible tubes such as are used with tooth-paste and shaving creams, the idea being to do away with the annoyance of unscrewing and screwing on the cap which so often exasperates us.

Ans. The drawings submitted to us of the device are very ingenious indeed and hold out a possibility of a good invention. We, however, would advise our correspondent to simplify the idea, as at present it seems too complicated, having too many parts. We would also advise our correspondent to submit the idea to a patent attorney with a view to obtaining copies of prior patents on this particular class of work.

INTERRUPTER.

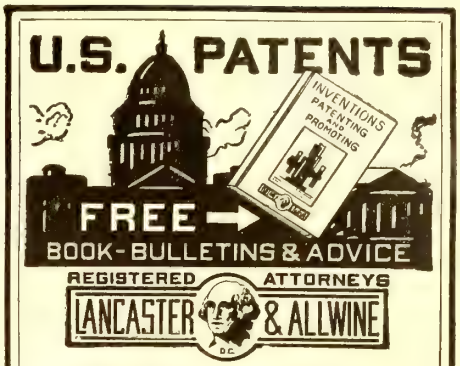
(155) Geo. Shaw, Talmage, Neb., has conceived an idea for the improvement of interrupters for small wireless sets and other outfits requiring the use of a small transformer or spark coil. The idea is to use a certain form of interrupter in an air-tight chamber, under sufficient air pressure to prevent the burning of the contacts. He thinks that a small hand air pump could be secured to the chamber to pump up sufficient pressure. Is the idea a good one and is it patentable, and would there be a demand for it?

Ans. A scheme of this sort is decidedly not satisfactory because it has been shown that comprest air will retard an ordinary vibrator spring or, for that matter, any moving part which is supposed to operate under high speed. If instead of using comprest air you use a vacuum, enormously better results are obtained, as, for instance, in the Moore *Vacuum Interrupter*. Personally, we have no faith in comprest air interrupters, as we have never seen one work satisfactorily.

ELECTRIC CIGAR MOISTENER.

(156) Charles Bicker, Salina, Kans., says that he has an idea in the construction of a device to moisten cigars and tobacco in show cases. The idea is to make steam by heat developed from storage batteries, and to evaporize the steam in a certain manner.

Ans. While a patent might be obtained on a scheme of this kind, we do not know how valuable it will be without knowing full details. There are some very good and cheap electric tobacco moisteners on



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the market to-day and we have one in mind which seems to have the greatest sale, whereby an electric incandescent lamp is plunged in a basin filled with water, which owing to the heat of the lamp, is made to evaporate.

AMPLIFICATION TRANSFORMER.

(157) A. J. Camile, New York, N.Y., sends in a sketch and description of a transformer which is supposed to amplify alternating current ten times or more without any other means. He proposes in a sketch and description, that it will transform 110 volts 2 amperes into a current of 110 volts *31 amperes!*

Ans. No matter what a scheme of this kind may consist of, it is absolutely impossible. You cannot obtain energy for nothing and you might just as well try to lift yourself by your own boot straps. It simply cannot be done.

PATENT ATTORNEYS.

(158) Edmund von Szuppiny, Paterson, N.J., writes as follows:

"Wishing to find out thru whose services Edison, Maxim, or Lewis obtained their patents, I sent for the literature of a good many patent attorneys.

"Many of them list a considerable number of names and addresses of their clients who, however, are almost all unknown to the world at large, and no matter how I tried, I failed to find the names of Tesla, Hammond, etc., in any one of their lists.

"This makes the impression upon me that inventors of this magnitude do not care to intrust their inventions to the advertising patent attorneys.

"Will you kindly inform me what means or what agencies this—say Edison or Tesla—uses when wishing to patent one of their inventions."

Ans. The answer is a simple one indeed. We have good reasons to believe that several of the greatest inventors of this country patronize the advertising patent attorneys, but they usually restrict attorneys from using their name for obvious reasons, as it is naturally to their interest not to disclose who does their work for them. Personally, we think you will get cheaper and better service from advertising patent attorneys than from those who do not advertise, for the simple reason, that the former do a larger business and consequently can work cheaper. The quality of a patent obtained certainly does not make a lot of difference whether it is turned out by an advertising attorney or by one that does not advertise.

The editor, who is the owner of some eighteen patents, might state that nearly all of these were obtained from advertising patent attorneys.

TOY ELECTRIC HAMMER.

(159) R. DeWitt Duffield, Van Wert, Ohio, has submitted to us a simple design of a toy electric hammer and wants to know if such an article is on the market already and if it is worth while patenting.

Ans. This indeed is a very excellent idea and one of the best schemes for a cheap electric toy that we have seen lately. While there is nothing particularly new in the principle, we are certain that a patent may be obtained on the construction of same.

Our correspondent also submits to us a sketch of an electrolytic interrupter on which he desires our advice.

Ans. Nothing new is shown in this design, and similar interrupters are in use all over the world and a patent can certainly not be obtained on this device.

JOE'S EXPERIMENT.

(*Continued from page* 101)

forming the circle which surrounded the erect and alert chief, his pale face drawn and anxious as he eyed the watch he held in one hand.

"Do you think they'll stand it?" he asked in husky, worried tones.

"Sure, there isn't much load on," Pete Foley assured him.

It was just a minute before twelve. The generators below were purring smoothly, filling the whole building with a vibrant, steady hum.

Five seconds past—ten—twenty—the group grew silent, watching the chief, Mr. Robertson, as he squared himself in front of the main control panel. Twenty-five seconds past—thirty—forty.

At ten seconds before twelve Mr. Robertson reached for the push-button in the center of the panel marked, "Main Switch."

His hand rested on the metal disc for a moment and then as the watch held in his left hand marked five seconds before twelve, he prest the button.

There was a purr of mechanism behind the marble panel as the big main switch fell into place. The generators dipt a note or two in their hum, and then rallied as more water came thru on their turbines. The group watched the voltmeter on the panel anxiously, and as the seconds past and it did not waver, Mr. Robertson heaved a great sigh of relief and satisfaction.

"It works! It works!" he shouted, in sudden released exuberance. "They've got their power and we've got our franchise."

A white-linened, diamond-pinned director reached for the chief's hand.

"Don't congratulate me," Mr. Robertson hastened to forestall him. "We're saved because some one thought of a very simple expedient. Here, I'll show you."

He stept to a panel at his right, followed by the interested group. He paused before a rheostat, glittering in bright metal. From its connections two wires led down to a coil of wire on the floor.

"This coil," he said, indicating it, "is a resistance coil. It is connected in series with the field windings of the exciter. In this way the voltage of the exciter has been lowered, thereby reducing the strength of the alternator's field, which in turn lowers the voltage of the machine itself. As a result we have the voltage of the high tension line lowered to such a point that we are sending current directly into the Merwin service lines without any intervening step-down transformer. A very clever and simple expedient, which will work until the transformers arrive. And so I congratulate the man who suggested it to me, Mr. Peter Fo——"

"No, you don't. Not me," Pete interrupted, as Mr. Robertson turned to him. "Here's the boy you want to thank. He saved your plant and not me," and he pushed forward Joe Benson from the shelter of the post where he had been standing.

"He told me about this trick and asked me to tell you. So just give him the thanks and the reward," Pete went on, eyeing in triumph the astonished faces of the group about him.

"It wasn't much. Any electrical man could have thought of it," Joe said modestly, blushing happily in sudden confusion. "And anyhow I couldn't have done it, if Pete hadn't showed me things so well the day I was here looking around."

"Yes, that was the day he was in the way," Pete said, with a significant glance toward Mr. Robertson.

But the chief had recovered from his surprise and had stept forward to the blind

(*Continued on page* 152)



8c in Stamps Brings You **DUCK'S** **300 - PAGE ELECTRICAL and WIRELESS CATALOG**

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This tuner is designed especially for use in receiving from the long wave length undamped transmitting stations in this country and European countries. Stations in Germany and all important Government stations use undamped apparatus.

This tuner is of the best design, construction and finish throughout. It is designed for wave lengths from 2,000 to 15,000 meters.

The windings are of Silk Covered Wire, machine wound on substantial unshrinkable tubes. The primary tube is 8 in. x 13 in. The secondary tube is 7 in. x 12 in. The inductance of the winding is varied by switch, all sliders being eliminated. The primary is varied in steps of two turns each and the secondary is controlled by a 15-point switch, giving very close tuning.

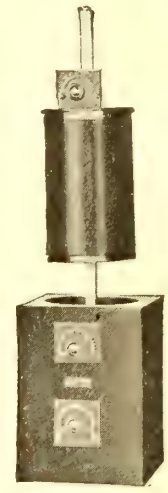
The advantages of vertical mounting are obvious and inspection of the cut will convince all that this is the ideal construction. The instrument occupies 10 inches square space on the operating table, while the old style requires three feet.

The secondary is counterbalanceed and the touch of a finger moves it to any position. When raised to its extreme height the coupling between the primary and secondary is 8 inches, allowing very selective tuning. The counterbalance weight is inside the square nickel-plated brass tube.

The case and all woodwork is finished in a rich hand rubbed mahogany finish. All metal parts nickel plated. All connections are mounted on the Bakelite panels.

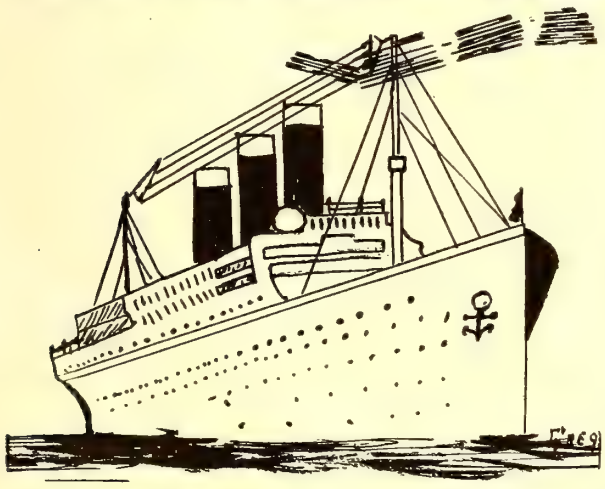
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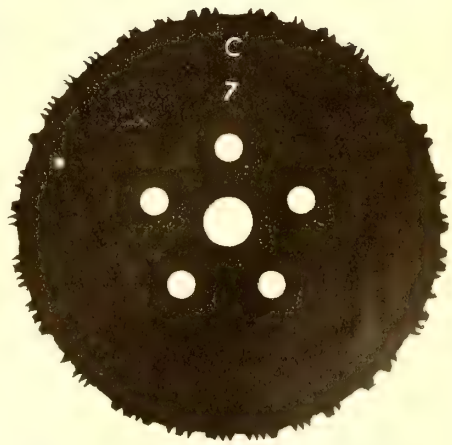
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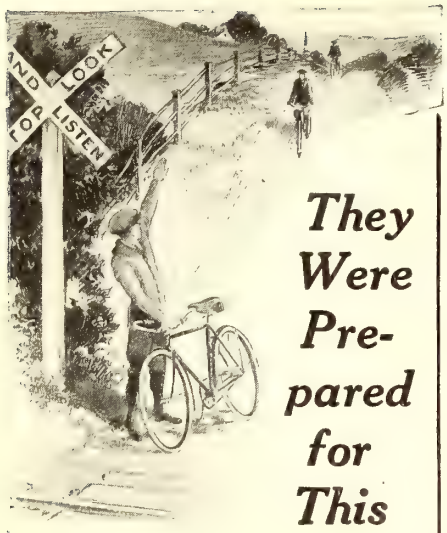
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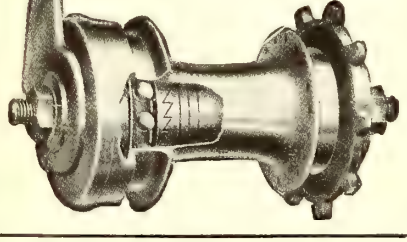
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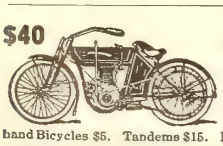
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Deninger, The Price Cutter, Rochester, New York

JOE'S EXPERIMENT.

(*Continued from page* 150)

boy, before the circle of directors could close in on him.

"Shake," he cried, gripping his hand. "Any boy who can think of a thing like that deserves a chance to learn more, whether he can see or not. So if the company doesn't out of gratitude, I'll see to it myself that you go to the best technical school in the country."

ELECTRICITY AND LIFE.

(*Continued from page* 105)

culosis and other pulmonary troubles often yield to the "effleuve" treatment.

3. Perhaps the most remarkable therapeutic effect of heavy high-frequency currents is their power to liberate heat in the tissues of the body. For this purpose the so-called "D'Arsonval current" is used. This is a secondary current of high amperage derived from the heavy coil of copper strip shown in Fig. 6. The lower terminal of this coil is connected with the condenser pad on which the patient is seated; the tubular metal electrode is held in both hands and connected thru a Milliamperemeter with the upper turns of the coil. The clip is moved to different turns as in wireless tuning, until the meter shows the highest reading for a given amount of exciting current. The patient's circuit is in this way tuned in perfect resonance with the primary oscillations. After a few moments the patient's wrists become hot, the heat rapidly extending up the arms and into the body until profuse perspiration is produced. Ordinarily we do not carry the treatment as far as this: the safe dose for an average patient being not over 700 milliamperes for twenty minutes. This is "D'Arsonval Autocondensation", and is applied with great benefit to patients suffering with *Arteriosclerosis* ("hardening of the arteries"), and in a variety of other diseased conditions involving malnutrition.

4. In diseases in which we wish to induce a regenerative inflammation, promote circulation and absorption, and increase cell activity, the method known as "Diathermie" is employed. Instead of the hand electrode and condenser-pad the D'Arsonval current is applied thru two small sheets of block-tin about 2 x 4 inches. These are applied to the skin on either side of the affected part and a current employed which gives the patient a decided sensation of penetrating heat. Average treatments use from 1000 to 1600 milliamperes. In treating consumption (pulmonary tuberculosis) one electrode is placed on the back and the other on the chest over the affected lung. One Tuberculosis Hospital in which this treatment was given daily to a number of patients reported 85 *per cent of cures!* The author is working on an apparatus which will make possible the use of Diathermic treatment in the homes of patients suffering from this disease.

For office use and for the Electro-medical specialist ("Electrotherapeutist") the writer has recently designed an apparatus from which remarkable results are being obtained (see Fig. 6). The Tesla and D'Arsonval coils are excited by a wireless transmitting set of the well-known "Hytone" type. The *rotary quenched gap* with its exceedingly high-spark frequency produces an almost sustained wave in the High-frequency coils. Both for the Tesla and D'Arsonval treatment the writer believes this apparatus superior to any that he has used up to the present time. The vitalizing and exhilarating effects are extremely pronounced. The machine has the added advantage that there is no troublesome spark gap to adjust, the strength of the current being regulated by a many-stept rheostat in the primary transformer circuit.

Much has been done in adapting high-frequency currents to the treatment of disease, but much remains yet to be done before we shall be able to avail ourselves of the wonderful healing and vitalizing powers which these currents undoubtedly possess. The writer hopes to be able to continue his studies along this line, believing that when we can scientifically apply to our patients *pure undamped waves* of definite form, frequency, amperage and voltage, we will obtain results far surpassing anything that we have dreamed of up to the present time, and that in the future the scientific use of high-frequency currents will become the greatest method ever discovered for the healing of disease, the promotion of health and the maintenance of a *"More Abundant Life!"*

EXPERIMENTAL PHYSICS.

(*Continued from page* 106)

goes out solidly, so that now our siphon has its "arms" filled and acts the same as the ordinary siphon.

EXPERIMENT 28—The following is an interesting and amusing experiment. It can be made to appear mysterious, and is important because in it lies the principle of the submarine. In Fig. 24-A, 3 is a jar or other cylindrical glass vessel about two-thirds full of water. 2, is a small, light glass bottle, or better, a small glass vial. 1, is a piece of sheet rubber stretched over the top of the jar. Before placing 1 in position, vial 2 is partly filled with water and inverted so that it just floats upright. On pushing down on the sheet rubber the vial (Cartesian diver) sinks and on releasing it rises again. When we push down on the sheet rubber, we compress the air in the jar and hence it forces more water into the vial. Since it was originally adjusted so that it just floated, the addition of more water into the vial makes it heavier and hence it sinks. On releasing the sheet rubber the pressure in the jar becomes normal again, and hence the pressure in the vial causes the excess water to come out and the vial returns to its original position. Fig. 24-B, shows a more mystifying form of the same experiment. 3, is a Florence flask, while 2, is the same vial adjusted exactly as in Fig. 24-A. 1, is an ordinary cork stopper. After the vial is adjusted, the stopper is put in carefully. (It may be necessary to adjust the vial so that it floats *almost upright* so that on pushing in the stopper, a little more water enters the vial and it just floats upright.) On holding the flask in the hand it is found that one can, by squeezing it, compress the air and make the diver perform. Thus one can make the diver obey one's command to rise or sink, without the audience perceiving the cause. Obviously a thin flask which will yield to squeezing is necessary for this experiment and the ordinary Florence flask answers the purpose very well. The real submarine boat is so constructed that no water can enter it, even if it is wholly submerged, except at the will of the occupants. It is able to float like any other ship just as our vial can float. If the occupants wish the boat to submerge, water is allowed to enter into special compartments until the weight of the boat slightly exceeds the weight of

the water it displaces. When they wish to rise again, some of this water is forced out.

EXPERIMENT 29—We are all familiar with the fact that objects weigh less in water than in air and that some things float in water. No one who has ever taken a bath has failed to notice this, and as a matter of fact the great *Archimedes,* who first formulated the *law of buoyancy,* first noticed the buoyant effect of water while taking his daily or yearly bath (I do not know which). If a block of wood, a piece of stone or marble, or a brick and a piece of cork of the same size and shape are weighed in air, they are found to have different weights. If then each is weighed in water (see Fig. 25-A) they are again found to weigh differently but they all weigh less, and as a matter of fact it is noticed that the LOSS IN WEIGHT is in each case the same, except in the case of the cork which floats and does not weigh anything. If next we fill a can until it nearly overflows and immerse one of our objects (except the cork) in it, and catch the overflow water in another can and weigh it (subtracting the weight of the can), we find that *the weight of the water displaced is equal to the weight lost when the bodies were immersed* in the first part of the experiment. In Fig. 25-B, abcd, represents the cross-section of the body used. The pressure at ad, is equal to the weight of the column, eoad. The pressure at cb, is equal to the weight of the column, ceob. The difference between the two is the resulting buoyant force at cb, and is equal to the weight of a column of water adcb, which of course is the amount of water displaced. The cork being lighter than water, if it were immersed the buoyant force would be greater than its weight and therefore it is forced to the surface. Hence the cork will sink only until enough water is displaced so that the buoyant force equals its weight, *i.e., only part of it will sink.* The ordinary ship floats because it is constructed so that if it were immersed, the buoyant force would be greater than its weight.

(To be continued)

THE NAVAL RADIO OPERATOR.

(*Continued from page* 109)

Members of the Electrical Class are quartered on the receiving ship at either Mare Island or New York. The school buildings are situated in the Navy Yard. Outside of the regular school hours a course of instruction is contemplated whereby they will be instructed in the regular duties of a man-o'-war's-man; this is necessary, as every man aboard ship, irrespective of rating, is a member of a military organization. Shore leave is granted in accordance with the regular Navy custom, usually from 4:30 p. m. to 7:30 a. m. every other day. Leave of absence is granted after completion of course.

The course at the Electrical School comprises twenty-two weeks of advance work and three weeks of examination. The schedule of marking is based on 4 as perfect and a final average of 2.8 is necessary in order to obtain the rating of electrician upon graduation. Each man is assigned a mark upon daily oral recitations and weekly written examinations. The final examination is in writing. In the radio course the greatest emphasis is placed upon the ability to send and receive the Morse and Continental codes, also radio regulations.

OUTLINE OF THE RADIO COURSE.

The outline of the radio course is as follows:

Machine Shop (bench work).
Magnetism and Electricity.
Alternating Currents.
A. C. and D. C. Instruments.
Batteries.
Motors and Motor Control.
Radio Power Circuits.
Primary Circuits.
Secondary Circuits.
Condensers and Oscillating Currents.
Radiating Currents.
Transmitting Sets.
Receiving Circuits.
Receiving Sets.
Service Radio Sets and Routine.
Wave Meters and Measurements.
Radio Regulations and Fleet Work.
Radio License Booth.
Review and Examination.

To the above course is added several weeks of practical work and special details. Students enter the Electrical School at any time and commence the course on the Monday following their date of entrance. Each week corresponds to a class or grade and shows the subject which the student is studying, and the lapse of time since entrance to the school.

The first eight weeks of the radio course are devoted to subjects pertaining chiefly to general electricity and serve as the ground work for the study of radio. Text books used in the first eight weeks are "Swoope's Lessons in Practical Electricity" and "Bullard's Naval Electricians' Text Book."

Both the Continental and Morse codes are taught. Two operating tables, each with a capacity of twenty men, are fitted with head 'phones, sounders, and transmitting keys. The instructors are Chief Radio Electricians. Each instructor is assigned an operating desk having control over a certain number of tables. The students are assigned to tables according to skill in receiving and are advanced to faster tables whenever necessary. Final examinations are held after the completion of the twenty-second week. The average operating ability of the students completing the course is 25 words per minute. A great many of the students, however, approach a speed of 30 words per minute.

It is believed that men completing the radio course at the Electrical Class successfully have obtained an excellent general knowledge of radio and have fitted themselves for rapid and sure promotion in this branch of the Naval service.

THE HOW AND WHY OF RADIO APPARATUS.

(*Continued from page* 113)

chanical pressure can be exerted axially upon them, in order to make the gaps thoroly air tight. For outputs above one-half K.W., the gap often becomes unduly heated, and it is common practise to place a small motor-driven blower or fan beside the gap, in order to cool it by carrying off heat from the cooling flanges.

At Fig. 4, we have what is known as a *rotary-quenched* spark gap. This particular design of gap has met with considerable favor, especially for small radio transmitters, of from one-quarter to several kilowatts output. This gap possesses the distinct and remarkable quality of producing a high-tone in the telephones at the receiving station, even tho it is used on a low frequency or 60 cycle transformer at the transmitting station.

In the first place, this gap operates with a remarkably small clearance between its two semi-circular fixt spark electrodes and its rotary electrode, or having a gap about



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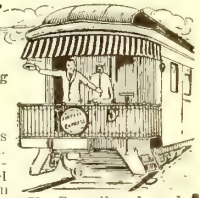
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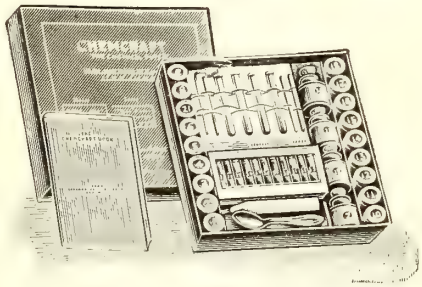
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three-thousandths of an inch in length. The gap operates in an air-tight chamber formed by a heavy metallic casting, which carries suitable cooling vanes, and besides which there are provided a number of auxiliary cooling vanes as shown in Fig. 4, at the rear of the gap. Being air-tight at the start, this gap operates in the same manner as the design shown in Fig. 3, known as the Telefunken gap. To obtain a high spark note with the rotary quenched gap of Fig. 4, the two fixt and also the rotary electrodes have their faces accurately machined or milled-out at equal distances, resulting in a number of teeth, ,between which the spark occurs. These gaps have to be built very accurately of course, as the gap itself measures about .003 inch, and it is desirable to have the sparking distances constant and similar. A typical gap of this class has the sparking surfaces and the copper on both stationary and rotary elements milled with thirty-six radial slots, so that when rotated by a small motor at 1,800 R.P.M., the resultant tone corresponds to that of a 540-cycle alternator. It is necessary that the width of the spark segments are so proportioned that sparks will occur during not more than one-half of the total time, as otherwise the telephone diafram at the receiving station is retarded in its excursion away from the magnet, thereby resulting in a decrease in the sound intensity.

[*Those interested in this spark gap will do well to look up the matter in the excellent paper by Mr. Melville Eastham, entitled "The High Tone Radio Telegraph Transmitter" in the December, 1914, issue of the proceedings of the Institute of Radio Engineers.—Editorial Note.*]

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(*Continued from page* 117)

so rapid that it will not produce an audible sound in the receivers, so that the discharge of an Oudin coil cannot be used for the transmission of wireless messages, altho who can say, if it is properly conducted to the aerial, that it does not travel as far or farther, than an undamped wave.

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EXPERIMENTAL CHEMISTRY.

(*Continued from page* 127)

be left in a closet, or some place else for a week, or until the water has disappeared. The reaction for this experiment is:

$$\underset{\text{Copper}}{3Cu} + \underset{\text{Nitric Acid}}{8HNO_3} = \underset{\text{Copper Nitrat}}{3Cu[NO_3]_2} + \underset{\text{Water}}{4H_2O} + \underset{\text{Nitrogen Monoxid}}{2NO}$$

MADE FROM ACIDS AND SALTS.

EXPERIMENT NO. 61—

Put 5 or 10 grams of marble chips into a wide test tube and add about 10 cc. of dilute Nitric acid, [HNO_3] [half acid and half water]. Apply the splint test by applying a lighted splint to the mouth of the test tube, after the action has progrest for a short time. After the action has stopt, and if not clear, filter, and evaporate most of it.

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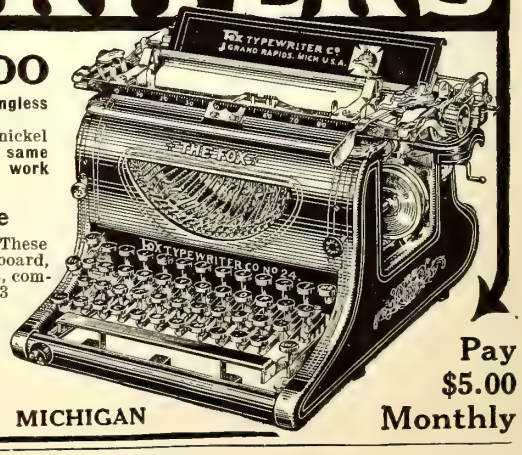
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EXPERIMENT NO. 62—

Put 2 or 3 grams of Ferrous sulfid [FeS] in a test tube and cover it with water. Place this near an open window, or in a place where a draft of air can be created to carry away the escaping fumes. Add 5 cc. of Hydrochloric acid [HCl] [keeping in a draft of air]. When the action stops, filter and evaporate. Equation:—

FeS	+	2HCl	=	$FeCl_2$	+	H_2S
Ferrous Sulfid		Hydrochloric Acid		Ferrous Chlorid		Hydrogen Sulfid

EXPERIMENT NO. 63—

Put 10 grams of fine salt [Sodium Chlorid] [NaCl] in a large test tube, and add 10 cc. of concentrated Sulfuric acid [H_2SO_4]. Carry on this experiment near a window or where a draft of air can be created. Heat the solution over a Bunsen burner very cautiously, and moderately. After the action has progrest for 5 or 10 minutes let the tube cool, then pour in 15 or 20 cc. of water, to dilute or dissolve the solution. If the liquid is not clear, filter it, and evaporate the filtrat [the liquid which passes thru the filter paper]. If concentrated sulfuric acid is present, it will destroy the filter paper.

Equation:—

2NaCl	+	H_2SO_4	=	Na_2SO_4	+	2HCl
Sodium Chlorid		Sulfuric Acid		Sodium Sulfate		Hydrochloric Acid

Soluble and Insoluble Substances.

All the common acids are soluble. Some of the bases are soluble, some insoluble. An insoluble substance is one which does not dissolve, or which dissolves very slightly in water. Besides water there are many other solvents, as, alcohol, chloroform, ether, carbon disulfid, and the various alkalis, and acids, and unless a certain solvent is mentioned, water is the one referred to. To be able to distinguish clearly between soluble and insoluble substances, is the basis of chemical analysis.

Soluble salts, are usually prepared by [1] neutralization, as in experiments 54, 55 and 56; [2] by the action of an acid on a metal, as in experiments 58, 59 and 60; [3] by the action of an acid on a salt, as in experiments 61, 62, 63.

In experiments 54, 55 and 56, we prepared a soluble salt by Neutralization. Upon making a mixture of the acid and base [in solution] a reaction took place and a salt was formed. As a salt usually gives a neutral reaction, a point is reached, in the mixing, if it is done very carefully, at which the whole mixture was neutral to litmus. If the solvent water was evaporated at this point, the salt should be obtained as a solid, which in some cases may break up owing to excessive heat.

In experiments 58, 59 and 60, we prepared a soluble salt by dissolving a metal by an acid. The result which we obtained is called a chemical solution and consists of two stages; [1] the metal combined with the negative part of the acid, and formed a salt; [2] the salt dissolved in the liquid, the larger part of which is water. Thus it is clear why a salt which is insoluble in water is not usually made in this manner.

In experiments 61, 62 and 63, we made a soluble salt by the action of an acid on other salts or compounds. Metallic oxids, carbonats, and sulfids are the most common of these. Suppose we wish to make some calcium chlorid [$CaCl_2$]. We know that it is soluble, and suppose that Hydrochloric acid [HCl] will probably dissolve the calcium. But we also learn that calcium is not a common metal in the laboratory, so we look for an inexpensive compound upon which the Hydrochloric acid will act. The carbonat [$CaCO_3$, limestone, or marble], is plentiful, and hydrochloric acid attacks it with great vigor. The reaction would be:

$CaCO_3$	+	2HCl	=	$CaCl_2$	+	H_2O	+	CO_2
Calcium Carbonat [Limestone, or Marble]		Hydrochloric Acid		Calcium Chlorid		Water		Carbon Dioxid

Insoluble substances, salts and bases, are prepared in the laboratory almost wholly by one process, *Precipitation*. An insoluble salt or base may be made by mixing two solutions, one of which contains a compound of the metal, the other a compound of the non-metallic part of the insoluble salt, which will appear in the mixture as a precipitat. Lead sulfat [$PbSO_4$] is made by pouring a solution of lead nitrat [$Pb[NO_3]_2$] upon a solution of Sodium sulfat [Na_2SO_4] .

$Pb[NO_3]_2$	+	Na_2SO_4	=	$PbSO_4$	+	$2NaNO_3$
Lead Nitrat		Sodium Sulfate		Lead Sulfate [precipitats]		Sodium Nitrat

Acids are usually made by acting with a less volatile acid, as Sulfuric acid [H_2SO_4], on a salt of the acid required. We have seen that salts can be made by the union of an acid and a base, and we now learn that an acid can be obtained from its representative salt. Sulfuric acid is generally used, for making acid, because it is one of the less volatile acids, and thus it readily parts with its hydrogen and takes a metal in its place. A salt of the acid desired must be put with the sulfuric acid; for example, if Hydrochloric acid [HCl] is wanted, Sodium chlorid [NaCl] or some chlorid is used. If Nitric acid [HNO_3] some nitrat, as Potassium Nitrat [KNO_3], should be used.

Soluble bases, especially the alkalis, may be made by acting with calcium hydroxid on certain salts of the base required. Other bases, for example Sodium or Potassium Hydroxid, may be used in place of Calcium hydroxid. Ammonium hydroxid [NH_4OH] is prepared from a salt of Ammonium, as, Ammonium Chlorid [NH_4Cl], Ammonium Nitrat [NH_4NO_3], Ammonium Sulfat [$(NH_4)_2SO_4$, etc., by heating it with a mixture of calcium hydroxid [$Ca[OH]_2$] [slaked lime].

$2NH_4Cl$	+	$Ca[OH]_2$	=	$CaCl_2$	+	$2NH_4OH$
Ammonium Chlorid		Calcium Hydroxid [Slaked lime]		Calcium Chlorid		Ammonium Hydroxid

Sodium hydroxid is made from Sodium Carbonat [Na_2CO_3] and Calcium Hydroxid.

Insoluble bases are made by mixing two solutions, one of which contains a base and the other a compound of the metal of the base required. Ferric Hydroxid [$Fe[OH]_2$] can be prepared by adding Sodium hydroxid solution to a solution of Ferric chlorid [$FeCl_3$]. Any other soluble ferric [but not ferrous] salt would do as well, and any other soluble hydroxid. Ferrous hydroxid [$Fe[OH]_2$] requires a soluble ferrous [not ferric] salt.

SOLUTION:—

In Experiment 5 [August, 1916, issue of THE ELECTRICAL EXPERIMENTER] we illustrated *Solution* by experiment. We found that by dissolving the sugar in water, we formed a *Solution*. Sugar is said to be Soluble in water, and the water is termed the *Solvent*. The sugar is the *Solute*. A substance is said to be in solution in a given liquid, when it is evenly distributed thruout the liquid in such fine division that its particles cannot be seen, and which do not settle or precipitate upon standing.

The most important property of water is its ability to dissolve a large number of substances. Liquids which do not separate but form a uniform mixture when

(*Continued on page* 156)



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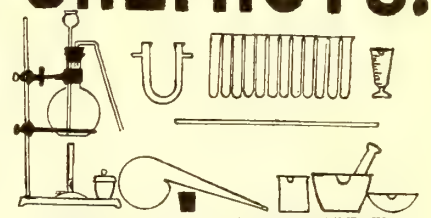
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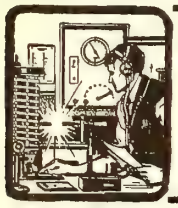
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brought together, such as alcohol and water, or glycerine and water, are said to be *Miscible.*

An insoluble solid, like starch-powder or clay, can be dispersed thru water by shaking, but the mixture will be *Turbid* like muddy water. A turbid mixture of a solid and liquid is called a *Suspension.* In time the suspended matter will settle, leaving the liquid clear. Dissolved matter will never settle.

SOLUBILITY FACTORS:—

The *solubility* of most substances is decidedly affected by the temperature. Solids are usually, but not always more soluble in liquids at high than at low temperature. In Experiment 5, we found that sugar was more soluble in hot water than in cold. Calcium Hydroxid, used in the preparation of limewater, is more soluble in cold water than in warm water.

The solubility of gases decreases as the temperature rises. Ammonia and Carbon dioxid are less soluble in hot water than they are in cold water. Different substances vary very much in their solubility in a given solvent, and different solvents differ in their power to dissolve the same substances.

SATURATION:—

If a small portion of salt is dissolved in a large quantity of water, such a solution is then said to be *Dilute.* The substance is uniformly distributed in all parts of the liquid in a dilute solution, as it is in one containing a much larger proportion of the dissolved substance.

By slowly adding salt to a measured volume of water, it can be shown that there is a limit to the quantity which the water will dissolve. One liter of water at 20° C. will take up any quantity of salt up to 360 grams, and no more.

At this point the solution is said to be *Saturated;* or in other words, the water has dissolved all the salt it can under given conditions. If any more salt is thrown into such a solution it will simply fall to the bottom and form a layer which, no matter how thick, *does not increase the amount dissolved.*

EXPERIMENT NO. 64—

Take 100 cc. of water and saturate it with sugar at 20°. It will take up 200 grams. Now heat the liquid to 100° and dissolve more sugar in it. It would probably take up 300 grams additional, but only add about 20 grams. Allow the liquid to again cool to 20°. This solution must be allowed to cool *without any disturbance* and *kept perfectly quiet* in a clean bottle; the separation of the extra 20 grams of sugar may not occur for a long time. This liquid contains more sugar than the saturated solution contains, at the same temperature, and when in such a condition is said to be a *Super-saturated Solution.*

Drop a crystal of sugar into the above super-saturated solution, and if the experiment has been performed correctly, this crystal will precipitate, or throw down, the extra 20 grams of sugar in crystals, and the saturated solution will be formed.

DELIQUESCENCE:—

If Potassium Carbonat is exposed to the air, it absorbs the moisture from it, becomes damp, and finally forms a solution. This, if substances absorb sufficient moisture to dissolve them, or become wet, the name *deliquescence* is applied to this behavior, and the substances are said to be *Deliquescent.* Substances which so absorb moisture from the air are also said to be *Hygroscopic.*

EFFLORESCENCE:—

This term should not be confused with *Effervescence,* which is the escape of a gas from a liquid in which it is either generated or has been held by pressure.

If a crystal of washing soda is exposed to the air in a dry place, it will lose its water of crystallization and become covered with a fine powder. This is called *Efflorescence.* Copper Sulfat [Bluestone $CuSO_45H_2O$], retains its water in ordinary air but in very dry air it turns white and *Effloresces* rapidly.

CRYSTALLIZATION:—

When a saturated liquid is cooled and the solid precipitates, the latter is quite likely to form crystals, especially if the cooling is slow. Evaporating the liquid from a saturated solution precipitates the solid, often in crystalline form. These are crystals from solution. They may also be obtained from *Fusion, i.e.,* melting a crystalline substance and allowing it to cool slowly. Another method of obtaining crystals is to make an insoluble compound in the usual way, by mixing two solutions. Generally precipitates obtained in this way are *Amorphous* or *indistinctly* crystalline, as time is not given for the forces of crystallization to arrange the molecules in crystalline form. Crystals may also be obtained by the sublimation from a vapor. Some substances do not crystallize at all and are termed *Amorphous,* meaning without crystalline form.

EXPERIMENT NO. 65—

Fill an evaporating dish half full of water, heat it [using asbestos pad on tripod or ring stand support], and add to it alum, either powdered or in small pieces, until the liquid shows a tendency to become thick. Stir it, and remove the flame, and stretch across the dish a narrow piece of calico or cotton cloth so that the middle portion will hang in the solution. Set aside to cool. It may be well to allow to stand a week before examining. This experiment illustrates crystallization from a supersaturated solution.

EXPERIMENT NO. 66—

Cautiously boil about 5 grams of copper sulfat [$CuSO_4$], pulverized, in 10 cc. of water in a test tube until it is dissolved. Then place the test tube in an oblique position and let the liquid cool. It should be allowed to stand for some time. The crystals obtained can be dried between filter or blotting paper and preserved. This experiment illustrates *crystallization from solution.*

EXPERIMENT NO. 67—

Melt 15 or 20 grams of brimstone (Roll Sulfur) in a short, wide test tube. Cover its mouth now and then with cardboard if the sulfur should take fire. After complete *fusion* let it stand still till it starts to solidify on the surface; then pour off half of it into a dish of water and set the rest aside to cool. Examine the part in the water, pulling it to note its elasticity, etc. When the part left in the tube is solid, break the tube and look for crystals.

EXPERIMENT NO. 68—

Put 3 or 4 crystals of Iodine into a wide, perfectly dry test tube. Have a dry stirring rod in the right hand, and with the left hand, hold the tube containing the Iodine in the flame of the Bunsen burner. As soon as dense purple fumes begin to rise in the tube, remove the tube from the flame, and thrust the stirring rod into the tube, nearly to the bottom, being careful not to touch the sides of the tube with the rod. Keep it there until the Iodine vapor has settled, and examine both the rod and tube by means of a lens. This experiment is the same as Experiment 12 [ELECTRICAL EXPERIMENTER, September, 1916, issue], and illustrates the formation of crystals by *sublimation.*

EXPERIMENT NO. 69—

Place a piece of Ferrous Sulfat [$FeSO_4 5H_2O$], in some place where it may be exposed on a piece of paper for a week or so, after which time examine for white powder. This experiment illustrates *Efflorescence.*

EXPERIMENT NO. 70—

Expose a piece of Calcium Chlorid [$CaCl_2$] on a paper for a week or more. Note any phenomena. This illustrates *Deliquescence.*

The laws of precipitation state:—

[1] That when two substances are mixed in solution, a new compound can be formed that is insoluble in the solvent employed, such compound will be formed and will appear as a *precipitate.*

[2] When, on mixing different substances, a new substance that is volative can be produced by the rearrangement of the atoms of the partaking substances, such new substance will be produced and will appear as a *gas.*

EXPERIMENT NO. 71—

Suppose we wish to prepare Silver Chlorid [AgCl]. We know that this compound is insoluble. Therefore we must select a soluble salt of silver, and also a soluble chlorid. Silver Nitrat [$AgNO_3$] being the only soluble silver salt in common use, we make a solution of it. We may also take most any chlorid, because they are mostly all soluble. Sodium Chlorid [common table salt] being one of the cheapest, we shall use it. Take a little Sodium Chlorid and dissolve it in water. Pour one of the solutions into the tube containing the other, and the precipitat of silver chlorid which we wanted is thus obtained. Save the precipitat for the next experiment. This experiment also illustrates a substance which is insoluble in water.

EXPERIMENT NO. 72—

Prepare some Silver Chlorid [AgCl] as in Experiment 71, taking not over 5 cc. of each solution and using for one the silver salt prepared. Let the Silver Chlorid subside and pour off the upper supernatant portion of the liquid, leaving the solid with some liquid. Add a little Ammonium Hydroxid [NH_4OH], cover the mouth of the tube with the thumb, and shake well. If the solid does not all disappear, add more Ammonium Hydroxid. Upon the addition of Ammonium Hydroxid, the precipitat should be dissolved and a clear translucent solution formed. Thus we have *prepared a solid from two clear liquids,* and *then dissolved the solid with another liquid.* This experiment shows that substances which are insoluble in water, are made soluble in various other liquids.

(To be continued.)

Statement of the Ownership, Management, Circulation, etc., required by the Act of Congress of August 24, 1912, of The Electrical Experimenter, published monthly at New York, N. Y., for April 1, 1917.

State of New York, County of New York, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Hugo Gernsback, who having been duly sworn according to law, deposes and says that he is the Editor of The Electrical Experimenter and that the following is to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business manager are: Publisher, The Experimenter Publishing Co., Inc., 233 Fulton St., New York City; Editor, Hugo Gernsback, 233 Fulton St., New York City.; Managing Editor, Hugo Gernsback, 233 Fulton St., New York City; Business Manager, Hugo Gernsback, 233 Fulton St., New York City.

2. That the owners are: The Experimenter Publishing Co., Inc., 233 Fulton St., New York City; Hugo Gernsback, 233 Fulton St., New York City; S. Gernsback, 233 Fulton St., New York City; Mrs. K. Hymes, 233 Fulton St., New York City; H. W. Secor, 233 Fulton St., New York City.

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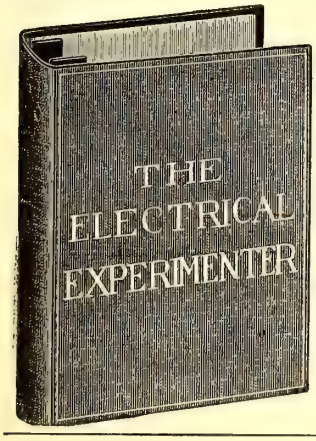


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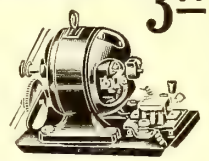
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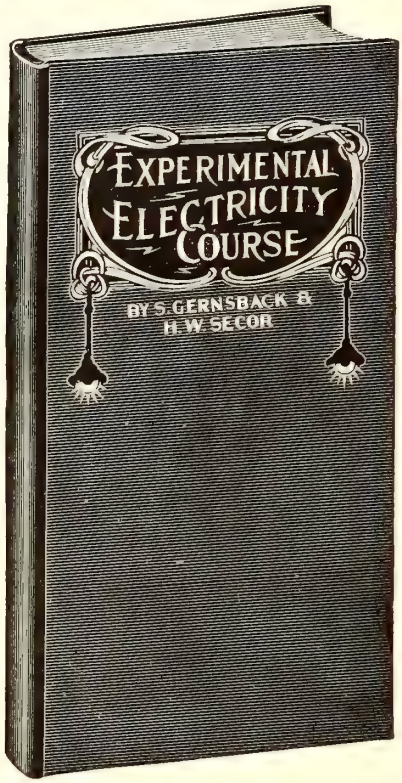
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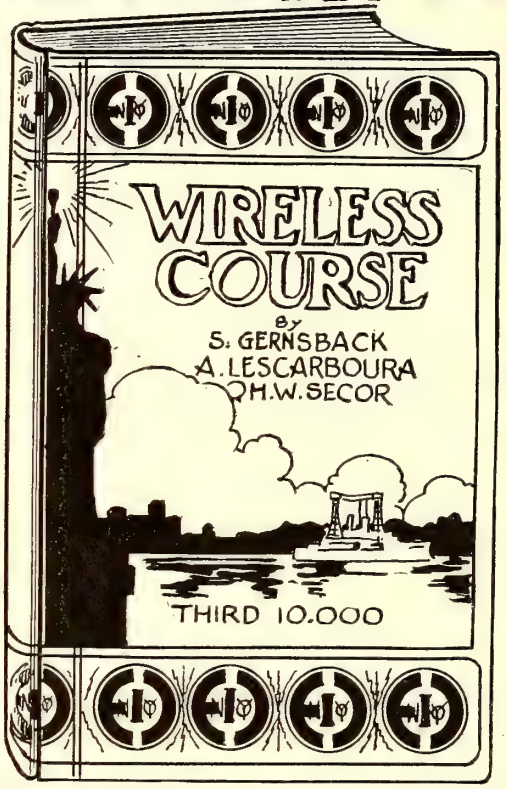
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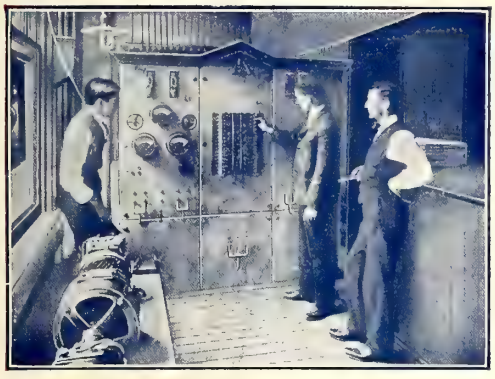
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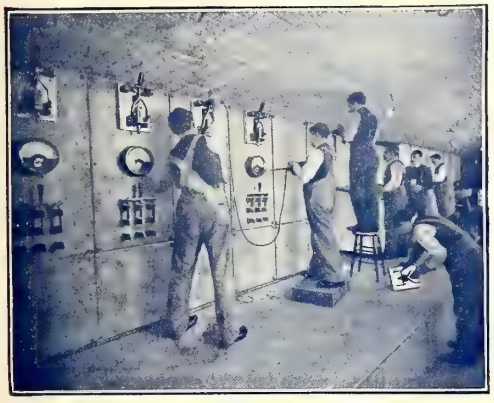
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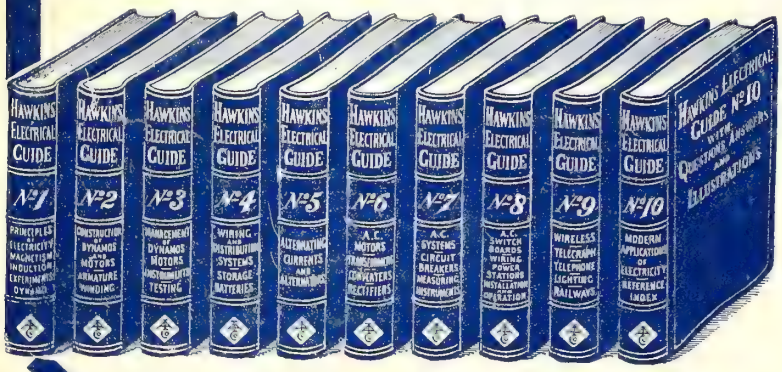
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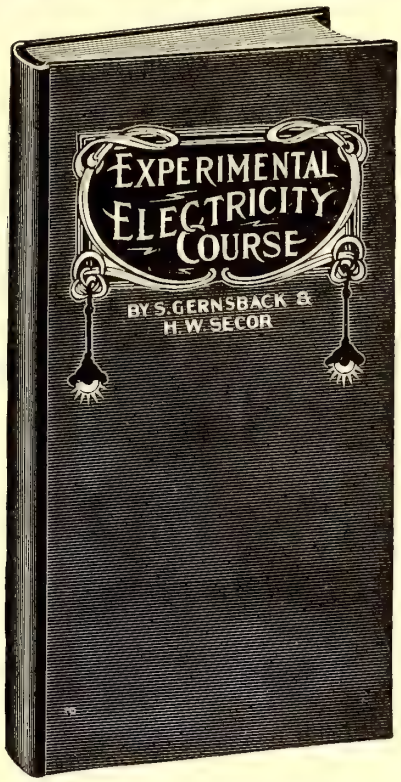
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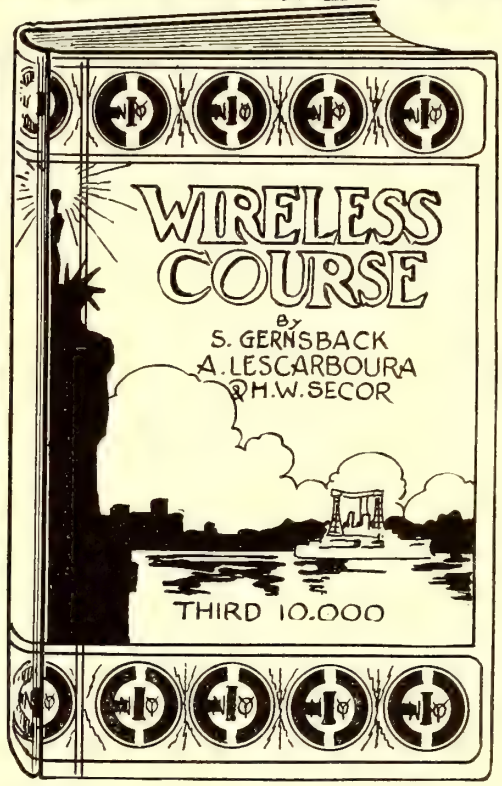
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UNIVERSITY OF MICHIGAN
AUG 31 1917
U. S. PATENT OFFICE

War and the Inventor

IN this great crisis, a word to our patriotic inventors will not be amiss. As I have pointed out before, the average inventor is a poor business man and a worse salesman. No matter how clever or how ingenious he is, he will insist upon presenting his story in the worst possible manner. As a rule he has labored for nights upon nights in solving an important problem; every phase of the invention is so clear and lucid to him that he becomes irritable and angry if those about him do not at once grasp all the details. Or else, in his enthusiasm, he will sit down and taking a piece of brown wrapping paper and a pencil, he will forthwith begin to write out a few often unintelligible phrases, garnished with incomprehensible sketches, which are supposed to clearly explain his invention. He closes the missile by offering his device "free and gratis" to the Government, puts it in an envelope addrest to the Secretary of the Navy, and then mails the letter, thinking that he has done a great patriotic act. Then if a long ominous silence follows, the inventor as a rule becomes embittered and hostile to the Government.

Now, this is no exaggeration. As Editor of *"Patent Advice"* I receive from twenty to thirty letters a day, to be transmitted to the Government, if in my estimation the device is practical. And not two of these ideas are submitted in a presentable or even an intelligent manner. Penciled letters prevail and often the sender forgets to sign his name. And in Washington the War and Navy Departments are deluged daily with just this sort of mail, ninety-nine percent of which is discarded. And it probably happens once in a while too, that the Government loses a really good idea simply because the one submitted was unintelligible and in consequence found its grave in a waste basket.

Now the man at his desk in Washington is human—and consequently weak. Try as he may, he will pay more attention to a neatly typed letter, than to a scrawly penciled note. A correctly drawn sketch will at least arouse a passing interest, whereas a misshapen free-hand pencil design, will rarely fetch a spark of enthusiasm.

The inventor would not dream of running to the War Department in armsleeves, unkempt, unshaven and in a soiled and torn shirt. But he insists on sending the child of his brain just that way.

If you have an idea that you think is worthy, this is the way—the only way—to proceed. Remember first, that the Government receives daily thousands of useless letters from inventors—*yours* may be useless, no matter what YOU think. Remember too that there is no greater intoxicant than a newly born invention; under its influence you are in no condition to think straight, least of all sending your invention to Washington. I have been intoxicated myself dozens of times in precisely this manner and I know whereof I speak.

First you should take your plan to a trusted friend who is versed in mechanics or electricity. Invite criticism. Obtain expert opinion. Remember you don't know it all—no one does. Edison says he is just beginning to know a few Nothings.

If the expert advice convinces you, that you really have a worthy device, then and only then begin to think about Washington. Have someone typewrite your idea in a neat and clear manner AND MAKE IT SHORT. Long explanations hurt your cause. Use the telegraphic style, just as if you had to pay for each word and don't attempt to make your own drawing, unless you are thoroly familiar with drafting instruments. Find a draftsman who will make a creditable drawing in China ink upon a bristol board. Then sign your name and address to BOTH description and drawing, and mail the two FLAT. Don't roll either manuscript or drawing. But use a piece of heavy stiff cardboard to keep the contents of your letter from being folded in the mails. If you do this I promise you a warm letter of thanks from the official who reads your invention.

Moreover, don't send your letter to your Congressman or to your Senator, as many misguided inventors are wont to do. At best it only delays it. Instead, address it to either the *Secretary of War,* or to the *Secretary of the Navy,* all depending upon what subject your invention treats. Last but not least don't worry our officials with torpedo or submarine catchers which depend upon magnets. The majority of ideas submitted are based upon this popular delusion. Here are facts: If you had an electromagnet that would attract one million pounds (no such animal was ever built!) a steel torpedo rushing by it at a distance of 20 feet would not be deviated one inch from its course. For the largest electromagnet exerts practically no *tangible* force a few feet away from its poles.

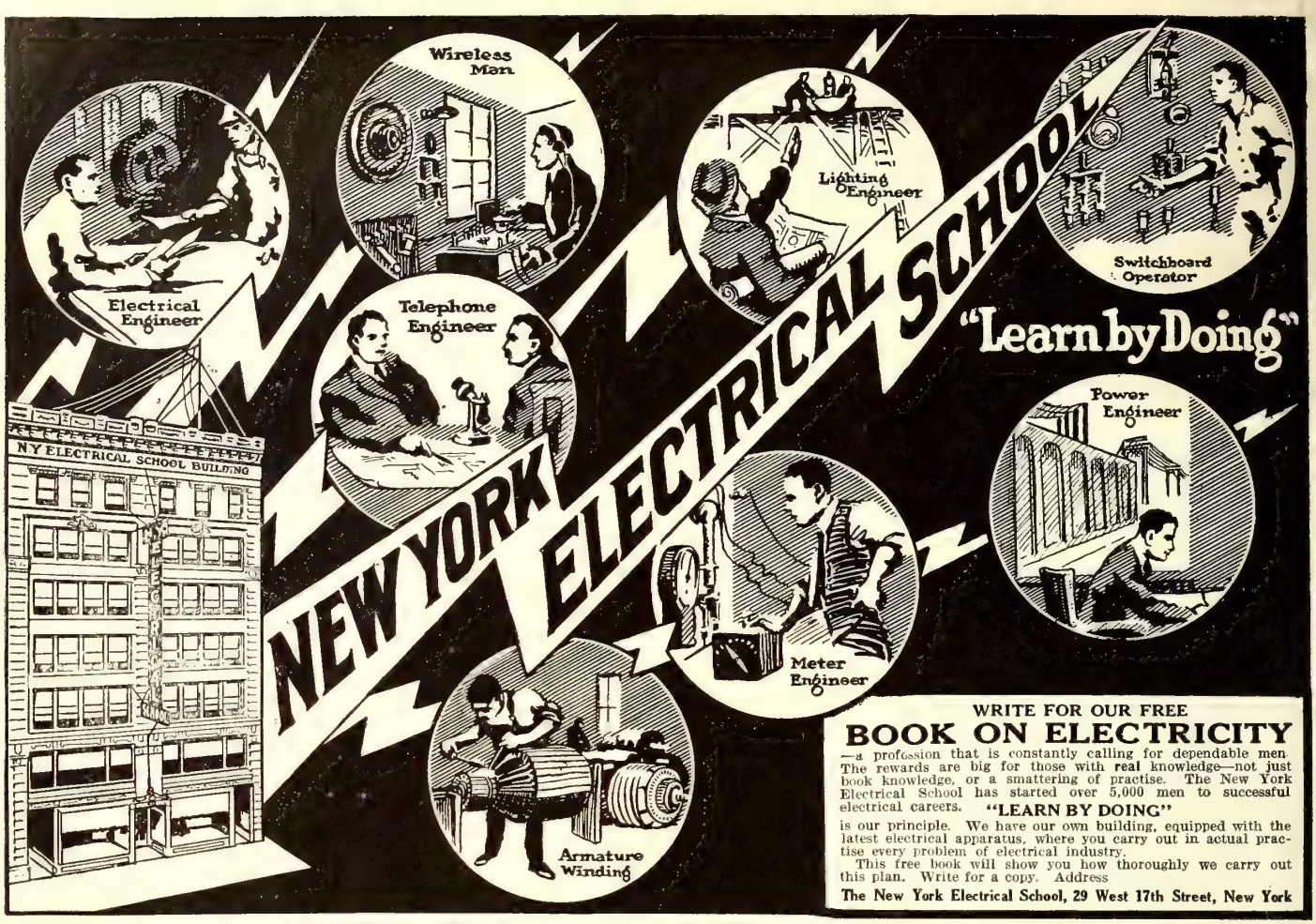
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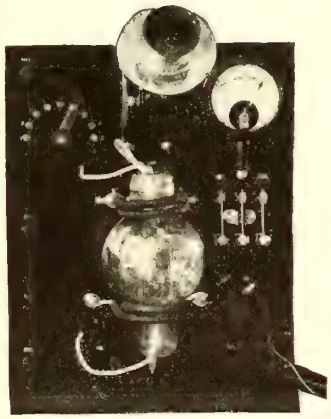
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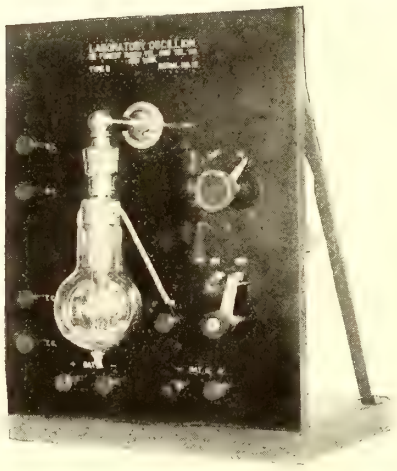
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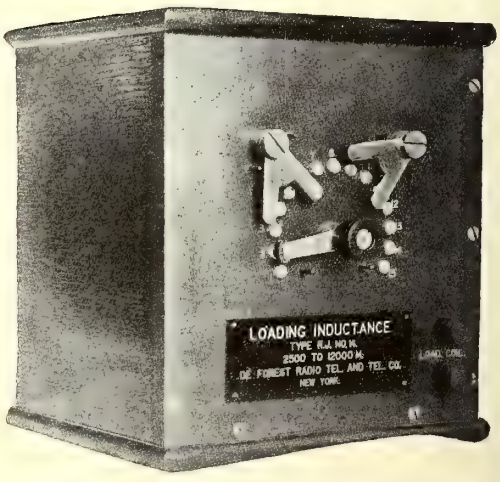


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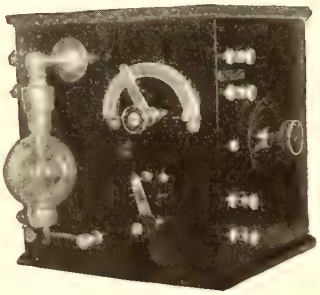
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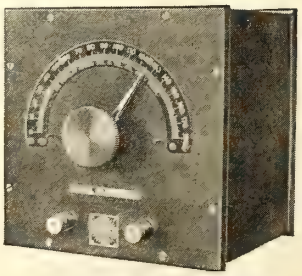
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THE ELECTRICAL EXPERIMENTER

H. GERNSBACK EDITOR
H. W. SECOR ASSOCIATE EDITOR

Vol. V. Whole No. 51 July, 1917 Number 3

Locating and Destroying Submarines with Red Light

A NEW method due to Yankee ingenuity and intended for locating submerged sub-sea boats at a considerable range has recently been worked out. It has been described by a retired naval officer and appears to have made a favorable impression on the navy's experts.

If once it becomes possible to locate the presence of an enemy submarine, then the greatest worry of cargo steamship captains will be over, for when the "sub's" location is spotted then the vessel's guns will be trained on the spot. As soon as the under-water boat comes to the surface to take her sightings she will be met with a hail of shot and shell.

The new method, holding great promise for the destruction of the submarine and its entire elimination as an efficient weapon of warfare is now being perfected, and it is probable that within a very few weeks vessels may navigate the high seas with safety, so far as submarine attacks are concerned.

As may be imagined, the experimenters in this field are not willing to make public the actual experiments, details and results accomplished, but the following outline of the method now under consideration will be of great interest to the public.

Inasmuch as the great advantage of the submarine over surface vessels is the fact that it is hidden from view, if by some means the exact location is made known to a vessel before she approaches within the danger range (2,000 to 2,500 yards) of the submarine, the menaced vessel can invariably escape.

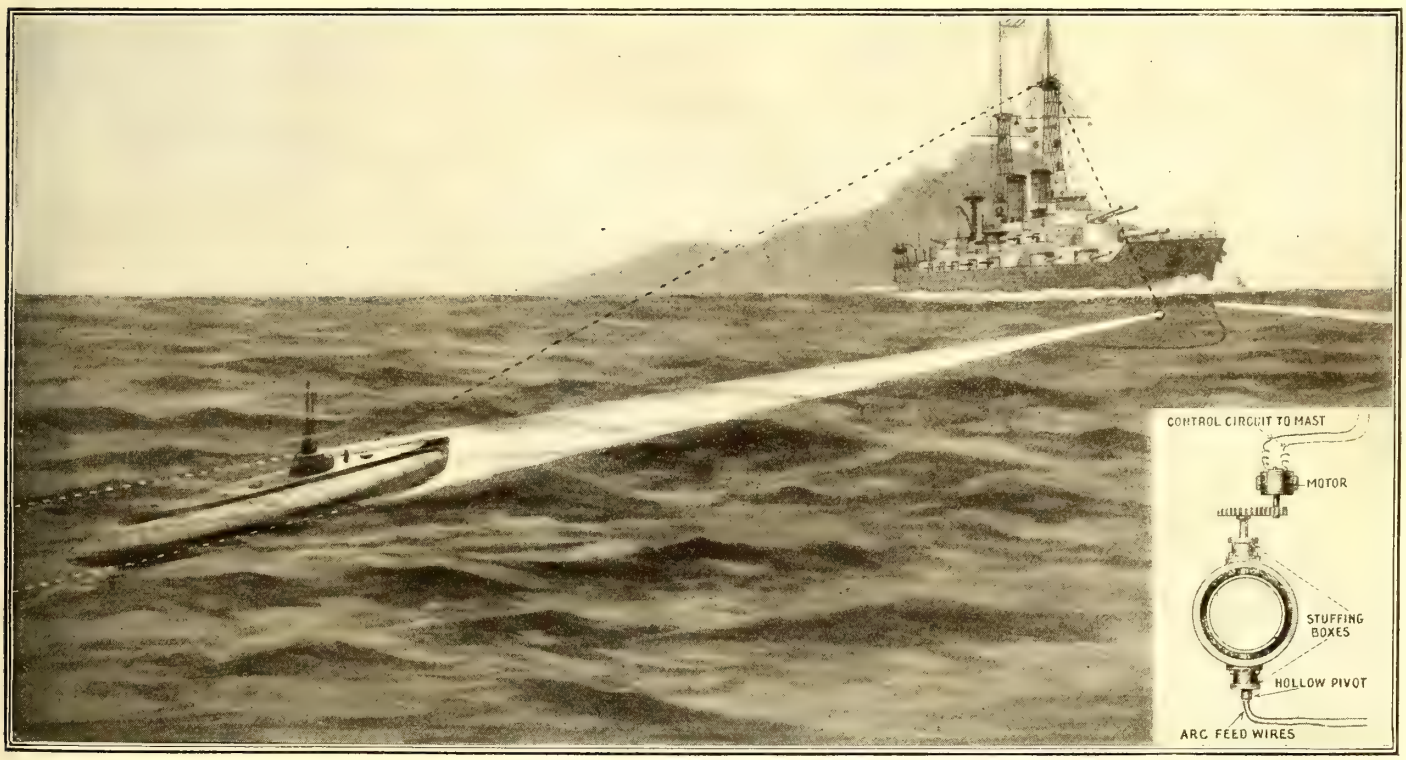
In seeking methods to be employed for certain purposes, inventors and experimenters frequently turn to the five senses when beginning the solution of a baffling problem. We cannot feel, smell or taste a submarine over a mile distant, so we are left only two of the senses remaining—the sense of the eye and that of the ear.

The microphone enables us to hear more or less distinctly the engines of the submarine when they are working at more than slow speed, but this is not sufficient, as a submarine lying in wait to torpedo a vessel needs only to turn her engines over very slowly to maintain her depth below the surface.

A submarine vibrator operated by electricity has produced an echo from an iceberg two miles distant, but it is doubtful if the system can be improved to efficiency in the case of the submarine. Now let us consider our remaining sense: sight.

When our ship approaches the danger zone of the submarine the latter is maintaining a heading which is nearly at

(*Continued on page* 215)

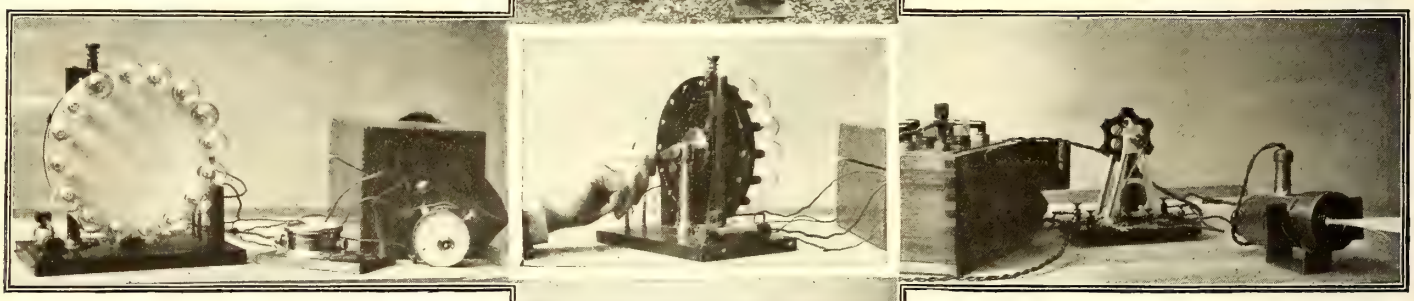


Why Not Locate the Submerged, Yet Always Dangerous, Enemy Submarines by Continually Flashing a Powerful Red Searchlight Beam Back and Forth Thru and Under the Water, Asks a Yankee Genius. Once a "Bulge" Is Spotted (Day or Night) in the Light Beam, the Observer on the Mast Signals That Fact to the Gun Crews. Consequence—as Soon as the Periscope Appears the Already Trained Guns Open Fire. The Spotting Range Is Over Two Miles, Day or Night.

Cold Light

WE are accustomed to seeing the electric or other source of light with unfeeling senses, *i. e.*, without stopping to realize for one moment that—while it is undeniably true that the modern electric light is a masterpiece of scientific attainment, thanks to Edison and other investigators—we are actually paying many times what we should expend for this human comfort. Think for one moment that only *3 per cent* of the electrical energy put into a modern gas-filled, tungsten filament, incandescent electric lamp is realized as *useful light;* the balance of the energy is paid for and uselessly dissipated in the form of heat and other radiation.

The fire-fly is one of the greatest and absorbing wonders of all Nature. Why?—because he knows how to produce practically a *cold light.* The illumination engineers of today are studying the problem with all the resources at their command. There ought to be—there must be a way in which to convert all or nearly all of the electrical energy into useful light. The electric motor converts electrical energy into mechanical energy with an over-all efficiency of 90 to 98 per cent. Suppose we had perfected an electric motor with an efficiency of but 3 per cent; how many motors do you think there would be in use? Yet we are content, at least until

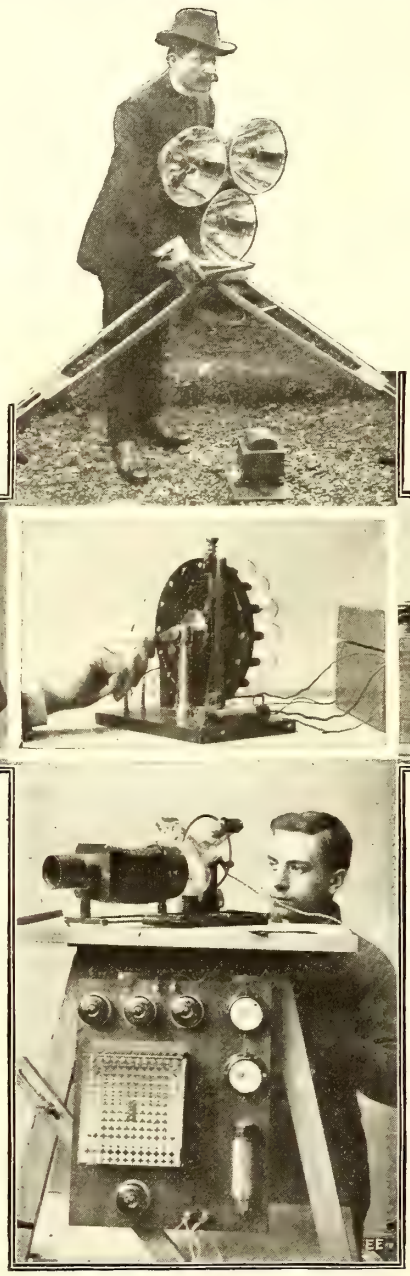


Above — Complete Dussaud Experimental "Cold Light" with Generator and Current Measuring Meters.

we know more about the subject, to use electric lights with this almost unbelievably low conversion efficiency.

One of the nearest approaches to man-made cold light is that of Professor C. F. Dussaud, French scientist and investigator. The accompanying views show some of the successful apparatus devised by him, also their applications. Dussaud has evolved a very ingenious arrangement, which, altho not giving a true *heatless* light, yet produces light with a negligible quantity of heat.

The elementary principle upon which this so-called cold light is based is that of impressing at sufficiently close and intermittent intervals an excess voltage of several times the normal value to each lamp. To accomplish this a number of incandescent lamps are arranged in a circle on a rotatable disc as shown herewith. This disc may be rotated by hand or by an electric motor. The lamps have metal bases and a metal brush contact is caused to press against one base at a time. All the lamp bases have one of their poles connected to a common return contact, made in the form of a ring at the back of the disc, against which a second metallic brush makes contact. As seen it now becomes possible to rapidly switch one lamp after the other into circuit, consecutively. The persistence of vision of the retina of the human eye defies the detection of the lamp substitution, the intermittent flashes producing the effect of a steady light. Each lamp is in consequence lighted for so short a time period that the infinitesimal amount of heat developed is quickly dissipated. The *cooling* interval is about twice that of the *light* interval. The lamps, moreover, can in this way be operated on 3 to 4 times the normal voltage, vastly increasing the efficiency and illumination of each filament thereby. It is said that Dussaud has succeeded in obtaining 250 to 800 C.P. of *cold light* for several hours from a bank of 16 lamps rated normally at only 25 to 80 C.P. with an energy in-put of 50 to 160 watts.



Top Center View—A "Cold Light" Projector of the Dussaud Type Intended for Use by Firemen and for Military Purposes. Center—Rear View of "Cold Light" Machine. Lower Center—A Three-Lamp Projecting "Cold Light" Apparatus.

Professor Dussaud employs an optical system with his lamps, in other words, either lenses or mirrors. The result is that while the heat effect of the electric current is dissipated over a great area, the luminous rays are concentrated in a very small point or space. The tungsten lamps employed are of Dussaud's own design. Some of them are only 0.8 to 1.6 inches in radius. Groups of three are used in some models. They are successively flashed in the focus of a condensing lens, without breaking down the filament or blackening the bulb. Indeed, it is said that the results produced are identical with those obtained with an electric arc *ten times more intense.*

For motion picture projection machines the new cold light possesses wonderful merits, enabling the operator to run the film off as slowly as desired, and even to stop the film for examination when necessary. Dussaud, scientist, has projected motion pictures on a screen 15 feet square with an electrical energy consumption of 150 watts, compared to the 5 to 10 kilowatt (5,000 to 10,000 watts) arcs now used. And the cold light machine, complete with generator, could be carried easily in the hand. Due to this rapid dissipation of heat, it becomes possible to employ celluloid instead of glass plates for ordinary lantern slides with no danger of igniting the celluloid or of causing it to shrivel up. Dussaud has prophesied that with his cold light it will be possible to use celluloid films ¾ of an inch by 1 inch in size instead of glass plates 3¼ by 4 inches. The celluloid can be cut into long strips, perforated along the edges so that it can be printed mechanically, as in making moving picture positives. Indeed, he claims that a single operator can make twenty-five thousand celluloid prints a day. These tiny photographs can be made by any amateur at a cost of not more than a cent, and can be projected on the screen by means of small, low-priced projectors.

Above—The Microscopic Projection of a "Cold Light" Beam as Devised by Prof. Dussaud of France.

By utilizing the marvelous cold light auto-chrome plates can be projected, which otherwise suffer when exposed to the intense heat of the electric arc. Powerful lights can be concentrated upon parts of the human body without danger of scorching them, with the result that foreign bodies can be located very readily in the muscles.

The cold light lends itself admirably to the photographing of interiors. The inconveniences attending the use of ordinary magnesium flash powder are well known. Powerful cold lights render it possible to make very brief exposures without filling the atmosphere of the room with smoke and fumes.

With a small electric battery and a simple lens, a beacon light of long range can be cheaply produced. Such an apparatus will be found serviceable on small sailing boats as well as by soldiers. It is easy enough with such a device to telegraph optically for great distances. One of the views shows the microscopic projection of cold light.

How the Submarine Can Hit a Ship It Never Sees

By H. WINFIELD SECOR

THE German submarine has finally become a most menacing factor in the great world-war and now presents a first-class problem to all the would-be and master inventors —electrical, mechanical—and fourth-dimension. Remember reading now and then in the daily papers how "another" merchant vessel was torpedoed and the officers *saw no submarine?* Sank in 10 minutes and crew left in the water to float ashore or possibly to be picked up by a patrol boat. Yes, there have been a lot of such cases as this and even more mysterious ones. For instance there is the case where the ship's lookout remembers having seen an enemy submarine several miles off—much too far to be within torpedo range. Moreover, nothing more had been seen of the enemy after the first sighting, but suddenly—a terrible explosion fairly lifted the boat out of the sea—torpedoed? Sure as guns? But how? asks everyone, from Captain down; yes, how? and in broad daylight!

That's the question—and it now seems that there is an answer. Possibly the reader has guest it by looking at the accompanying illustration. At any rate here's a new aspect, and what is more, a thoroly practical one of the science of submarining. Let us admit that the officers on the merchant ship spot a periscope several miles away, or even a mile and a half away. That's an almost impossible target to hit with any kind of gun and the chances are the submarine couldn't shoot a torpedo once in ten times to hit the merchantman at such a range.

However, the German sub-sea boat commander doesn't have to worry about sinking the freighter with a torpedo from *his* submarine. Not at all. Give him a few minutes to draw a bead on your position and your speed, as well as the course, with his periscope and range-finding instruments. That is all the information he requires to sound the death knell of the proud merchantman.

And sound it he does, for as soon as he has the necessary data on your status and position, he at once transmits it thru the water by powerful sound waves to one or more submerged sub-sea fighters lying in the path of the on-coming steamer. Knowing the location, direction and speed of the unsuspecting commerce boat, the hidden submarine (or submarines) can discharge a torpedo sufficiently accurate to spell the finish of the "barred zone" prey.

The illustration shows this remarkable maneuver in a grafic manner. The merchantman may even fire on the periscope of the distant submarine, but as aforementioned the chances of hitting it at a range of 1½ to 2 miles are very slim. Besides, the spotting submarine may have been watching the steamer for some minutes before the latter's look-out spies the cunningly disguised and mottled periscope. At the first shot from the steamship's gun crew the submarine may disappear. Consider that the U-boat commander has the range of the enemy; he at once dispatches the data by sub-sea telegraphy or telephony, so that other U-boats lying submerged or awash at the surface, will receive the information on their sound wave apparatus.

All this may sound somewhat mythological—but it is not. Our own sub-sea fighters and war vessels are all equipt with similar instruments. They are based upon the researches of Prof. Reginald A. Fessenden, the well-known American inventor and scientist, and involve the principle that water will transmit sound waves remarkably well. To set up such sound waves of sufficient power to carry several miles (in tests, this method of communication has worked up to 20 miles) a special heavy diafram is employed, which is caused to vibrate rapidly by electromagnetic means. A similar diafram is used at the receiving station, and which is set into vibration by the sound waves or vibrations in the water. Prof. Fessenden has succeeded in telephoning several miles by means of such sound vibrations propagated thru water. Thus we see how it is not only feasible, but entirely possible for a submarine to torpedo a ship without ever having seen it.

(The above-mentioned sound wave sub-sea telegraph apparatus was fully described, with photographs, in our August, 1915, and February, 1916, issues.)



The Latest Reports Regarding Submarine Activities Frequently State that the Ship Was Torpedoed by an "Unseen" Sub-sea War-vessel. This Can Easily Be True for, by Utilizing Telegraphic Sound-waves Propagated Thru Water (Fessenden System), a Relatively Distant "Range-finding" Submarine Can Signal Her Hidden Allies as to the Position and Course of the Enemy. Thus the Submarine That Fires the Fatal Torpedo Need Never Show Its Periscope.

ELECTRICAL TREATMENT OF BRITISH WOUNDED.

In a recent number of the "Lancet," Dr. W. J. Turrell describes various applications of electro-therapy at the Radcliffe Infirmary, Oxford, England. One interesting point is the treatment of unclean wounds by ionization; produced either by the application of salt solutions traversed by an electric current, or by means of ultra-violet rays. As is well known, electric currents are now much used in treating certain varieties of rheumatism.

Of considerable importance is the application of mild electric "shock" to stimulate the voluntary movements; the treatment is specially efficacious in those cases of nerve shock where the patient is under the delusion that he has lost the power of his limbs.

However, the application of electric methods to cases of "shell-shock" calls for discretion. In some such cases the patient is not at all benefited and, indeed, exhibits "electrophobia."

Currents are also a valuable means of testing the action of various muscles and the powers of sensation, and in producing movements which break down internal adhesions or the binding of scar-tissue. The static machine is considered specially useful in this direction.

Does Radiant Light Possess Weight?

By A. R. McPHERSON

THE study of light presents some very interesting facts in regard to that mysterious force of Nature, which permits man to view the visible objects of this material world, and altho we are still in the dark, so to speak, as to the true nature of light, much progress is being made which will perhaps, even in the present generation, reveal the facts concerning light. The first theory advanced as to the nature of light was the *materialistic* theory, which involved the idea that light was composed of *material particles of matter.* This theory was rejected years ago, but like the alchemists' dreams of the transmutation of matter, which it seems is now becoming a reality, so this materialistic theory is again coming into favor.

The present generally accepted theory states that light is identical with electro-magnetic disturbances, such as are generated by oscillating electric currents or moving magnets; but this must presuppose the existence of an imaginary medium called *ether,* which is supposed to pervade all space, and is in the interior of all bodies of whatever nature. It is thin, elastic, and capable of transmitting vibrations with enormous velocity. Every luminous body is in a state of vibration and communicates vibrations to the surrounding ether. This, in short, is the electro-magnetic ether theory which has been evolved in recent years.

It is the belief of many, however, that *ether,* to exist at all, must be in a material form such as a gas, in order to harmonize with natural laws. To quote from "New Knowledge": "Mendelieff, the Dean of chemical science, has recently originated the conception that the ether, instead of being some mysterious form of non-matter, as generally believed, is actually the lightest and the simplest of the elements, and a *definite form of matter.* He believes it to be one of the inactive gases of the Argon family of elements and he assigns to it the position 'X,' in the zero group of his revised periodic arrangement of the elements. The atomic weight of the ether he concludes to be one-millionth of that of *hydrogen* and its atoms consequently travel with enormous velocities. This extreme velocity explains the all-pervading character of the substance."

Prof. T. J. J. See, a scientist whose researches are known thruout the world, recently made public the following statement in regard to light:—"The whole theory of ether is abandoned as having no real existence, light being caused by electrically charged particles, shaped like eggs, revolving about their shorter axes."

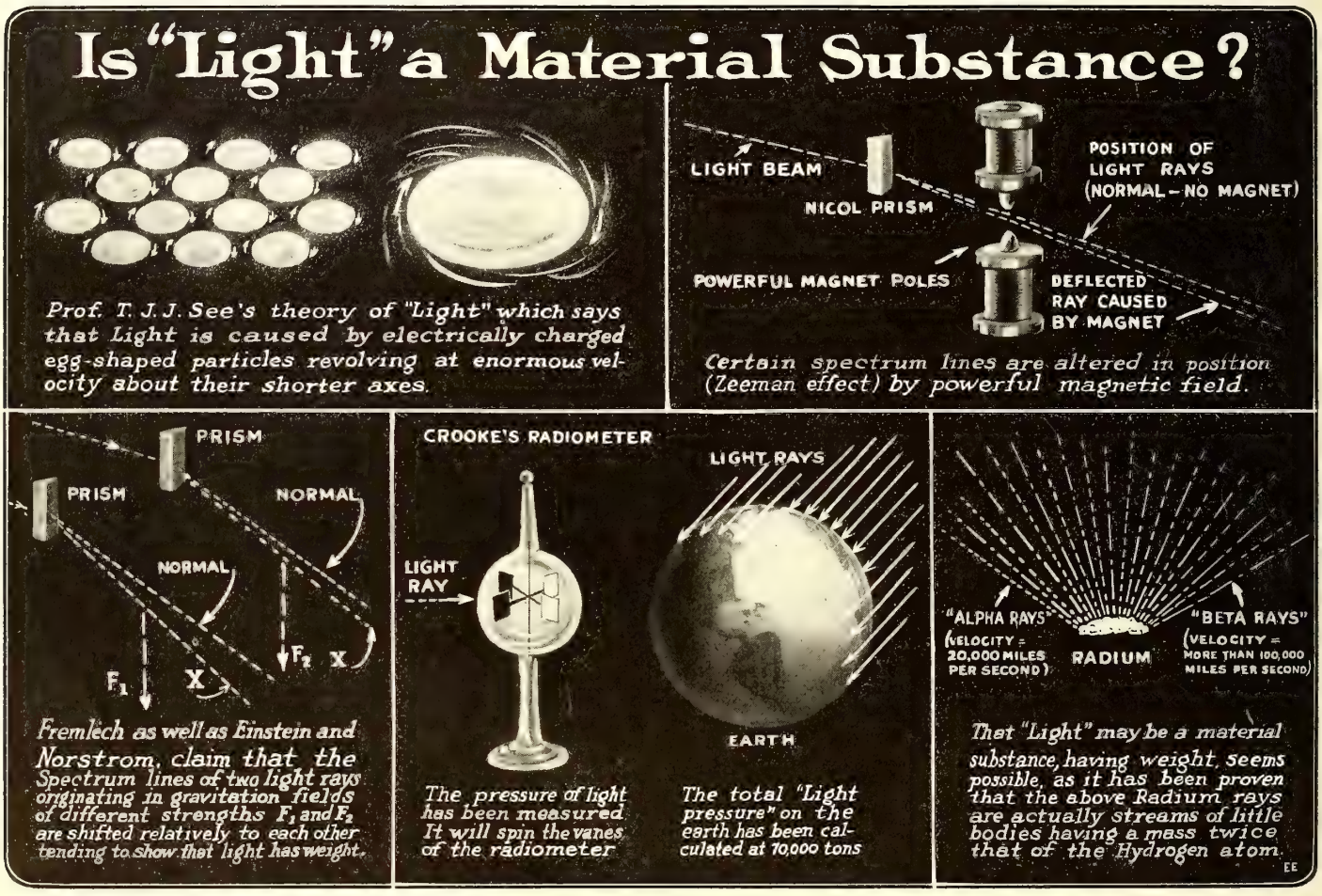
It would thus seem that there is considerable difference of opinion about the nature of light, and the writer has endeavored to gather together some of the leading facts and theories which tend to throw some "light" on the subject.

If it can be proven that light has *weight,* it must necessarily follow that it possesses material form and properties. No influence of any form of attraction on light had been noticed until about twenty years ago, when Zeeman showed that a powerful magnet visibly altered the position of certain lines in the spectrum.

Now it appears that gravitation has a similar, tho not the same effect. According to the theories of Einstein and Norström, there should be a real influence of gravitation on light. It is asserted that the spectrum lines of two light-rays originating in gravitation fields of different strengths are shifted relatively to each other. As Fremlech has now shown, the shifting is very well explained, so far as its amount is concerned, by Einstein's theory. An influence of an impulse proceeding from the sun, on shifting, cannot be the cause; for in this case, single lines would be shifted in different degrees. But the measurements show that the shifting of the lines, both in amount and direction, is the same for all, as Einstein's theory of the influence of gravitation requires. The shifting of the lines calculated with Einstein's formula agrees remarkably well with the average observed values. The influence of gravitation on light may now be regarded as partially proved, and thus it may also be inferred *that light possesses weight.*

From the above facts it may be demonstrated and must also be proven that light exerts pressure, since it is a material substance possessing weight. This peculiar truth was proven mathematically as early as 1873 by Maxwell, tho it was applied then and still is to a certain extent in support of the *electro-magnetic wave theory.* In 1901, Peter Lebdew actually proved and measured the *mechanical pressure of light.* The pressure discovered was small, of course, but the minuteness of a thing is often an inverse measure of its importance, as this light pressure has been found adequate to explain some of the earth's greatest

(*Continued on page* 215)



War and Radio In the Movies

THE hero of the realistic Bluebird photoplay—"Treason," is a Government telegrapher in the service of a mythical European country at war with its neighbor. He is selected to go to the front, and this arouses the jealousy of his chief, who regards it as a personal affront. Pettrus distinguishes himself at the front as a telegrapher, and is invalided home. He finds, instead of promotion, that he is degraded to the position of messenger. His chief has tampered with a telegram, ordering him to spare Pettrus as much as possible.

He feels deeply the neglect of his country, and confides his feelings to his friend the tobacconist, who in reality is a "spy." The man sends information to the enemy (top view) by means of wireless apparatus concealed in a trunk in his rooms. (extreme right photo). He works upon Pettrus' resentment until he finally persuades him to steal the new code from the home of the Head of the Secret Service, with whose daughter Pettrus is in love. No sooner has he done so, than he repents, and would give anything to undo his act.

The Head of the Secret Service has been watching the tobacconist, whom he knows to be a spy. He now questions Pettrus, who finally confesses. The Head of the Secret Service helps him to recover the code. There is a thrilling automobile chase, which ends in a terrific smash over the side of a cliff. The tobacconist is killed, and Pettrus seriously injured. In the hospital, he returns the code to the Head, who promises that his act shall be a secret between them. The woman with whom his Chief has been on terms of intimacy finds the doctored telegram, and in revenge for neglect, exposes the Chief to the Head of the Government telegraph department. The delayed reward for Pettrus' services arrives, and the spite work of his Chief is revealed.

The Universal serial "The Voice on the Wire" is concerned with a series of murders, committed in the same way, by an attack on the victim over his heart which leaves a bruise the size of a human thumb. No other clue is left except a message from a mysterious voice spoken over a disconnected electric wire, which warns the victim of his end, and exults over the detectives, as each time they fail to circumvent it. In the eleventh episode, a strange invention is introduced. This is a material development of the science of mental telepathy. (In the "movies," they do it!) By a wireless arrangement, the mind in control can communicate with the mind it influences, and the machine is made to register the thought. By its use (central view here shown) the investigator who is tracing the crimes, learns of the plans of a group of criminals, who are supposed to be connected with the murders, and in whose power the girl who he loves was formerly held.

The enemy having "captured" New York City, in Greater Vitagraph's preparedness spectacle "Womanhood," Harry Morey, who plays the part of Paul Strong, Director of Energies, U. S. A., proceeds to evolve a plan by which he can be appraised of their movements and act accordingly.



Mary Ward (Alice Joyce) the Heroine of the War Film-Play—"Womanhood" Is Caught Using Her Pocket Radiotelephone Set.



Top Center:—A Stirring Scene from "Treason," the Great Photoplay of War, Radio and Love. Center Scene:—A Moment from Universal's—"The Voice on the Wire." Lower Center:—Paul Strong, Director of Energies, U. S. A., in "Womanhood," Receiving a Report from His Sweetheart in the Enemy's Stronghold (Extreme Left) "Via Radio."

His sweetheart, Mary Ward, played by Alice Joyce, is also the object of Prince Dario's enamouration. Count Dario is one of the commanders of the invading host and the son of Marshal Prince Dario, the militaristic Commander-in-Chief of the Ruritanians, the name given the "enemy."

Thru Count Dario's influence, Mary is offered a position in the invader's headquarters which is located in the Woolworth Building. Mary seeing in this an opportunity to serve her country, accepts, and vehemently denounces her native land.

Paul Strong, perceiving in Mary's position an opportunity to strike a telling blow to the "enemy," accordingly outfits a wireless telephone contrivance whereby Mary, thru her close association with the "enemy," can inform him of their plans without incurring their suspicions. (See left and lower center photos.) The copper gutters on the roof of the Woolworth Building are used as antenna. Mary employs a pocket radiophone instrument, which she connects with the improvised antenna, thru a secret switch, cleverly hidden in the brass scroll work of an electrolier on the side wall.

ODDLY IDENTIFIED BY RADIO.

American naval officers are highly amused over a recent "wireless romance" connected with an American destroyer. The story well exemplifies traditionary sea caution and hangs on the fact that by reason of two Americans having been roommates at St. John's College at Annapolis years ago, information was confirmed at sea that otherwise would have remained doubtful.

One man is a civilian doctor, who has taken an important post in Great Britain, the other is a paymaster in the navy. Two days before the destroyers sailed from the United States these old friends ate a farewell dinner. The doctor was to sail by a liner, but was ignorant of the ship's name and date of sailing. The paymaster was under orders to join his destroyer.

Here You Have a Chance to See a Spy's "Trunk" Radio Apparatus at Work. An Absorbing Moment from the Master Photoplay—"Treason."

When several days at sea the destroyer got into distant connection one night with a certain vessel, and made a code inquiry as to the vessel's position, course, and speed. No direct reply was made, the vessel fearing a submarine trick and the possibility of a stolen codebook. Instead of answering a demand was made to the destroyer: "Give the name of your ship in code." The destroyer complied.

Even this was not enough. A second wireless was sent out: "What is the name of your paymaster who is the friend of Dr. ————, a passenger aboard this ship?"

Then the paymaster of the destroyer was called into the wireless cabin and asked if he knew Dr. ————. "Sure," he replied. "He was my best pal. We were roommates at college, and had dinner together two nights before I sailed. Where is he?"

The destroyer sent out another radio, saying: "Paymaster ————, the doctor's oldest friend."

After this corroborative statement the vessel at last gave her position, course, and speed.

U. S. Battleships to Run on Land

By H. GERNSBACK

EVERY war brings out a host of fantastic as well as ridiculous new inventions which are supposed to annihilate the enemy. Most of these wild-cat schemes are of course as impractical as they are fantastic, and while they look good on paper, the devices do not stand up in practise, either because of inherent defects or because science and technic have not progrest sufficiently to do justice to the device.

Thus a submarine invented by no less a genius than Robert Fulton, propelled by several men and which was actually run under water, was sanctioned by Napoleon, the inventors hoping to sink the blockading English fleet. The submarine failed miserably, to Napoleon's utter disgust. Nevertheless the failure was not due to the principle being inherently wrong. Rather science had not progrest sufficiently to make the submarine a success one hundred years ago. Napoleon, if he were to come back today, would certainly experience a radical change of mind, as to the success of the submarine.

In the same manner, when John Ericsson constructed the "Monitor" in 1862, he was met with a good deal of ridicule—at first. No one believed that his steel "cheese-box on a raft," war vessel could do much damage, or even give a good account of itself, let alone winning a battle. The world knew different after the "Monitor" defeated the famous "Merrimac."

Makeshifts have been used in every war, and every important battle has them. Sometimes these makeshifts actually prove decisive in a battle, perhaps for the simple reason, that insofar as they usually contain the element of surprise, the enemy, not being prepared for the unusual onslaught is defeated.

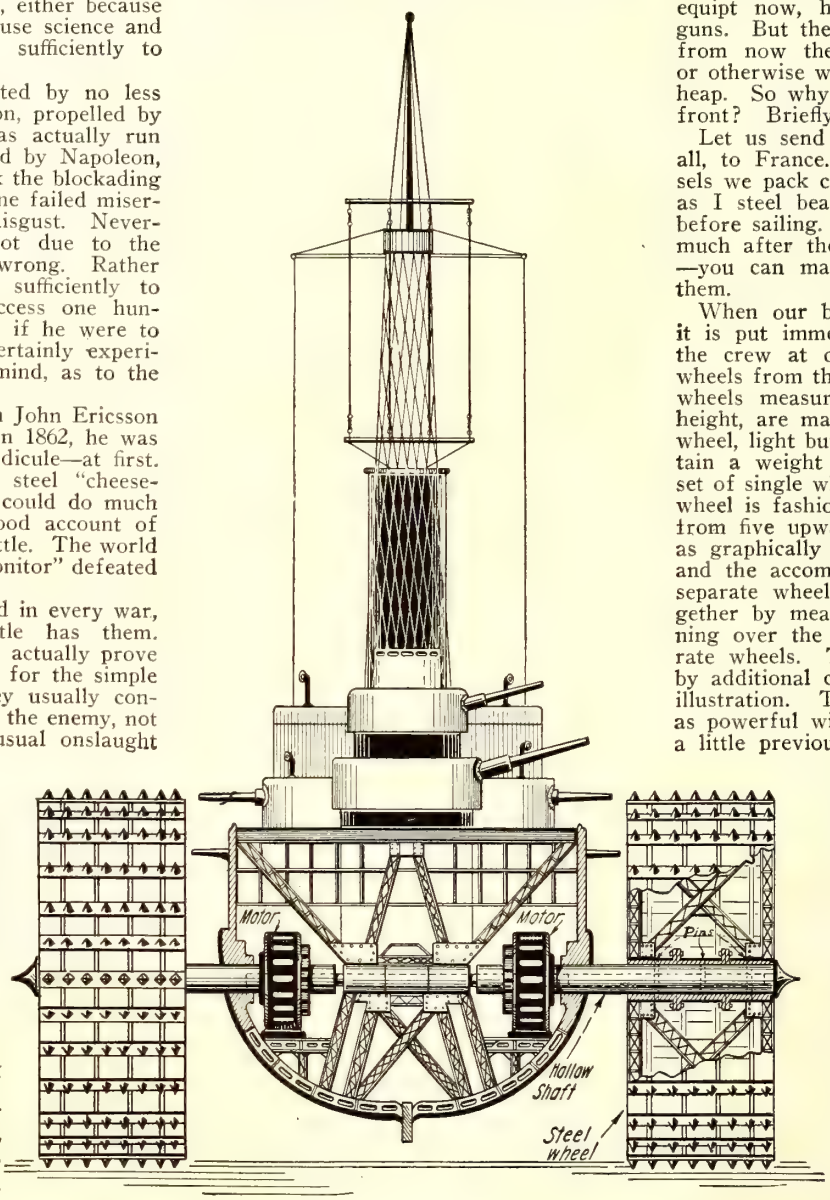
Perhaps the most famous instance where a big battle was won with a makeshift was the Battle of the Marne, in 1914. No more impossible or ridiculous weapon than an ordinary taxicab could be imagined to launch a modern army, equipt with the world's best artillery. Nevertheless, when the defender of Paris, General Gallieni, requisitioned every Paris taxicab, and flung these thousands of squeaky vehicles, which had never been designed for such work, against the German hordes, they simply had to give way; and the taxicabs won. One of the world's greatest retreats was mainly due to these peaceful fare-eaters. Perhaps taxicabs will never be used again in such a manner, but at any rate they did their full duty once. The experiment proved worth while.

Therefore when I propose to run battleships over land, I am fully aware of the ridicule I will be subject to. I am also aware of all the objections that will be cited against the fantastic-appearing plan. Nevertheless, I insist that the idea is not half as impractical as it may appear at first. And at any rate I believe I have found a way showing how it may be done in a simple manner. I give the idea to the country for what it is worth.

I do not claim to be the originator of the idea to run battleships or other ships over land. That idea is old already. Twenty-five years ago there was published in a German weekly an idea to run a powerful car, moving over a dozen closely spaced paralleling tracks, under a ship. This car, after the ship was made fast to it in a suitable manner, was then to be drawn overland—over the present Panama Canal route—by powerful locomotives.

Lately other plans have appeared showing battleships running thru cities and over the houses, but no one volunteered to show how it might be accomplisht. A battleship weighs anywhere from 10,000 tons upwards—quite a respectable weight. How then can we run such a monster on land? How can it be propelled?

Now that we are at war, our first duty is to help our allies, *and to help them quickly*. The time is too short to build new colossal war engines which could be used at the front at once. Our army will not be fully ready till a year from now. Our navy cannot help very much on sea. For if the British, French and Russian navies, which are at least four times as powerful as the German navy, cannot destroy the latter, the addition of our own navy will not matter much one way or another. The German navy simply stays behind her mine fields and bides her time.



Putting Wheels on Our Battleships and How It Is Accomplisht. The Wheels Here Shown Are Fashioned of Angle and I Steel Beams, on the Plan of Structural Steel Toys. Such Wheels Are Tremendously Strong. Slow Running Electric Motors Coupled to the Steel Shafts Drive the New Monster Over Land.

But the U. S. navy has a number of battleships of the pre-dreadnought type, good ships as yet, but obsolete as first-line ships. I refer to ships of the *Oregon, Iowa, Illinois, Kentucky, Massachusetts, Indiana* class. These ships are fully equipt now, have good crews and good guns. But the chances are that ten years from now they will be used as targets or otherwise will be relegated to the scrap-heap. So why not send these ships to the front? Briefly, the idea is this:

Let us send these ships, men, guns and all, to France. In the holds of the vessels we pack channel irons and T, as well as I steel beams, cut to the right length before sailing. These pieces are fashioned much after the structural toy steel pieces—you can make almost anything out of them.

When our battleship arrives in France, it is put immediately into dry dock, and the crew at once proceeds to make the wheels from the channel steel. These huge wheels measuring over 50 to 60 feet in height, are made on the plan of a Ferris wheel, light but strong. Of course to sustain a weight of 10,000 tons or more, a set of single wheels won't do. Rather each wheel is fashioned of a number of wheels from five upwards, paralleling each other, as graphically shown on our front cover, and the accompanying illustration. These separate wheels are bolted or riveted together by means of steel "I" beams running over the circumference of the separate wheels. The latter are strengthened by additional cross-truss work, as seen in illustration. Thus a very light, as well as powerful wide wheel is formed. With a little previous drilling, the crew should be able to construct the necessary six wheels in less than one week—yes, it can be done; providing the pieces are cut to the right dimensions at home.

Next the *thirteen inch* hollow steel shaft is considered. This, of course, has been brought from America too. The hollow shaft is advised, first because it weighs less, and second because such shafts are equally as strong as solid ones, within a reasonable proportion.

The two wheels at the stern are "idlers," the same as the front wheels on an automobile. No power is applied to them, they simply rotate on the shaft, extending from one wheel to the other, clear thru the ship. The two small center wheels are also idlers. They serve to take up undue shocks, which might break the ship in two, when negotiating difficult terrain.

The two front (bow) wheels are the "drivers". They are bolted solid to the shafts, two of the latter being used as will become apparent at once. Our illustration shows that the two shafts revolve in a common bearing (which might be an old reconstructed gun barrel). Each shaft in turn is directly coupled to a slow-running electric motor armature, as clearly shown. And this, by the way, is the much discust electrical drive, adopted in our latest monster battle cruisers, now being constructed. From this it becomes apparent how the land battleship is propelled overland in a simple and practical man-

(*Continued on page* 216)

The Marvels of Radio-Activity

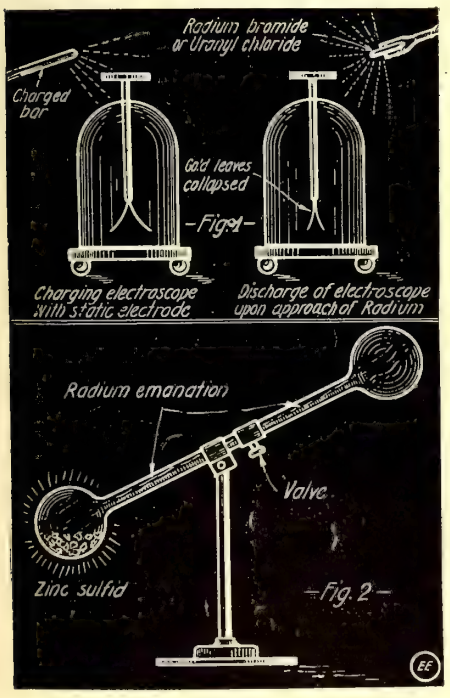
By JEROME S. MARCUS, B. Sc. (Ch. E.)

First Paper of a New Series

THE subject of Radio-activity deals, not only with Radium as many believe, but with a whole class of substances, the best examples of which are Radium, Uranium, Thorium, Actinium, and the chemical compounds of these substances. *Radio-activity* is the name given to the property which these substances have of giving off or emitting certain radiations spontaneously, these rays having the power to penetrate thru matter which is opaque to ordinary light.

History.

Shortly after the discovery of X-rays and their properties by Professor Röntgen in 1895, many students of physics began to investigate the different phosphorescent bodies to ascertain whether they would or not emit rays of the same character. Professor Henri Becquerel, a Paris physicist, discovered in 1896 that the compounds of Uranium which had a phosphorescence (that is, they would glow in the dark after exposure to daylight) would weakly affect a photographic plate. He then found that salts of Uranium which were not phosphorescent also affected a plate, thus showing that it was the element Uranium which possest the peculiar ray-emitting property.



Top:—Discharging an Electroscope by Radium. Lower Illustration Shows a "Radium Light" Which Will Give Sufficient Illumination to Read By.

It was then found that these rays or radiations of Uranium, like X-rays, would discharge electrified bodies, produce phosphorescence in certain other bodies, and penetrate many things that ordinary light would not. Fig. 1. (Experiments on these points will be given later.) These rays were named after their discoverer, "Becquerel rays." It was also found that in carrying these ray-emitting substances around in one's pocket, burns which are very hard to heal are caused, known as "Becquerel burns."



Gold Bar, About the Size of an Ordinary Building Brick, Worth $18,268.53. Tube of Radium the Size of a Match, Worth $18,000.00 (150 Milligrams at $120.00 Per Milligram). Photographed in the Mint, at Denver, to Show Relative Value of Gold to Radium.

Investigation of these radiations were immediately taken up, especially by E. Rutherford, then a student in the laboratory of J. J. (now Sir) Thomson at Cambridge, England. Their properties will be discust later.

Mme. Curie, of Paris, made a systematic investigation of a large number of substances to test whether they possest the same rays as Uranium. At about the same time, in 1898, she and Professor Schmidt discovered that Thorium and its compounds were radio-active. Mme. Curie and her husband then began an exhaustive investigation of the Uranium compounds, and found that the activity was an atomic property, *i.e.*, it was proportional to the amount of Uranium present. While working on this basis with *pitchblende*, an ore from Joachimsthal, Austria, which contains Uranium, she found that the activity was four or five times greater than it should be. This led her to the conclusion that there must be something else with stronger properties than the Uranium. The Austrian Government placed a large amount of the ore at her disposal, and she set about separating the extremely small amount of this then unknown substance. Her efforts were finally rewarded by the isolation of "Polonium" and a substance of such intense ray-giving power that she termed it "Radium." *Radium bromide* has about two million times the activity of Uranium.

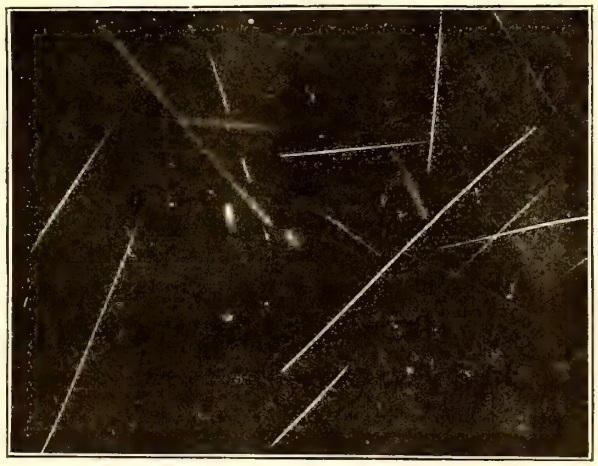
Radium has been found to be an element of definite atomic weight, and accompanies the Barium which is separated from the pitchblende. It is not proved as yet whether Polonium is an element, but it accompanies the Bismuth in the ore, and is separated from it.

The discovery of these substances was made in 1898 and in 1899, M. Debierne discovered another radio-active material which he called "Actinium," and which follows the iron in the pitchblende and seems to be connected with the Thorium.

It has been shown by recent investigators that almost all substances in nature are more or less radio-active. Among these are freshly fallen rain or snow, many spring waters, etc. From this, the idea has been advanced that radio-activity is due to certain radiations from the sun itself. These are supposed to be connected with the appearance of the Aurora Borealis and other phenomena of atmospheric electricity. In the spring of 1903, Professor J. J. Thomson discovered that waters from deep wells contained a certain gas which was radio-active, and other substances are being found which also possess the power of radio-activity.

* * *

Becquerel showed that the rays from Uranium, like the X-rays, were capable of discharging an electrified body, when charged either positively or negatively. (Experiment—A gold leaf electroscope is charged by touching to any source of static electricity, *e. g.*, a glass rod rubbed with silk. An Uranium compound—any salt purchased from a chemical house, the author uses Uranyl chlorid in his experiments—is then brought near the knob. The leaves are seen to collapse. (Fig. 1.) This property of radio-active substances is used as a delicate quantitative test for the amount and intensity of radiation. A special electroscope has been devised for work in Radium research, the rate of collapsing



Remarkable Photograph of the "Alpha" Rays of the Radium Emanation. By C. T. R. Wilson.

(*Continued on page 207*)

Back to the Days of "Volta"

VOLTA, inventor of the first electric battery, after whom the standard International unit of electrical pressure—the *volt*—is named, was one of the early, most brilliant and indefatigable workers in the realm of pure electrical science. He was born in Como, Italy, Feb. 18, 1745, in a house which had been the homestead of the Volta family for over 300 years. Paradoxical as it may seem, true genius is often linked with less brilliant traits of character, and as a child we are told that Alessandro Volta was very backward. Even to the point that he could only speak one word "No," when he had reached his fourth birthday.

But, like many other great scholars of the world, he suddenly developed a great affinity for philosophy and became an earnest student of scientific subjects, especially the natural wonders of nature—particularly electricity. When he was 17 years old he had won prizes in philosophy and at 18, the famous Abbé Nolet, strongly imprest with the youth's superior and divining knowledge, had him write essays on electricity for the great men of the day, as people in general knew very little about this mysterious force at that early period.

The first formal scientific papers of Volta were issued in his 24th year and fourteen years later there appeared his *electrophorus* (see illustration, Fig. 1.) followed by his *electroscope*. The photographs here reproduced show the now historic apparatus built and used by Volta in his laboratory. Fig. 1 shows a variety of electro-static apparatus, including a static electric charging device—the electrophorus, at extreme left, and the detector of static charges—the electroscope at extreme right. Both of these devices are still in use in electrical laboratories where the elements of pure science are studied. Besides, the electricians of today have found many practical applications for the electroscope, never even dreamed of by the illustrious Volta. One important commercial and highly important application of the sensitive electroscope is in the measurement of radio-activity. The Radium production companies employ this method in testing their products. Fig. 1 also shows various plate condensers, invented by Volta.

While professor of physics at Pavia, he conducted experiments which led to the discovery of the *Voltaic pile*. One of the accompanying illustrations, Fig. 4, shows one of the most remarkable historic documents extant—the original letter, written in French, of Alessandro Volta addrest to the Société Royale de Londres describing his new electric battery (Voltaic pile), consisting of alternate zinc and copper discs separated by dampened blotter paper sheets. This formed the basis of present-day electric batteries. There is no doubt that modern electricity really starts with this famous letter. For it was Volta's battery that produced the very first electric galvanic mark. It was Volta who led the first galvanic current thru a wire. And it was his battery that produced for the first time useful dynamic electricity.

(*Continued on page* 212)

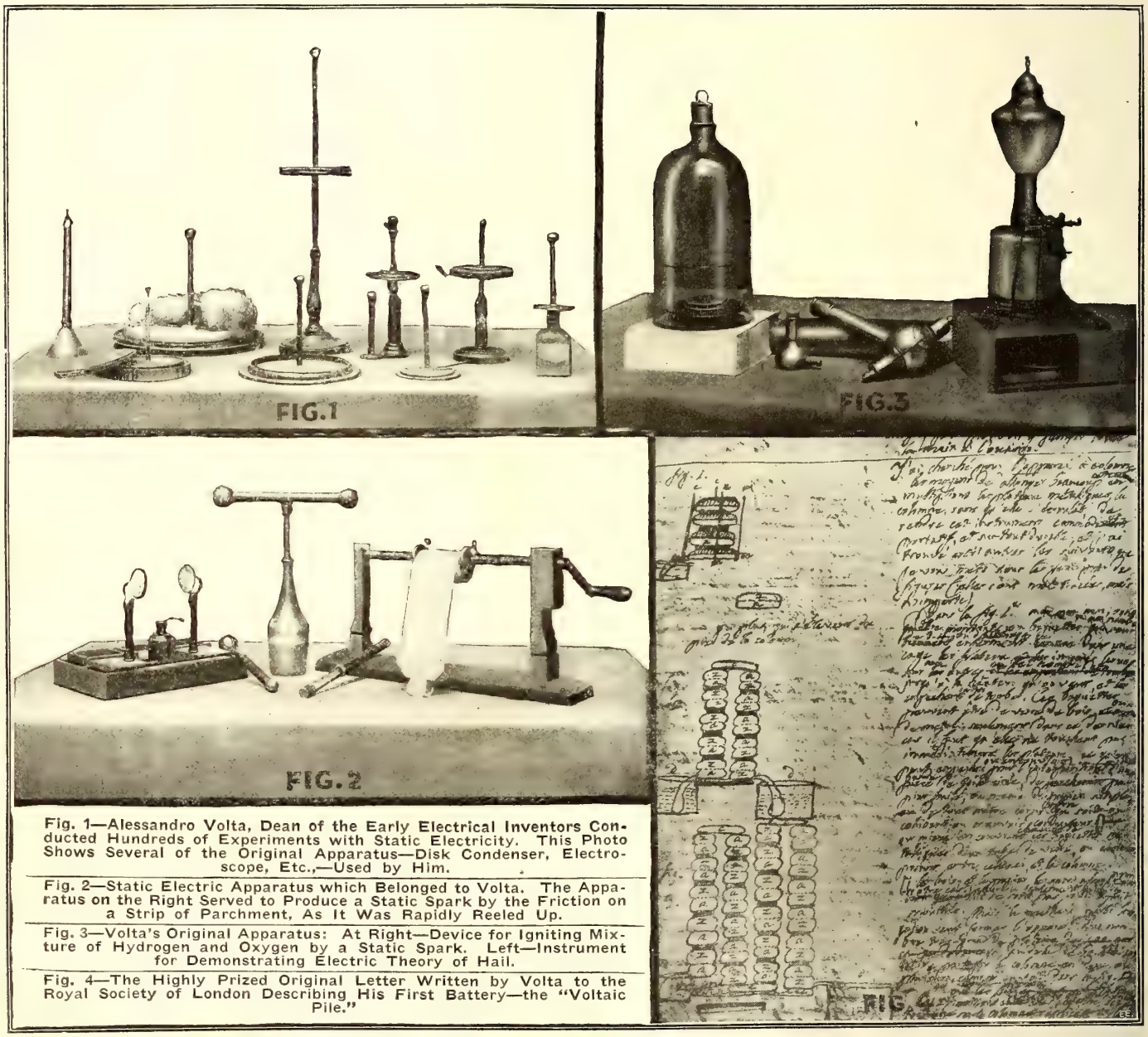


Fig. 1—Alessandro Volta, Dean of the Early Electrical Inventors Conducted Hundreds of Experiments with Static Electricity. This Photo Shows Several of the Original Apparatus—Disk Condenser, Electroscope, Etc.,—Used by Him.

Fig. 2—Static Electric Apparatus which Belonged to Volta. The Apparatus on the Right Served to Produce a Static Spark by the Friction on a Strip of Parchment, As It Was Rapidly Reeled Up.

Fig. 3—Volta's Original Apparatus: At Right—Device for Igniting Mixture of Hydrogen and Oxygen by a Static Spark. Left—Instrument for Demonstrating Electric Theory of Hail.

Fig. 4—The Highly Prized Original Letter Written by Volta to the Royal Society of London Describing His First Battery—the "Voltaic Pile."

SOME ODD X-RAYS

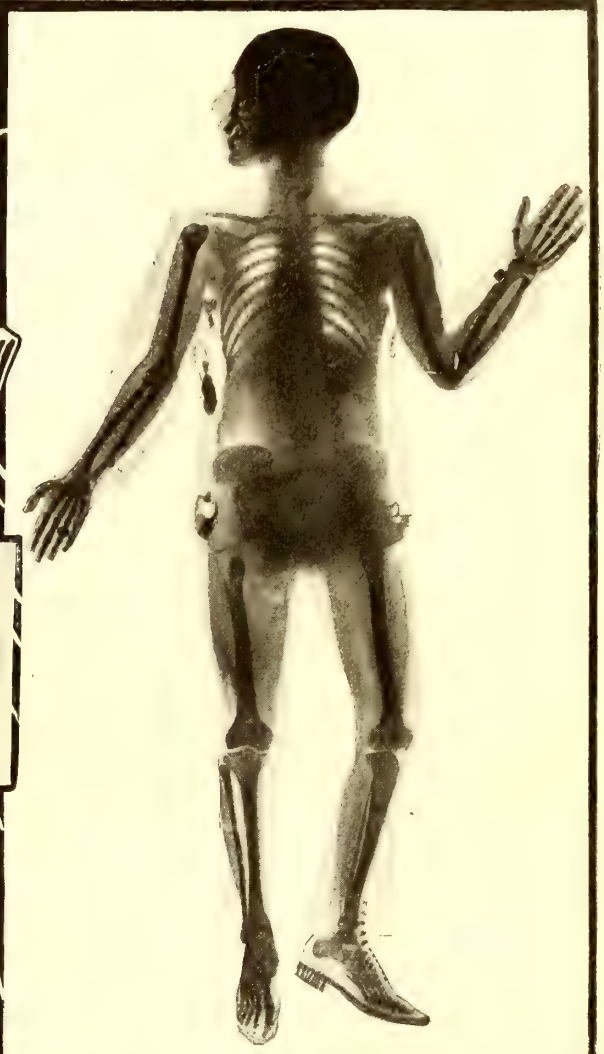


In Child-hood Days We Used to Enjoy Reading About the Two-headed Giants Who Strode Over the Land with Seven League Boots. But Here We are Face to Face with a Real Two-headed Human Being. The X-Ray Shows the Two Distinct Spines Very Clearly. (Photo from Dr. W. B. Snow.)





"I Never Eat Shad Because It Has so Many Bones"—That's What They All Say. Speaking of Fishes, Ladies and Gentlemen, Meet This Rotund Member of the Finny Tribe In All His Glory of Bones of Every Shape and Size. What the X-Ray Reveals.



On Another Page There is an Article on Prof. Miller's Great Researches on Sound. Here You Have a Chance to Meet That Scientist, and as You See, He Wishes to Conceal Nothing from You. One of the Most Wonderful X-Ray Photos Extant, Showing As It Does the Entire Human Body, Clothes and All. Note the Watch, Keys, Pocketbook, Etc.



Remarkable X-Ray Photo of a Four-Legged Chicken, Five Hours Old. Now That the High Cost of Living Is Our Daily Topic It Is Pleasant to Note That Nature Comes to Our Aid and Beats the Poultry Trust to It. "Mom, I Want the Western Hind Leg" Will Soon Be Heard All Over the Country. Photo G. E. R.



Did You Believe That the New-born Child Had No Bones? Here's Evidence to Prove That the Stork's Gift is 100 Per Cent Complete In His Physical Structure. (Photo Dr. W. B. Snow.)

Are You a Mason? If You Are Not, Perhaps You Can Figure Out What Mystic Order the Gentlemen Posing for This Skiagraph Belonged to. Note the Twisting of the Wrist Joints Due to Clasping Hands. (Photo from Dr. W. B. Snow.



Lightning—How to Protect Yourself From It

By W. G. WHITMAN, State Normal School, Salem, Mass.

LIGHTNING, that awe-inspiring natural phenomenon which compels the attention of child and adult alike, is the cause of about 800 deaths and of 1,500 injuries sustained by the people of the United States in a single year. It also causes the destruction of many millions of dollars worth of property yearly.

Lightning is a more vital subject in the country and small village than in the city. It is rare that lightning strikes in the large towns or cities. The isolated building or object is in greatest danger. The subject is of varying economic importance too in different states. Records show that lightning does more damage in Iowa than in any other state. Maryland, Wisconsin, New York, Ohio and Illinois follow in the amount of damage received from this source.

That the harmless spark obtained by rubbing a cat's fur in cold winter and the terrifying lightning of a hot summer day are closely related, belonging as they do in the same family of natural phenomena, has never been surmised by the average school pupil. In fact many older people have not thought of them as related phenomena, even tho Franklin proved their identity in 1752.

Benjamin Franklin while experimenting with electricity noticed certain resemblances between the sparks produced artificially and the natural lightning. Both flashes were instantaneous; gave intense light; followed a crooked path; produced noise; set combustible material on fire and killed animals. From observation of the similar behavior of the two, he was led to a strong belief in their identity, so he determined to perform some experiment which would prove their likeness or unlikeness. And on July 4, 1752, he sent a kite into the clouds during a thunder storm and succeeded in bringing electrical energy from the cloud thru the kite string to a key at its lower end. This string and key were insulated from the earth by a silk cord. Franklin obtained sparks from the key just like those he had produced in his laboratory, thus did he demonstrate to the world the fact that lightning is an *electrical discharge*.



Thousands of Cattle on the Great Farms of the West Are Annually Electrocuted by Lightning Discharges Which Charge "Ungrounded" Metal Fences and Demolish "Unrodded" Barns and Outbuildings. The Highest Authorities Recommend That All Buildings Be Equipt With Proper Lightning Rods.

The boy who shuffles his feet over the carpet and draws a spark from the water faucet or gas burner is a *dynamo* unawares; he generates electricity and discharges it at a pressure of thousands of volts.

It is usually true that the air above the earth is *positively* electrified and that the earth differs in electrical pressure from all space around it by many—possibly 150,000 volts. It is not constant, however; conditions are always changing and the electrical tension is variable. Such a difference of potential as this is not sufficient to produce lightning.

When clouds are rapidly formed by air currents rising into the air, enormous quantities of electricity are produced. We do not know exactly how it is produced. The latest theory, that of Dr. Simpson, explains the electrification as resulting from the splitting of rain drops into smaller particles as they tend to fall thru a rapidly rising current of air. In some way clouds do become highly charged with electricity. Sometimes they are *positively* charged and sometimes *negatively* charged. When two clouds or a cloud and the earth are at sufficiently great difference of potential the resistance of the intervening air is overcome and a discharge takes place producing the common phenomenon of lightning. Sir Oliver Lodge calculated that a flash of lightning one mile long is probably due to a difference of potential of 5,000,000,000 volts, but it is generally thought now that this figure is too high. Trowbridge has found that a difference of potential of about 25,000 volts between battery terminals will give a one-inch spark thru air.

The duration of a flash of lightning is usually under 1/50,000 second and may be only 1/1,000,000 second. Because of *persistence* of vision we apparently see the flash for a longer time. According to calculations made by Lodge, a discharge from a cloud 10 yards square, fully charged, at a height of one mile, liberates 2,000 foot-tons of energy. This energy is enough to warm 2½ quarts of water to the boiling point and then change it to steam in a trifling part of a second. Such intense heat warms the particles of air to incandescence and is the cause of the flash seen. Heated air conducts electricity better than cold air, so at times other flashes will follow in the path of the first one before the air has become cold. These multiple or oscillating flashes may continue for 1/1,000 to 1/200 second, but altogether they apparently make but one flash to the eye.

The discharge of this cloud, 10 yards square, gives enough energy, in 1/20,000 of a second, if properly directed, to hurl 1,000 barrels of flour 20 feet into the air. When this energy heats the air in the path of the lightning discharge it causes sudden expansion with explosive violence and when the expanded air cools and contracts a vacuum is formed, into which air rushes again with implosive force. When you blow up a rubber balloon to an excessive pressure, explosion results with a loud sound. When an incandescent bulb is broken, air rushes into the space, and when it meets it produces a loud sound from the implosion. These two cases illustrate the production of thunder. One part of a lightning flash may be a mile farther away from you than the nearer part. The thunder from the more distant part will reach you about 5 seconds later than that from the nearer part. Thus while a flash may be instantaneous, the thunder which you hear may be of considerable duration. Thunder from several flashes may unite. Thunder may be reflected by one or more clouds. In these ways the *rumblings*, characteristic of thunder, are produced.

Objects standing on the surface of the earth become a part of it and are electrically charged the same as the earth. Standing above the earth's surface they form excellent discharge points since the air gap from them to the cloud is less than from the surrounding earth to the clouds, and furthermore, the electrical density or ten-

sion is greater at points, corners and angles than on surfaces. Whatever the object may be thru which the discharge starts, it instantly becomes the conductor thru which electricity passes either to or from a large area surrounding it. If an object only discharged an amount of electricity equal to that which it held before the discharge, there would be little danger or violence, but when it becomes the conductor to carry the electricity of a considerable portion of the earth about it, the large quantity of electricity passing in so brief an interval causes violence and damage.

A similar discharge of the earth occurs when an object on the earth is electrified by a near-by cloud by induction and a discharge passes between them. The discharges at the storm front are usually the most severe. After the first few discharges the air seems to become a better conductor and the lightning is less severe.

Any high object reaching above the earth carries the electrostatic field nearer to that of the cloud, thus increasing the possibility of an electrical discharge between them. The tremendous heat energy which is produced from the electrical discharge of a large cloud highly charged is sufficient to heat air particles to incandescence, to melt minerals and metals, to vaporize solids and liquids with explosive violence and to set fire to combustible matter. It is little wonder that trees are splintered and buildings set on fire when they make a path for the lightning to the earth—or from the earth—for it is believed that fully as many discharges are from the earth to the clouds as from the clouds to the earth.

Protection against lightning is needed on isolated buildings, tall chimneys, steeples and flag poles. Such protection is secured by use of a metal cage or series of rods with high points and the whole thoroly grounded. The material must be of sufficient capacity to carry off large quantities of electricity and it must not corrode readily. Copper and galvanized iron are the two metals most commonly used for lightning rods. The lightning rods or conductors should not be insulated from the building because the object of the rods is to drain electricity from all objects about or a part of the building. Conductors ought not to be placed near or parallel to an inside pipe, because the discharge might jump thru the wall to it, causing fire, or it might produce a powerful heating effect in it, resulting from induction. A safeguard against such a disaster is to connect the lightning rod system at the highest and at the lowest points with inside structural beams and water pipes. Sometimes gas pipes are connected but because of the inflammability of gas, many prefer not to connect them. All exterior metal work of the building, as gutters, railings, etc., either should be connected to the lightning rod at a level below their own or they should be grounded by a separate cable. The grounding of lightning rods is a very important matter. They are frequently connected to large copper plates which are buried in a mass of coke at a depth which is below the permanent water level of the earth.*

The metal cage or rods should have a number of high points extending above the level of the building; and should have few joints and no sharp bends. Our commercial currents will follow good conductors around any amount of curving, but lightning will often jump off from a good conductor at a sharp bend, even tho it must pass thru a poorer conductor.

There are two ways in which lightning rods protect a house. First, they serve as conductors carrying the discharge harmlessly; second, they tend to discharge the earth slowly. Often such an amount of electricity escapes by this slow discharge that a lightning stroke is prevented, or if not prevented it is less severe. Occasionally a rodded house is struck, but the damage is much less than if the house had been unrodded. The idea that lightning rods draw lightning, and are a source of danger, is unfounded even if the rods are poorly grounded. The majority of fires resulting when lightning strikes rodded buildings occur when masses of metal, gutters, pipes, etc., *are not connected* to the lightning rods or *are not grounded.*



Actual Photograph Taken After a Severe Electric Storm Showing the Lightning's Toll in Valuable Live-Stock. The Barn Was Unrodded, as May Be Surmised, for It Is Very Seldom that Fatalities Occur Where Buildings Are Properly Covered with First-Class Lightning Rods, Thoroly Grounded in Damp or Wet Earth.

Sir Oliver Lodge classifies lightning as *"A" flashes* and *"B" flashes.* The A flashes are less sudden and violent, and are what the Germans term *cold lightning.* Lightning rods are effective protection against them. The B flashes are sudden and violent, and are what the Teutons term *burning lightning.* Lightning rods will not always safeguard against these flashes. Both the A and B flashes are fatal to man. *Ball lightning* is produced when the B flashes strike the ground. The A flashes are the more common. When a storm is at such a distance that flashes of light are seen but no thunder is heard, the flashes are termed *heat lightning.* The thunder may be refracted above the head of the observer or it may be at such a distance that its intensity is so decreased as to become inaudible.

If a person forms a part of the conducting path of the discharge, he is likely to suffer and yet the stroke may not prove fatal.

The heart is the chief danger spot. It is not the voltage but the current which passes thru the heart which is the important thing. Tho with a given body resistance, an increased voltage causes an increased current to pass. It has never been determined with accuracy just how much current can pass thru the human body with safety. It doubtless varies with individuals. High voltage causes paralysis which may stop breathing, and even the heart's action. First aid in lightning stroke should be *artificial respiration,* the same as is used to restore a drowning person.

No danger results when a comparatively large current flows thru the lower trunk alone, but as low a pressure as 65 volts has been known to prove fatal, when it past thru the thorax.

The resistance of the skin varies with its dryness, moisture, greasiness, and by the area which is in contact with an electric conductor. A bare wire carrying our ordinary lighting current at 110 volts or 220 volts pressure may be handled safely if the skin which the wire touches *is dry* or if the person's boots by which the current leaves

(*Continued on page* 212)

WHAT TO DO IN A THUNDER STORM.

If you are out of doors in a very severe electrical storm, it is well to observe the following rules for your own protection.

1. Keep away from wire fences. They may carry a dangerous electrical charge long distances. Cattle in pastures are frequently killed from the neglect of farmers to ground the wire of the fence.

2. Keep away from hedges, ponds, and streams.

3. Keep away from isolated trees. Oak trees are frequently struck; beech are seldom struck. It is safe in a dense forest.

4. Keep away from herds of cattle and crowds of people.

5. Do not hold an umbrella over you.

6. It is safer to sit or lie down in an open field than to stand.

7. Drivers should dismount and not stay close to their horses.

8. Do not work with any large metal tool or implement.

If you are indoors:—

1. Keep away from the stove and chimney. The hot gases from the chimney may conduct the lightning to and down the chimney.

2. Do not take a position between two bodies of metal as the stove and water pipe, for example. An exception to being near metals is the case of an iron bed. One of the safest places is on a mattress in an iron bed, provided you do not touch the metal. The metal surrounding you makes a safe cage which will prevent the lightning from reaching a person inside.

3. Do not stand on a wet floor nor draw water from the well or faucet.

4. Do not stand directly under a chandelier, near a radiator, nor on a register.

5. Do not use the telephone.

*Specifications for installing lightning rods are given in Technologic Paper No. 56, Bureau Standards, at 35c, procurable from Government Printing Office, Wash., D. C.

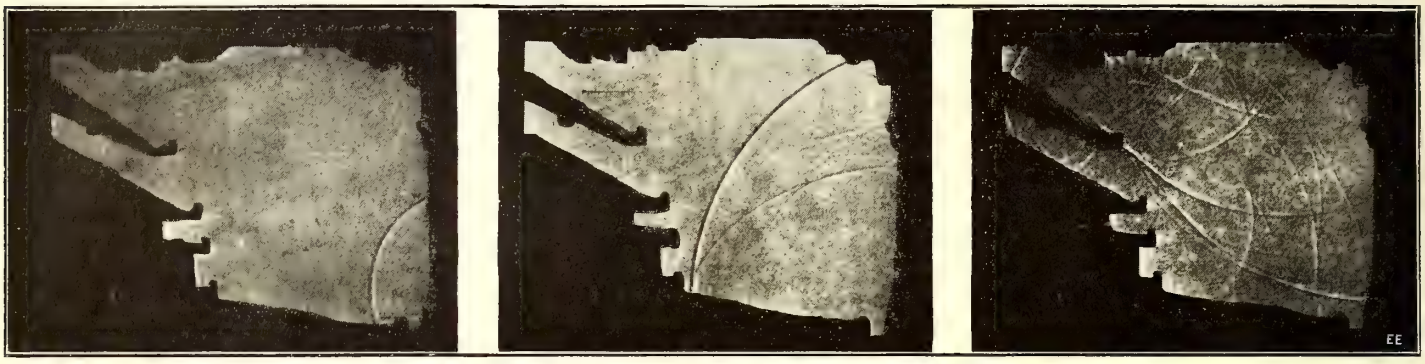
The Science of Sound

SOUND is that mysterious phenomenon of nature by which we are able to communicate intelligence to one another, and by which it becomes possible to accomplish many industrial and scientific wonders, and according to Professor Dayton C. Miller, of the Case School of Applied Science, Cleveland, O., we may define sound as the sensation resulting from the action of an external stimulus on the sensitive nerve apparatus of the ear. In other words, it is a species of reaction to this external stimulus, excitable only thru the ear, and distinct from any other sensation. Atmospheric vibration is the normal and usual means of excitement for the ear. This vibration originating in a source known as the *sounding body*, which is itself always in vibration. For instance, the source of the sound may be constructed especially to produce a certain quality as in a stringed instrument, whether the string is plucked or bowed, and its consequent vibration transferred to the wooden or other sound-board and which in turn impresses the motion upon a larger mass of air.

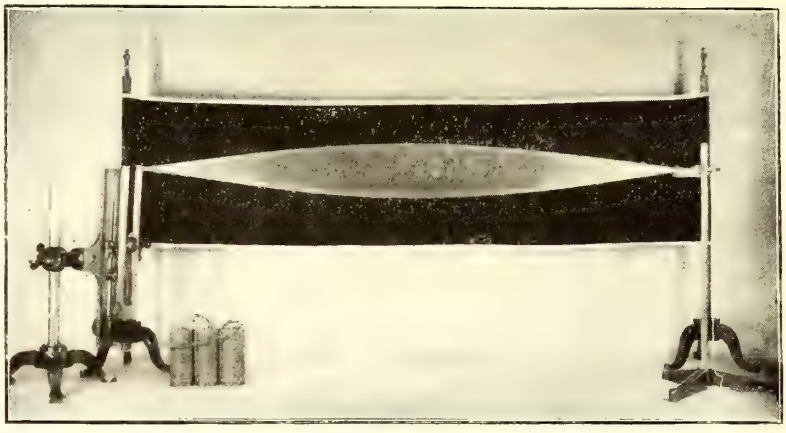
The word sound is used by the scientist to designate the vibrations of the sounding body itself or those which are set up by the sounding body in the air or other medium, and which are capable of directly affecting the ear, even tho there is no ear to hear; the sound going forth just the same.

The accompanying illustrations which we are enabled to present thru the courtesy of Prof. Miller, who is considered a very high authority on the science and physics of sound, illustrate but a few of the hundreds of extremely interesting demonstrations and peculiar devices which have been worked out in the physical study of sound.

One. of the accompanying illustrations shows how laboratory apparatus may be set up so as to cause a single taut string to vibrate in a single loop. In taking the photograph of the vibrating string, a black background was provided, so as to show the loop of vibration more clearly. This single loop corresponds to a simple tone consisting of a fundamental only. The string is secured at one end to a stationary support, and at the other to one prong of a special electrically-operated tuning fork. The tuning fork may be adjusted for different frequencies when desired and in general corresponds to the usual musical tuning fork, except that a small electro-magnet is placed between the two prongs. When a battery current is past thru this electro-magnet, it attracts the opposite leg and sets the fork vibrating, the battery current being interrupted at every swing of the tuning fork limbs by virtue of a platinum contact mounted on the vibrating fork. The string may consist of a silk cord.



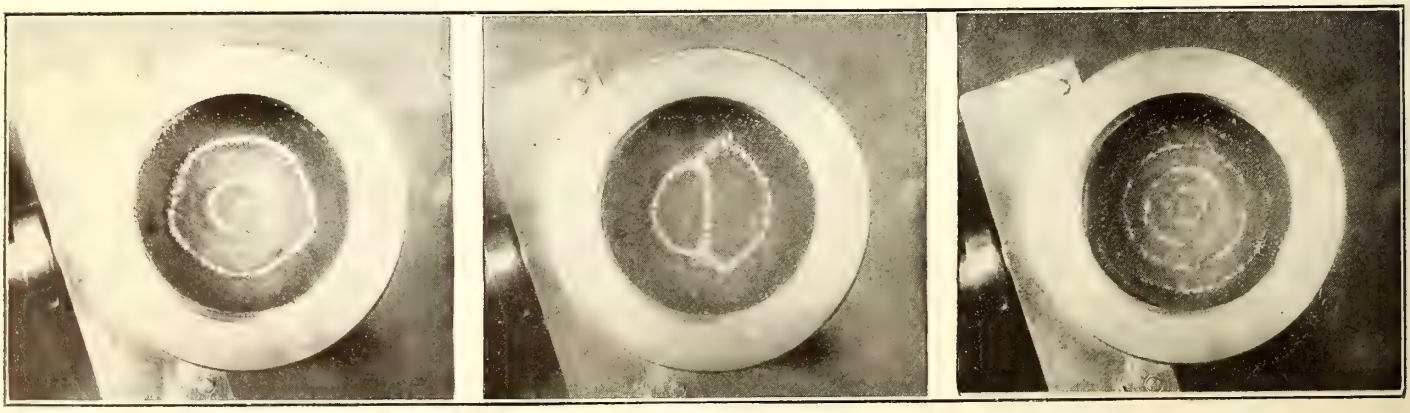
Prof. W. C. Sabine of Harvard University Has Made the Accompanying Remarkable Photographs Showing First—the Start of a Sound Wave Into an Auditorium, (Left). At Center, the Sound Wave Photographed 3-100ths Second After Its Production on Stage. Right—Echoes in a Theater Developed from a Single Sound Impulse in 14-100ths Second, Resulting in What We Call "Reverberation."



Interesting View of a String Vibrating in a Single Loop, Corresponding to a Simple Tone of a Fundamental Only. An Electrically Vibrated Tuning Fork Is Used in This Experiment.

By simply changing the tension of the string so arranged, it can be made to vibrate in various sub-divisions corresponding to its harmonic over-tones. For instance, it may be caused to show two-loop, three-loop and five-loop formations, representing respectively the first, second and fourth over-tones.

One of the most remarkable sound analyzing instruments is Professor Miller's *Phonodeik*. This instrument has been made in several different forms for especially analyzing and studying the various fundamental tones and harmonics of musical and other sounds in the laboratory, but the one here shown is probably of the greatest interest to the layman. By means of the projection type of phonodeik (here illustrated), Prof. Miller was enabled to present some very startling effects in his recent lectures in New York City before the American Association for the Advancement of Science. When the

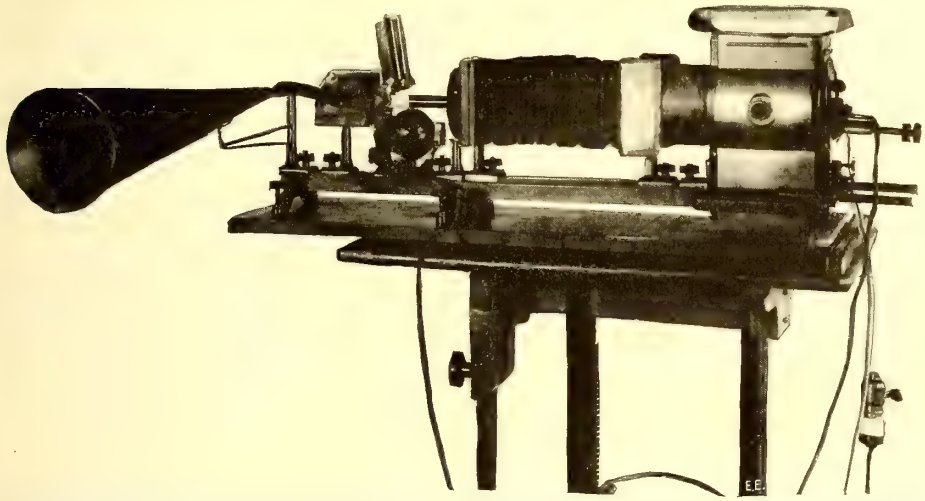


Many Valuable Studies of Sound Waves Can Be Made by Means of "Sand Figures." The Sand Is Placed on a Diafram Which Can Be Vibrated at Any Desired Frequency or Note.

word "War" for instance was pronounced into the horn of the phonodeik, its tiny revolving mirror caused a narrow beam of light to dance wildly on the stage screen, but when the word "Peace" was spoken into the instrument, the light beam smoothed out remarkably, exercising a wonderful and truly remarkable psychological effect on the audience.

The operation of the phonodeik, which is the result of many years' study, is based upon the use of a vibrating diafram, which is placed at the base of the horn shown. The movements of the diafram due to vocal or musical sounds projected into the horn cause it, with its vibrating mirror, to project a tiny beam of light, which falling upon a motor-driven revolving mirror, is thrown on to the white screen on the stage in the form of a long wave. The movements of the diafram are magnified forty thousand times or even more, producing a "light" sound wave on the screen which may measure ten feet in width and even forty feet in length, suitable for a practical demonstration of the physics of sound to an audience of any magnitude.

The projection phonodeik possesses many



The Marvelous "Phonodeik" Devised by Prof. Dayton C. Miller, Which, by Extremely Delicate Electro-Mechanical Attachments, Permits a Lecturer to Project on a Screen the Undulations of the Speaking Voice, Magnified 40,000 Times! Truly a Scientific Masterpiece and An Invention of Far-Reaching Importance and Application.

remarkable qualities, among which we find that, if the revolving mirror is kept stationary the spot of light on the screen moves in a vertical line as the diafram vibrates; tho these movements are superposed, their extreme complexity is shown since the turning points are made evident by bright spots of light. If we turn the mirror slowly by hand, then the production of the harmonic curve by the combination of vibratory and translatory motions is demonstrated. By the aid of a simple tuning fork, the simplicity and wonders of the sine curve are exhibited grafically. By using two tuning forks, it becomes possible to demonstrate before a large audience, the combination of sine curve waves. Also the relations of loudness to amplitude, and of pitch to wave length may be fully demonstrated. As the sound changes at the phonodeik apparatus, the light wave follows in consequence, and the projected image on the screen undulates rythmically, and in a most remarkable manner.

Three interesting illustrations are presented herewith which show the progress of a sound wave in a theater; the wave gradually swelling out into the auditorium until the main wave has reached the back of the gallery and been reflected.

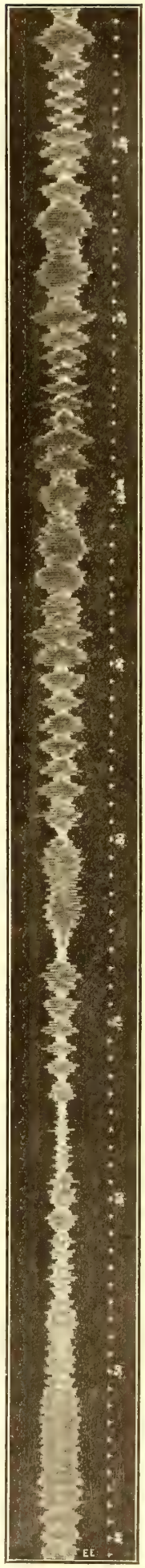
Sound waves, according to Prof. Miller, consist of alternate condensations and rarefactions which are projected thru space with a velocity of 1,132 feet per second (at 70° Fahrenheit), and for the tone "middle C," the distance from one compression to the next is about four feet. It would prove very desirable indeed to be able to actually photograph sound waves in air, but no practical means have as yet been perfected for photographing waves of this size. The accompanying photographs of a cross-sectional model of a theater showing the progress of a sound wave from the stage is due to the researches of Prof. W. C. Sabine, of Harvard University. Photographs such as these, showing the sound wave at any instant, are taken by instantaneous exposures and are obtained by the snapping sound produced by the electric spark discharge from a Leyden jar. The sound thus given off by a Leyden jar discharge consists of a single wave containing one condensation and one rarefaction, the wave length of which may be 1/16 inch or less, and the sound is relatively a loud one. Now if, while such a sound wave is past over a photograph plate in the dark, the wave is instantaneously illuminated by a single distant electric spark, then the light from the spark will be reacted by the sound wave which will then act as a lens and register itself on the plate. The accompanying photographs, due to Professor Sabine, show some of the work carried out by him in studying the problem of auditorium acoustics.

To make such sound wave photographs, a small cross-sectional model of the auditorium is first made. The photograph plate is placed behind the model; the sound is produced on the stage at the right, and the resulting wave is propagated out into the auditorium with a velocity of 1,132 feet per second. The second view shows the period just before the main sound wave reaches the balcony, and the final photo shows the wave 14/100ths second after the production of the original sound on the stage, when the main wave has reached the back of the gallery. It will be noted that a large number of echo waves appear, and which seem to come from many different directions, but which are actually generated by the one original impulse. The multiple echoes continue to develop with ever increasing confusion until finally the sound is diffused thruout the auditorium, when we have the condition known as *reverberation*. This explains the effect occurring in a theater, when we hear anyone say that the singer has such a powerful voice that the music reverberates thruout the auditorium.

A great deal of study can be and has been carried out in the realm of sound studies by means of *sand figures*. These are known as Chladnis' figures, and one of the accompanying illustrations shows three interesting forms produced by certain sounds. A large number of patterns can be formed by the various sounds, and which patterns or figures are always the same for the same note.

As an example of what has been accomplished in this direction, it may be of interest to state that, with a diafram of glass held in circular rings and placed horizontally, the vibrator being attached to the under side; when sand was sprinkled over the diafram, figures were obtained as the diafram was made to respond in succession to each one of eighty pipes corresponding to frequencies from 129 to 12,400. The characteristic nodal lines produced for each frequency were then photographed.

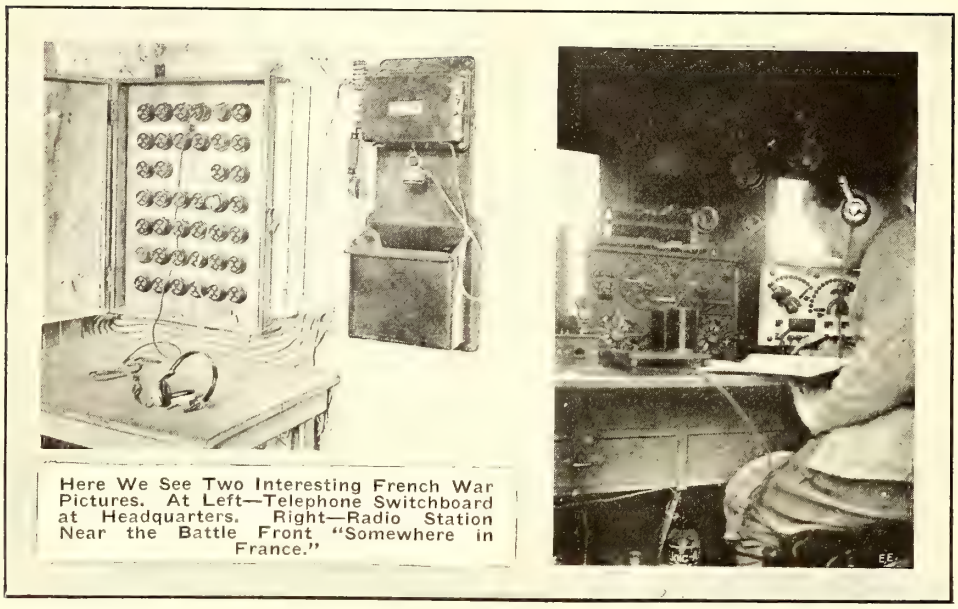
Our long, narrow illustration carrying the continuous undulating sound wave as shown at right is one of the most remarkable records of vocal music ever obtained. It was made in Professor Miller's laboratory, and is part of a record of world-famous opera singers singing the sextette from "Lucia di Lammermoor." The white dots along the edge of the record represent the time periods 1/100 *of a second apart*. The original photographic record of this bit of opera is nearly four times as long as the one here reproduced. The particular section of the record illustrated shows the voice undulations and variations of Mme. Tetrazzini and Signor Amato, *i. e.*, soprano and baritone voices *singing softly*. This particular section of the voice record has a duration of .80 second, and is for a single note.



The Voice Record at the Right Shows the Undulations Occurring When Tetrazzini and Amato (Soprano, and Baritone) Warble a Note from "Lucia di Lammermoor." Each Dot is 1-100th Second Apart; the Time Period of the Record Shown Is .80 Second and Is for a "Single Note."

TELEPHONE AND RADIO IN WAR-TIME FRANCE.

The French army has perhaps made greater use of all electrical means of communicating intelligence than any other military organization of the present time. The illustrations herewith show a central telephone switchboard at army headquarters and a typical radio station, of which many thousands can be found just back of the battle lines. The telephone, telegraph and radio stations are often located in the basement of a once beautiful chateau or church.



Here We See Two Interesting French War Pictures. At Left—Telephone Switchboard at Headquarters. Right—Radio Station Near the Battle Front "Somewhere in France."

The central telephone switchboard shows how cable lines are brought in from every important army division. By means of the flexible cord and attachment plug connected to the wall telephone instrument seen in the picture, an officer of the commanding staff may instantly ring up any division commander and transmit orders or receive a special report as to the progress of a battle at any certain part of the front.

The head telephone set lying on the table is used to listen in secretly into any line running from the trenches to headquarters. Thus the officer in charge may know at once if unauthorized talk is going on.

But to the radio operator comes a full share of mystery, romance and action. He sits with his head receivers clamped tight against his ears while from out of the boundless ether there comes the news of victory or defeat—the call for reinforcements—messages of every description and from many points along the battle front. Needless to say the military radio operator holds a most important position—an importance which the peace-time operator never even dreams about. In his hands there may lie the difference between life and death for hundreds, even thousands of men. He must not make a mistake and his instruments must always work—so long as his antenna stays up.

TORPEDO NOW USED AS LAMP-POST.

The accompanying illustration shows an odd electric lamp-post in use at Newport, R. I. It is formed of a one-time dangerous torpedo, which was captured in the Spanish-American War. The torpedo has been securely anchored in the ground and the electric feed wires, supplying the lamps at the top with current pass thru the hollow shell. The relative size of the torpedo may be judged by comparing it with the marine standing beside it. Rather an expensive lamp-post, as lamp-posts go, this particular one having cost about $7,000 originally when the Spanish torpedo factory turned it out.



Photo Copyright by Press Illustrating Service.

A One-Time Formidable Torpedo, Captured in the Spanish-American War, Now Serves as a Lamp-Post at Newport, R. I.

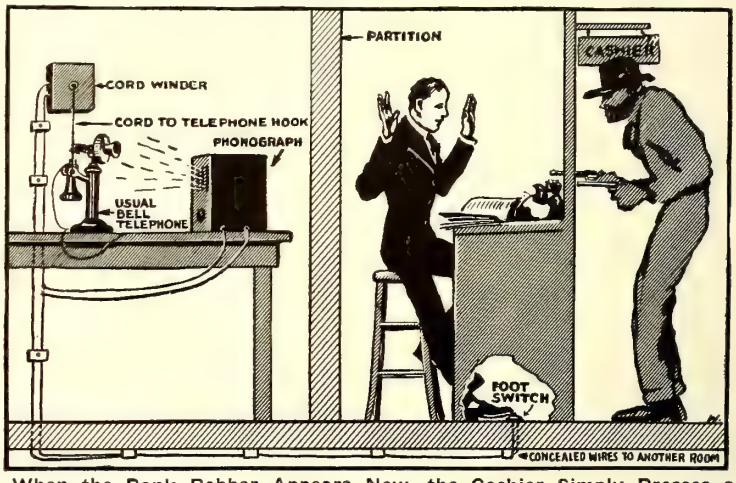
NEW INVENTION 'PHONES POLICE—"THIEF'S HERE."

Burglar detection is made a matter of certainty and simplicity by means of a device invented by Lee A. Collins, of Louisville, Kentucky, Patents are pending on the invention.

With the installation of the alarm, a burglar in forcing or gaining an entrance sets in motion the mechanical device, which then summons the police, giving them the name and address of the person whose home or office is being entered.

Another type of the device does not operate with a phonograph attachment, but instead has a buzzer which warns central, who in turn reports the matter to the police. Another type of the invention has a bell which is controlled by thermostats, and gives fire alarms as well as burglar alarms.

The alarm does not cease if a window or door is closed immediately after being opened, but continues at work until the connection is cut off. The device is simple in construction, and can be attached to any telephone. A special attachment makes it possible for bank or express company cashiers to start the mechanism by pressure of the foot or knee in the event an attempt is made at a hold-up. Two dry cell batteries operate the entire system. If the bank cashier is held up, for instance, he simply obeys orders and throws up both hands if he deems it best, but his foot is busy meanwhile, and when the foot operated trip-switch closes, the Collins automatic telephone alarm immediately gets busy. It raises the telephone hook (in another room, so the thief will not become desperate) and simultaneously starts a small phonograph located near the telephone. It carries a special record, announcing the bank's name, the location and the news that the "thief's here!" It repeats the message over and over again, notifying Central, who at once informs police headquarters.

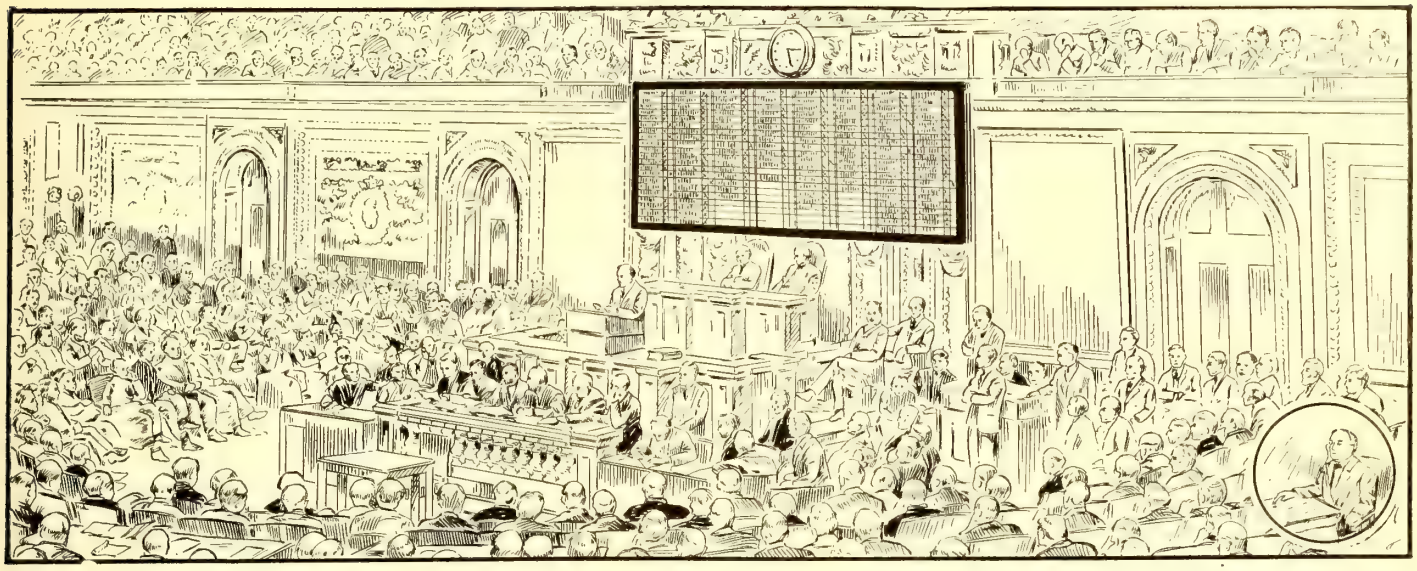


When the Bank Robber Appears Now, the Cashier Simply Presses a Button with His Foot. This Causes a Special Device in Another Room to Lift the Telephone Hook and Start a Phonograph Which Gives Central the Call for Police.

A trap drummer has discovered that electric lights installed inside his drums keep the moisture out and makes the drumheads tight.

The new battleship Tennessee will use 27,500 electrical horsepower, enough power to furnish heat, light and power for a city of 100,000 inhabitants.

Speeding Up Vote of Congress by Electricity



Instead of Wasting an Hour and a Half in Which to "Call the Roll" Alone in the House of Representatives at Washington, a Newly Proposed Electric Voting System Will Cut the Time Down to a Few Minutes, Resulting in a Saving of Thousands of Dollars Annually.

HAVE you ever been present at the roll call of the U. S. Senate or House of Representatives? If you haven't then it is perhaps difficult to realize how much valuable time is lost by calling the roll of such august bodies. Mr. Wilfred Lewis was quite surprised not long ago, as perhaps some of our readers will be now, to learn that it takes generally no less than an hour and a half to get a vote of the House of Representatives, using the tedious and antiquated process of calling the roll. In fact, a favorite form of filibustering in the House is to keep demanding roll calls on every question that comes up, some of them introduced for the purpose. It occurred to Mr. Lewis that in this electrical age some more efficient method might be adopted, and he proposes a far more accurate one, which he thinks might accomplish the same result in half a minute or less. Such a device has been in use in the Russian Duma for years, and presumably there is some reason why other legislative bodies have not adopted it.

Mr. Lewis goes on to say: "It occurred to me while listening to the debates in the House, followed by such interminable roll calls, that a vote on any question had better be 'seen than heard,' that the old maxim should not be applied exclusively to children. The talk, of course, will go on forever, but with a little preparation the vote might be flashed instantly on a screen back of the Speaker in full view of every member and be photographed by an operator in the gallery near the clock. This procedure would require that every member of the House have a lock-box in front of his seat which, when opened, would cause his name to appear in a certain space on the wall or screen. When a vote was called for, he would press a button showing 'Yes' or 'No' opposite his name, or simply vote 'present' by doing nothing. The number or title of the bill would be displayed at the same time; and if the record was illuminated, it could be quickly photographed.

"I believe the time will come when all legislative bodies will be equipt for voting in this expeditious way, and that the same method will be adopted by engineering and other bodies that have no time to burn.

"You can readily estimate the cost of the voting done by 500 or 1,000 high-priced men day after day and year after year in the present absurd way. The cost of installing effective voting machinery in Congress might be considerable, but it would soon be saved at the rate of perhaps $2,000 an hour in the cost of legislation; and more time could also be given to the consideration of the bills presented."

The illustration we present herewith shows President Wilson addressing a joint session of Congress in the hall of the House of Representatives, with an automatic electric vote-recording bulletin, as suggested by Mr. Lewis, mounted on the wall above the Speaker's chair.

The U. S. Signal Corps Wants You!

FOR the information of all applicants in Signal Enlisted Reserve Corps, we give below the general plan of the training and preparation the new units of Signal Reserve Corps are to receive before they are fitted for work in connection with other arms of the service.

"In the first place," says Major Carl F. Hartmann, of the New York Headquarters, "we have attempted to enlist only such men as are technically qualified to carry on the usual functions of the Signal Corps without additional technical training. We expect to give them additional training concerning the use and operation of equipment directly pertaining to Signal Corps Battalions, also an intensive course of military training which will make our organization an efficient military unit for active service.

"Our advice to men who enlist is to continue their ordinary pursuits until they receive the call from the President, then report immediately to the place designated. In the meantime it will be well for them to notify their employers that they will be subject to the call of the President, and must leave his employ when they are notified, otherwise their status with him will be the same as it has been formerly.

"Equipment for all men enlisted, such as uniforms, bedding, messing utensils, etc., will be available for issue at the camps of instruction. Each man enlisted will from the time he reports receive the same pay and allowances as the corresponding grade in the regular army. They are also entitled to transportation in kind and commutation of rations at 50 cents per meal for the time of actual travel from their homes to places to which ordered for active service. If transportation in kind is not furnished from their homes to place ordered for active service, they are entitled to reimbursement for the actual necessary cost of such transportation.

"The term of enlistment is for four years. However, the President of the United States has stated that the Reserve Corps will be held in active service only during the period of the emergency.

"It is proposed, in the Eastern Department, to organize ten (10) Field Battalions, Signal Reserve Corps, and the proper material for these organizations appears to be scarce.

"These Battalions will require men who have technical ability. Most of all, we want operators, both Morse and Continental. In addition to operators, men must be obtained who have had technical training, or who have had an education which will enable them to quickly grasp the mechanical and electrical work incident to the operations of a Field Battalion Signal Corps in active service. The men must, in addition to above qualifications, be strong and athletic, and preferably horsemen.

"A Field Battalion of Signal Corps is an organization for which college and technical men are especially adapted. The work is active and interesting. It is necessary everywhere, on the battlefield as well as on the lines of communication to the bases. The Signal Corps' drills involve the principles of nearly all the other branches of the Army, in addition to the interesting apparatus necessary for the transmission of information. We are prepared to follow the cavalry at whatever gait they desire to take. We work in conjunction with the artillery, and the infantry rely on us for their information. The Signal Corps has been termed the "Nerves of the Army," and is a very necessary branch of the service. At this time, due to the unusual expansion of the Army, promotion should be rapid

(*Continued on page* 214)

"Ham" Jones—Scientist

By HARLAN A. EVELETH

HENRY ALFONSO MARMADUKE JONES, alias "Ham" Jones, was a youth of seventeen summers, awkward and lanky, with auburn hair and freckles, and blue eyes which imbibed the beauties of nature—several sat near him in "Latin 1"—thru the lenses of omnipresent, iron-rimmed spectacles. "Ham" was *some* boy. He had attained a wide reputation among his fellow students as a wizard of wireless telegraphy and as an authority on all the intricacies of "hook-ups" and electrical phenomena pertaining thereto; in fact, the pages of his "Caesar" housed innumerable and priceless diagrams of diagrammatic data, while a rear view of this assemblage of students disclosed the existence of a secret service system of communication whereby others who desired information of a technical brand could obtain the same direct from the hand of the renowned scientist, "Ham" Jones. Thus it was with a great feeling of joy and expectation that I, a humble member of the secret service organization, accepted the magnanimous invitation of "Ham" to devote an evening of my leisure time among the electrical paraphernalia of his far-famed laboratory.

I ascended the steps of the front porch of "Ham's" abode with faltering steps that memorable night, and I pushed the push of the push-button with the end of an ink eraser; for I had heard rumors of "big sparks" and unexpected shocks, and rubber is an insulator—"Ham" had told me so.

"Hello! 'Spin'," quoth "Ham," as he swung the door open. "Glad to see you! Come right in and make yourself at home." And with that he gave me the "glad hand" and a pat on the shoulder.

"The pleasure's all mine!" I replied; I, alias "Spin" (short for "Spindle") being modeled somewhat along the graceful lines of a Geissler tube.

"Come right up stairs," chirped "Ham," so I trailed along behind him, up two flights of stairs to a hall leading to the laboratory in the attic.

"There's my room, you can open the door and step right in," gurgled "Ham." "I left something down stairs, I'll be back in a moment."

"All right," I said, innocently, and then grasped the knob of the door. I had pushed it about half open when the knob suddenly turned red-hot, or something, and it would not let go of my hand for all I could do to persuade it to. "Ham" stood on the stairs, with his hand beneath the railing, and laughed so hard that he finally sat down on the steps to keep from tumbling the whole length; thereupon the knob turned "cool" and I yanked my hand away.

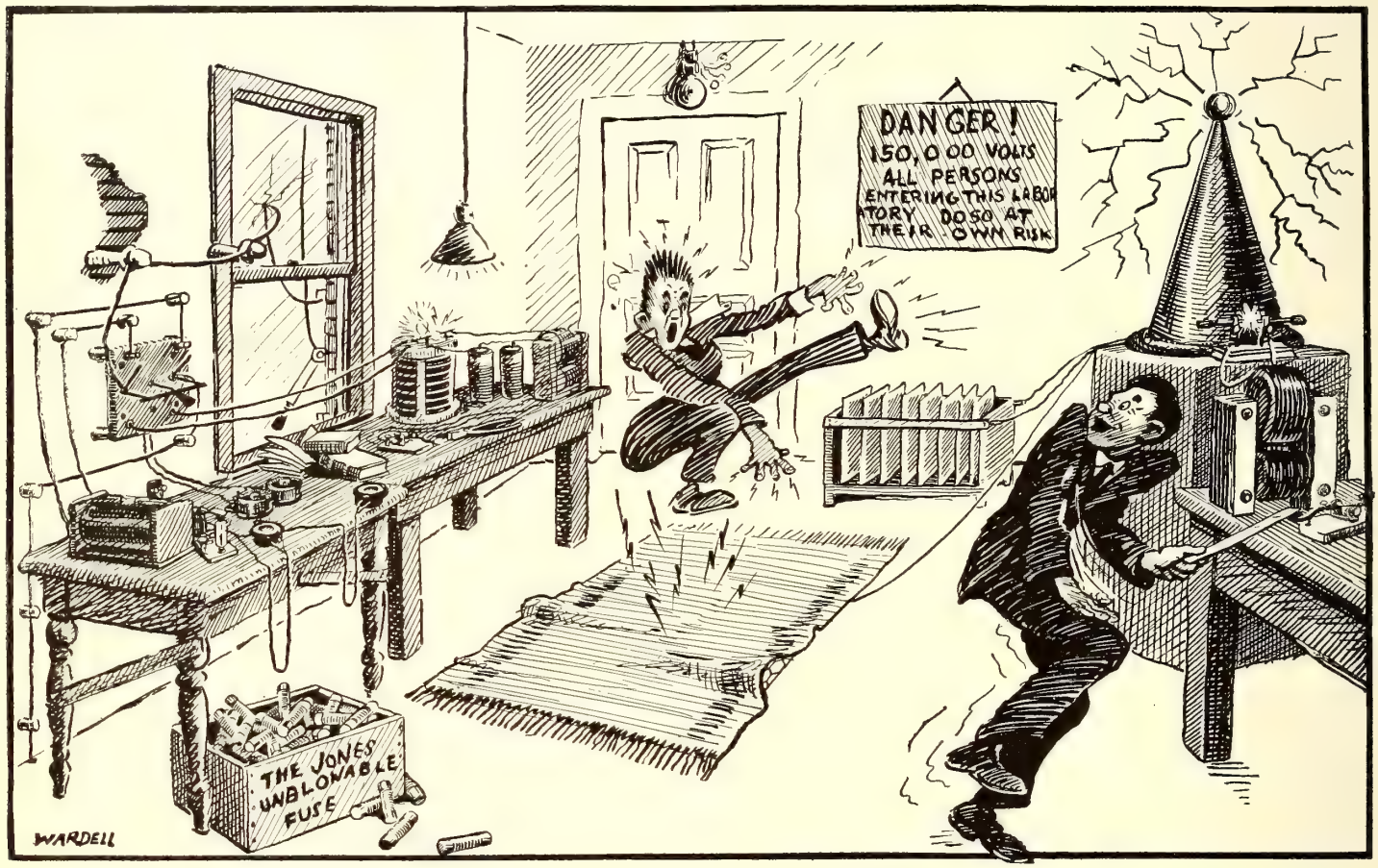
"You big boob!" I yelled, for I was scared and about ready to choke. "Do you want to kill a feller?"

"Aw forget it. You have to get used to shocks if you're going into the wireless business."

"Yes—well, will you let me try it on you?"

"Perhaps, later on, but I've got lots to show you—and besides, it's a waste of 'juice.' Come in and I'll show you my junk." So in I went.

"Ham" turned on a light, and thereupon my eyes opened wider and wider as I gazed in mingled awe and ecstasy upon the vast accumulation of multifarious electrical equipment which adorned the four walls and portions of the ceiling and floor of the laboratory; a bewilderment of coils of wire, switches, bells, insulators and instruments of every type and form imaginable—and surmounting the whole, a crudely lettered sign bearing the ominous warning:



". . . . He Picked Up a Fine Wire from the Floor, Fastened It to the Coil and Prest the Key. Suffering Cats! ! ! My Shoes Became Full of Carpet Tacks and I Leapt so High that My Head Nearly Hit the Ceiling. . . . 'Hen' Got to Laughing so Hard He Could Not Keep His Stick on the Key."

DANGER!

150,000 VOLTS
All Persons Entering This Laboratory Do So At Their Own Risk

"Hen," I said, in a plaintive tone, as if about to ask him for a job. "I guess I'll stand over near the doorway." I was careful to call him "Hen", for I feared dire consequences if I should offend his dignity.

"No, you stay right where you are," he retorted. "There will be no danger as long as you keep your hands off the wires."

"But how about those 150,000 volts?"

"Don't you worry about them. They are Tesla coil volts, and they won't do more than knock you down. I'll save the fireworks for the last, so that if you get killed you won't miss any of the show."

"Uh huh!" I gasped; then wondered if I had not better make a break for the door while I had the chance.

"Take a seat," said "Ham," "and I'll show you the wireless." So I gingerly took a seat, after first turning it upside-down to discover the presence of any diabolical mechanism which might be concealed in the cushion.

"Now, 'Spin'," he said, with a wave of his hand, as he assumed a professional attitude, "that apparatus over there on your right is called the transmitting set. It is hard for me to explain the function of the various instruments in terms which will be understood by the layman, so I'll try to use simple language. This instrument here is called a transformer, and it takes the 110 volts and cuts them up into pieces until there are fifteen thousand volts. That is thirty times as many volts as run the electric cars, so it is a very dangerous current to fool with. From the transformer the volts flow into this condenser, which piles 'em up like sardines, until there are so many that they jump across this spark gap. That coil of wire is called a helix. The volts get going around it so fast that some of them shoot off into the aerial, and from there into the *ether*. That's about all there is to it. The code is made by punching this key."

"That's a pretty complicated affair, all right," I ventured to say, "but there's one thing I don't understand. What do you mean by saying the volts go into the ether? I took ether when I had my arm broken, but I don't see what it has to do with wireless."

"Haw! Haw! The wireless ether is not a liquid, it's a substance, er——'inconceivably attenuated which is supposed to be coextensive with infinite space.' That is the only way I can describe it. I don't know much about it myself. However, these instruments over here are for receiving. The messages come down the aerial, and then pass thru those tuning coils, the receivers and the detector. The detector lowers the rate of vibration of the incoming current so that you can hear the signals, while the tuner regulates the wave-length."

"I think I understand, but can I hear a message?"

"Sure thing! I've got two, good (get that), one-hundred-ohm receivers and we'll have one apiece."

We clamped the receivers on our head, and "Hen" monkeyed with the switches and the detector and slid the contacts up and down the tuning coil as if he was sawing wood, but the only thing we heard was the test buzzer.

"There must be a loose connection somewhere," explained "Hen", as he made a minute examination of the wiring. Finally we heard a series of loud buzzes which suddenly broke into a long dash. "Hen" worked the tuner for all he was worth, but could not tune the station out.

"There's no use trying, it's another one of those *Hams* who sits on his key for the pleasure of hearing his spark. Those fellows make me sick; they have a habit of doing it just as I start to listen to——" Just then "Hen" lifted his elbow and the noise stopt. He didn't say a word; just looked a bit foolish and sawed his tuner harder than ever. Finally he jumped up, stuck his head and arms out of the window and did something which suddenly made the buzzes come in at a great rate.

"I guess that's one on me," said "Hen." "I forgot to open the ground switch. Now listen. Ah! There's Colon—keep quiet now, don't talk—hang it all, there's that fellow who sits across the aisle from me in Latin one; he's always butting in on me when I am trying to do long-distance work—listen! There's the 'R. B.' giving her 'O. S.' to 'B. H.'—Hear that low spark? That's 'H. A.' shooting the baseball scores. Gee! I wish I could copy him, but I can't, he's using Morse. I guess you have heard enough. Take the receivers off and I'll go on with the show."

So I did as commanded, thanked him for the demonstration, and told him, in earnestness, what a remarkable person he must be to comprehend the technique of such complex mechanism.

"Say, 'Hen'" I inquired, noticing the contents of a box reposing in the corner, "where did you get all of those fuses?"

"Fuses? Those are all burnt out. I bought them at a nickel apiece, and there's about two dollars' worth there in the box. I threw another dollar's worth away last night at a couple of cats. About a week ago 'pa' served me with an ultimatum to the effect that I was to buy no more fuses, so I have hit upon a scheme whereby they won't burn out so easily. I take the top off a burnt fuse and fill it with tin-foil, then force it back onto the fuse, and behold, I have a new fuse which lets more current thru than it did when new! You need not tell anybody about it, for I am thinking of getting the idea patented."

ARTICLES IN THE AUGUST "E. E."

We have a number of fine things in store for the August issue of The Electrical Experimenter. *Among the 125 articles already scheduled for the August number the Editors take pleasure in announcing the following:—*

"The Unsinkable Ship"—A solution to the submarine problem by Hiram Maxim himself. A feature article of the highest class.

"The Radio Bomb"—A thrilling wireless story that will keep you guessing every minute by C. M. Adams.

"Standard Time"—In which our friend, Thomas Reed, discourses in his inimitable style on the use of spider webs and electricity in checking standard time. Don't miss it—Readers.

Selenium, some new electrical and scientific aspects of this little known substance by Albert W. Wilsdon.

The Marvels of Radio-Activity. Part II by Jerome S. Marcus, B. Sc., (Ch. E.)

A Home-Made Arc Searchlight for the Amateur by Frank M. Jackson.

An Electrolytic Interrupter for Low Voltages by C. A. Oldroyd.

Making An Electric Clock by Thomas Reed.

The Present Status of the Audion by Dr. Lee de Forest.

Complete Details for Building a 20,000 Meter Undamped Radio Receiver by Wm. Burnett, Jr.

Amateur and Experimental Radio Research. Part II by Raymond Francis Yates.

"That is a good scheme, all right," I remarked. "I will say nothing about it; but what is that arrangement over there on the wall?"

"That is a little contrivance of mine whereby I am enabled to listen to conversation which takes place on the first floor. It consists of two microphones, a battery and a telephone receiver. I installed the microphones last Sunday when the rest of the family were at church; one is located behind the boiler in the kitchen and the other beneath the radiator in the parlor. Hold the receiver up to your ear and see if you hear anything."

"Yes," I said, "I can hear people walking around. Keep quiet a moment." The hissing and scraping noise gradually died down, and then there came to my ear a series of distorted words to the effect that ". . . I am sick and tired of the company which Henry continually brings to this house . . . they are a nuisance . . . . he is failing in his Latin . . . some night . . . throw his old wireless out of the window . . ." Whereupon I dropt the receiver and said to the unsuspecting "Hen," "It's getting pretty late. I think I had better go home."

"Hen" urged me to stay. "I will now show you the Tesla coil. I can't operate it very much in the evening, for it blinks the lights and is apt to cause trouble in the family." He tinkered with the switchboard, made new connections, then prest the key with a yard-stick and blandly continued, "The sparks I am about to show you consist of over one hundred and fifty thousand volts. They electrocute men over in Sing Sing with two or three thousand volts, so you can imagine what a dangerous current this is. That's it," as I backed away, "stand on the rug there and you will be safe." "Ham" Jones punched the key with his stick and long, purple sparks shot off from the knobs of the Tesla coil, flicked about like the fangs of a boa constrictor and snarled and crackled like a wounded "rattler." I stood on the rug in mute admiration of this exhibition of artificial lightning, ever fearful of an impending death. "Hen" let the sparks play over his hands and even pulled sparks from conspicuous portions of my anatomy. Surely, he was a genius, a second Edison, a great engineer to be; I told him so, but he only laughed and told me to wait a moment and he would show me something better. He picked a fine wire up from the floor, fastened it to the coil and prest the key. Suffering cats!! My shoes became full of carpet tacks and I leaped so high that my head nearly hit the ceiling; then down I came again on that red-hot carpet, and thus I danced in agony until "Hen" got to laughing so hard that he could not keep his stick on the key. I was mad clean thru, but what could I do with "Ham" leaning against the wall, so merry that the tears fairly rolled out of his eyes?

In about ten minutes the "Wizard" regained his former dignity and proffered an explanation of his ingenious trick. "Underneath that rug on which you so kindly stood," said he, "are a couple of square-yards of chicken-wire. I connect it with the coil by means of this fine wire, whenever I desire to pass the spark into the feet of whoever is standing on the rug. It works better on the ladies, for the soles of their shoes are not as thick as men's. I worked it on our Parson the other day, and the sermon I got from 'pa' a few hours later was sure brief and right to the point."

"'Ham'—er, 'Hen,' that's a pretty clever stunt, even if I was the goat," I ventured to say. "Those big sparks of yours are more interesting than the wireless, but I don't understand the peculiar way in which they seem to work. I don't see why they should jump into my feet when I do not have a second connection——"

"Of course you don't," interrupted "Hen." "I can't explain the reason in simple language. Now if you will step over here near the bed I'll show you some more interesting ideas. Before retiring I pull the shade, shut the door and turn on the electric light. All three of these are arranged to be worked electrically from a series of push-buttons located near the head of my bed. Step over here and I'll show you how the curtain works."

(*Continued on page* 217)

20,000 Volts Direct Current

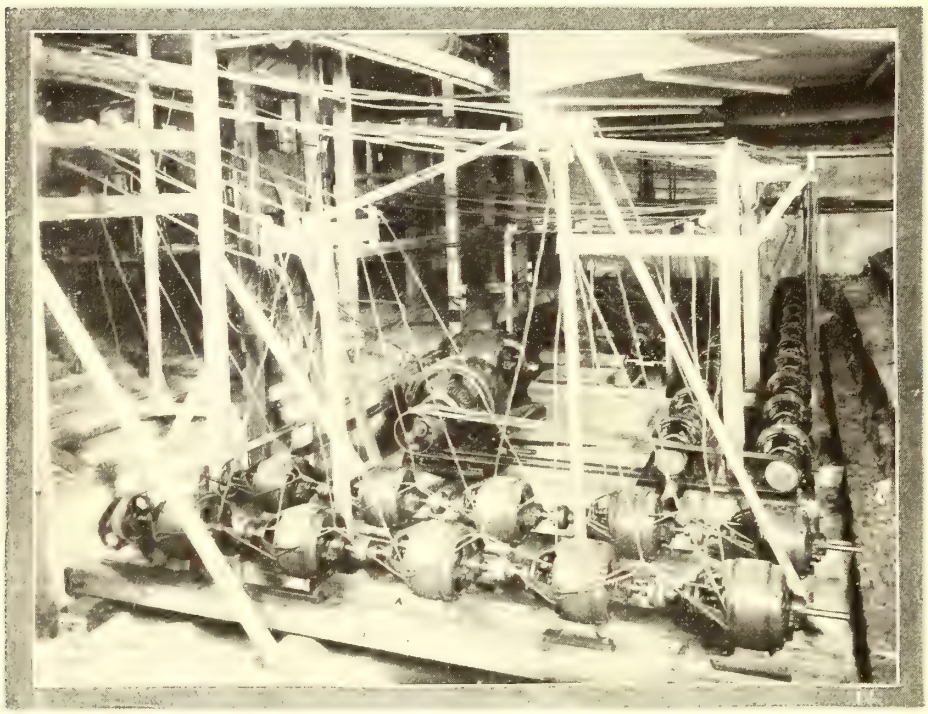
When a sufficiently high potential difference is imprest between two parallel wires, or a wire and concentric cylinder, separated by air or some other gas, this gas which for low potential gradients is a very good insulator breaks down and becomes a partial conductor. The phenomena connected with this character of conduction thru gases are known collectively by the name *corona*. The failure of the gaseous dielectric separating the metallic conductors is made evident by a flow of current from one conductor to the other, by a power loss and, in practically all cases, by the appearance of light at either one or both conductor surfaces. In some cases light appears in the intervening space.

Since the present theories as to the mechanism of corona formation do not satisfactorily account for all of the observed phenomena it was decided to carry out further investigations, says G. W. Davis and C. S. Breese in the Proceedings of the A.I.E.E., in the hope that when enough data were accumulated some theory based on fundamental principles and explaining the observed phenomena might be evolved. With this purpose in mind it was attempted to simplify the conditions of corona formation.

A wire and concentric cylinder were used in order to make the field radial and to get away from the secondary effects due to the high intensity electric field surrounding a second wire. Hydrogen was used as the dielectric in order to minimize the effects due to changes in the chemical constitution of the gas. When air is used as the dielectric the formation of ozone may produce marked changes in the voltage necessary for corona formation. Continuous potential was used in order to separate the effects accompanying a discharge from a positive wire to a negative tube from those which are characteristic of the discharge from a negative wire to a positive tube.

The continuous (direct current) voltage used in these investigations was obtained by means of a battery of forty 500-volt, 250-watt, continuous-current, shunt-wound generators connected in series.

These machines are divided into two sets of ten machines each and one set of twenty machines, each set being driven by a belt-connected continuous-current shunt motor. The generators are mounted on insulating bases and the shafts of the separate machines are connected by insulating couplings. In the newer part of the installation one terminal of each machine is permanently connected to the frame of that generator, in order definitely to limit the strain on the machine insulation to the voltage generated in one armature.



One of the Most Remarkable Electric Generating Plants Ever Built. It Is Used for Special Test Work and Comprises Forty 500 Volt D.C. Dynamos, Which, All Driven and Connected Together, Develop 20,000 Volts Direct Current!

The field of each machine is connected directly across the armature terminals, a single-pole knife switch being included in the circuit in order that the machine may either be made to generate or to run idle at will. These switches were operated by means of a hard rubber rod approximately eighteen inches in length, since they may be 20,000 volts above earth potential. The generators were run somewhat below rated speed in order to limit, to a safe value, the voltage generated with no external resistance in the field circuit.

READING BY WALL PAPER IS THE LATEST INVENTION.

Two-wheeled automobiles and torpedoes with mechanical ears to chase ships by sound waves are brain products of Professor Montraville M. Wood, who gave a demonstration of his inventions at the Union League Club recently.

By radioactive paints he asserts an expensive mural decoration may be manufactured which will furnish so much light a person may read by it.

"Within ten years," he said, "there will be plenty of nonskidding automobiles running on two wheels, built on the principle of the monorail and retaining their equilibrium by means of the gyroscope."

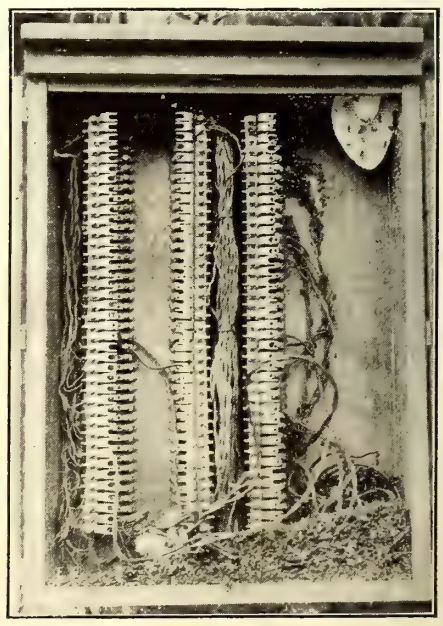
The "listening torpedo," of which Professor Wood is the inventor, is fitted with delicate mechanical devices which record the sound waves made by a ship's screw and draws the torpedo in that direction.

SEVENTEEN PICK UP FALLEN WIRE.

The curiosity of the human race knows no limit. In one of our large Eastern cities, says the *Au Sable News*, some men were at work installing a new wire on a busy street. For some reason the part of the wire that was already in place broke near one of the poles and fell to the ground. As the work of erection was not yet completed, the circuit was not in service and the wire was dead—but this fact was known only to the employees of the electrical company. One of the men, knowing the danger to the public from fallen wires, but also knowing that this particular wire was harmless, stood near by to note what action the passing throng would take. In fifteen minutes approximately 200 persons past this point, and of this number twenty-two showed some curiosity regarding the wire. Of the twenty-two who stopt seventeen, all adults who might reasonably be supposed to know better, stooped down and took hold of the wire, or at least touched it, and then, finding it harmless, past on. If the wire had been charged to a high potential, the first of the seventeen "doubting Thomases" would have been killed.

HOW BEES BECAME INTERESTED IN TELEPHONY.

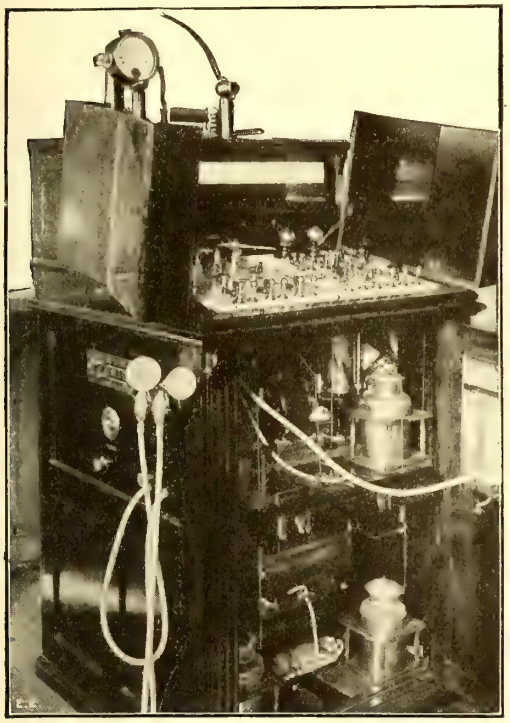
If C. W. Weston, manager of the Port Byron (New York) telephone company, had been in the honey business he might have welcomed the visit of a full sized swarm of bees which took refuge in the company's terminal box located on the main street of the village. After taking council with the local physician and druggist, and receiving no satisfactory advice, Mr. Weston's mind wandered back to the old days on the farm where on one occasion he had been compelled to test conclusions with several skunks. He procured some bi-sulfate of carbon and with it saturated a handful of cotton waste and packed it in every aperture of the terminal box. A careful and cautious examination was made the next evening, when it was found the deadly fumes had done their work. The accompanying cut shows the dead bees. Note the comb started in the top right hand corner.



Bee-lines and Telephone Lines May Not Have Any Common Bond Existing Between Them, But These Bees Evidently Thought So As They Calmly Proceeded to Build a Home In a Telephone Cable Terminal Box at Port Byron, N.Y.

A COMPACT ELECTRICAL HOSPITAL.

Electro-therapeutics is steadily claiming the attention of the present-day electrical engineer, owing to the rapid strides being made in this field, competition acting as the all-important stimulant.



A Remarkable Electrical Outfit of Extreme Compactness Which Yields Practically Every Form of Current the "Doc." May Require. It Is Rated at 5 Kilowatts.

Formerly, the electrical laboratory of the physician was littered with various apparatus, of no real consequence save to occupy space. But these conditions have been rapidly overcome, and to-day we find that the modern physician insists on his apparatus, where electricity is employed, shall be as compact and yet as complete as possible. Various equipments have been devised and introduced but none of these compare with that illustrated herewith which was designed and built by Harry Rosenthal, an electrical engineer of New York City.

The applications of these instruments are numerous a few of which are here mentioned: X-ray work, high frequency, Tesla and cautery currents of all intensities, Ozone generation for liquid saturation; apparatus for the production of mechanical vibration and air suction for skin treatment; also, the apparatus for the production of a remarkable new therapeutic ray, namely, the Rosenthal R-ray.

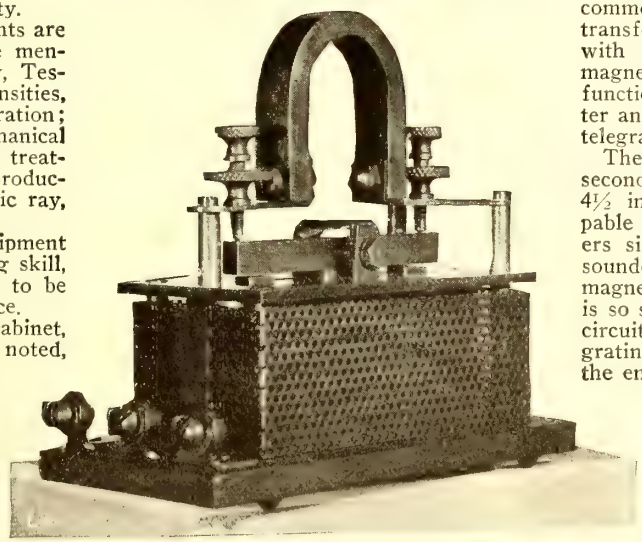
The construction of such an equipment requires a fine degree of engineering skill, considering the numerous apparatus to be fitted into the smallest possible space.

Commencing at the top of the cabinet, the two X-ray terminals will be noted, which are used to connect with the X-ray tube. A milliampere meter is stationed on the left, which is used for measuring the current sent thru the tube when in operation. The control switch-board consists of two white marble panels. Various binding posts are placed in front of the panel, each pair being used for a definite purpose, and the connections are made thru flexible copper conductors. Levers and switch arms are stationed about the panel suitable for controlling the many kinds of currents supplied. The two ball posts at the extreme right hand are used for connecting the apparatus used in the production of the X-ray. Each pair of terminals are controlled by an individual switch. Apparatus for applying the generated ozone may be seen in the upper left corner, and this consists of a special glass tube fitted with a fine nozzle.

The generating and main instruments are contained in the lower portion of the cabinet. A motor-driven suction pump is utilized for the production of mechanical vibration and the device which is applied to the patient is noted on the left side of the cabinet. It consists of nothing more than a rubber tube placed in a special receptacle and connected to the pump by means of another rubber tube. A second pump is used to force out the generated ozone. This is made in a glass tube hung on the door of the cabinet seen at the right. The terminals are connected to the high frequency circuit by means of brass clips when the door is closed, while the ozone is past thru a rubber tube to the pump, and finally to the glass bottles as above mentioned. Four high tension condensers are employed and these are placed in each corner of the lower compartment. The Leyden jars contain salt water as the interior coating, and connection is made thru a carbon rod. The Tesla transformer is placed on the door of the cabinet and its connections are terminated at copper jaws which interlock on metal lugs when the door is closed. The high tension current is supplied by a 5-kilowatt closed-core transformer and this is placed in the base of the cabinet. Its secondary terminals are led to a special rotary spark gap which is placed in the rear.

A TELEGRAPH SOUNDER THAT WORKS ON A.C.

Telegraph sounders all operate on direct or continuous current, such as that from a battery. But here is one that clicks away at a merry pace on alternating current! In brief, the current from the line thru the main line relay keeps the armature normally against the front contact, permitting current from a small alternating current transformer to energize a winding on a laminated iron core. On opening the main line and consequent demagnetization of the relay the armature makes contact with the back stop, thus energizing one coil of the transformer. The sounding lever of the transformer, fulcrumed on the center or common leg of the laminated core of the transformer, is alternately held in contact with adjusting screws kept continuously magnetized by a permanent magnet. The function of the magnet is to prevent chatter and hum of instrument and renders the telegraphic sounds uniform.



Something New in Telegraph Sounders—One That Actually Works Efficiently On Low Voltage Alternating Current From a Step-down Transformer.

The small transformer case (including secondary voltage regulator) measures 3x6x 4½ inches high. This transformer is capable of operating fifteen or twenty sounders simultaneously. Energy taken by the sounder is approximately four watts; the magnetizing energy taken by transformer is so small that the primary may be left in circuit continuously, as the ordinary integrating watt hour meters will not indicate the energy consumed.

The function of the contacts on transformer is to adjust voltage to best operation of sounder. Under proper conditions it is practically impossible to tell whether the sounder is connected to an alternating or direct current circuit. A trial equipment in a railway telegraph office has operated successfully on a sixty cycle circuit, but the device operates equally as well without any change on twenty-five cycles. A loud, clear sound is obtained by a movement of but 5/1000 inch of the lever.

A NEW TELEGRAPH TEACHING MACHINE.

The instrument here illustrated is intended to simplify the details of telegraphy. It is operated without the aid of an instructor. All that the beginner has to do is to follow the chart and execute the dots and dashes as they are printed thereon. It was invented by Mr. George J. Little and is called the *Simplograph.*

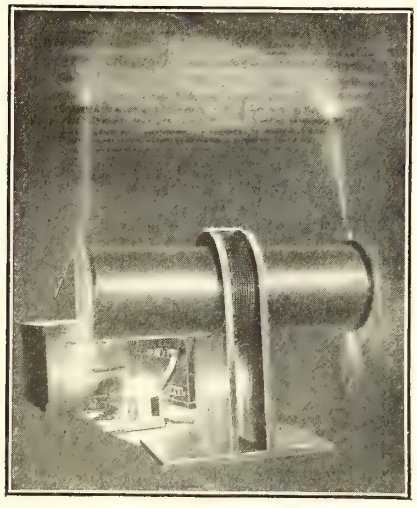
The object of having a key for each letter is to allow for the use of both hands simultaneously if desired. This gives the beginner plenty of finger exercise. This instrument is claimed to represent distinct advantage over the single key or other mechanical devices that are now on the market. A dry cell or two, connected up to the keyboard here shown, causes the buzzer mounted thereon to respond every time the keys are deprest. Incoming signals are received on the buzzer also. The key before each letter on the chart must be deprest the proper number of times for the corresponding dots and dashes. The device should prove of value to students.



The "Simplograph"—An Attempt to Make the Learning of the Telegraph Code as Simple as Possible. A Buzzer Sounds the Signals for Radio Students.

A 36-INCH SPARK TESLA COIL FOR LECTURERS.

Probably the most amazing and spectacular of all electrical apparatus is the Tesla or High Frequency Coil and no electrical



3 Kilowatt Tesla Coil in Full Activity, Giving 36 Inch Sparks. The Sparks May Be Taken Into the Body as Their Ultra-high Frequency Renders Them Harmless. This Is the Class of Apparatus with Which Our Pseudo-professors of the Stage Are Wont to Over-awe and Mystify Us.

laboratory or lecturer's outfit is complete without such an equipment. It is most astonishing to be able to draw coiling, flaming sparks from a few inches to several feet in length from your body to the coil without the slightest injury or discomfort. Hundreds of other interesting and strange experiments may be performed, such as lighting large numbers of vacuum or Geissler tubes of various brilliant colors by merely holding them in the hand near the coil without any wires whatever. The ordinary incandescent lamp will glow with a pale green light when held near the coil or connected to it. Various minerals and many precious stones will glow and fluoresce with unusual lights and colors under its influence. Its sparks when occurring over large flat areas produce a large quantity of ozone. A wire bent in the shape of the letter "S" and balanced on the point of a pin from its center, will rotate as a static motor with flames shooting from its ends when the pin is connected to one pole of the machine. All of these experiments and hundreds of others may be performed without the slightest danger, as the frequency of the current is so high as to render it harmless. You cannot even feel the spark if it is allowed to jump to a piece of metal held in the hand, but where the spark jumps directly to the skin it gives a slight pricking sensation only on the spot where the spark strikes. The coil has a movable contact on the primary for tuning it to the secondary. Proper tuning between primary and secondary is important for satisfactory results.

The Tesla Coil rated at ¼ K.W. will give a purple flame about 9 inches long when operating in proper tune or resonance, and when the electrodes are separated to a greater distance each is surrounded by a fan of coiling sparks several inches in length. It requires a condenser of approximately .01 M.F.

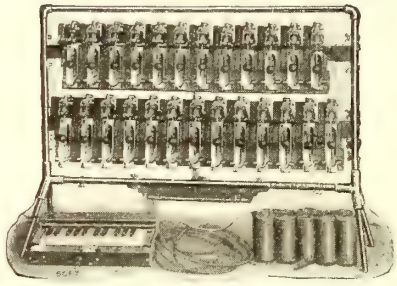
The coil shown in full activity is producing 36-inch high frequency sparks and is excited with a 3 K.W. radio transformer, a spark gap and a high-tension condenser of .03 microfarad capacity. These outfits operate from 110 volt, 60 cycle A.C. circuits and form an excellent apparatus for the lecture and stage platform.

ELECTRIC UNA-FON MAKES MUSIC TO BEAT THE BAND.

The electric Una-Fon here illustrated is played from a keyboard, the keys of which are exactly the same as those of a piano. No previous experience is necessary for its successful use and any piano selection can be played on it, both harmony and melody. The instrument is said to mark a new departure in tone quality, it having been likened by some to the *Vox Humana* of a pipe organ. The Una-Fon may be played either soft or loud and is equally adapted to use in theater or in the open. In street work, under fair conditions, it may be heard several blocks; it has wonderful volume and carrying capacity. On the water its clear, brilliant tone carries great distances. The maintenance expenses is kept at a low figure by reason of the storage battery supplied with each set, cutting the operating cost down to two or three cents an hour.

Each tone-producing unit is a patented special alloy, nickel plated, concave steel bar, mounted over a special resonator on a solid oak frame, with an electric playing action attachment. It remains in perfect adjustment, produces a fast vibrating stroke and wields a large composition mallet that brings out the full beauties of the tone. The instrument is not affected by atmospheric conditions, and retains its tone at all times.

The various electric actions are firmly



A Novel Electric Musical Instrument Which Is Played from a Keyboard Exactly Like That of the Piano.

mounted on solid oak cross-pieces on nickel plated floor rack that occupies minimum space and can be moved anywhere. The keyboard is connected thru a ten-foot flexible cable.

electric musical instruments such as the Xylophone, Marimbaphone, etc., as these can be played from the same keyboard.

The third unit of this instrument comprises a small, light battery case for holding dry cells of standard size, which is constructed with fastenings so that it may be attached to any part of the machine that is found convenient. The three parts of the apparatus are connected by a single cable, of such length that the whole apparatus can be instantly attached to any of the standard instruments now in use.

Special octave couplers produce a twenty-piece brass band volume. The detachable keyboard enables the addition of other

RADIO IN DENMARK.

Denmark has organized at Svenborg a school of radiotelegraphy with the object of giving complete professional instruction allowing pupils to obtain the necessary certificate to operate wireless stations.

LARGEST STORAGE BATTERY IN UNITED STATES.

The Detroit Edison Co., has in service in its Congress Street Sub-station the largest storage battery in the United States.

This installation is of interest, not only on account of the high capacity of the battery but also as showing the most recent practise in storage battery engineering as applied to urban direct current lighting systems.

This battery is kept fully charged and connected to the bus bars at all times in order to insure against an interruption of service. In case of failure of the customary sources of energy the battery is instantly available for use.

The battery consists of 150 large Exide cells having a capacity of 25,200 amperes at 110 volts for one hour and 80,000 amperes for ten minutes.

Elaborate endcell switches and battery control switchboard are employed for properly switching in the cells, charging them and regulating the counter electro motive force of the battery.

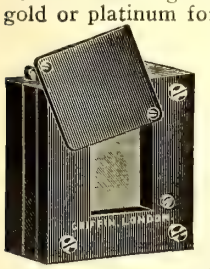
Many of the largest central power stations are equipt with storage batteries similar to this one, for the purpose of helping to carry the *peak* load, which may last only an hour or so, and which does not warrant the installation of additional dynamos to carry the mean average load, plus the peak load.



The Gigantic "Standby" Storage Battery of the Detroit Edison Co., Said To Be the Largest Storage Battery in the United States.

GRAFITE-SELENIUM CELLS.

The new type of Selenium Cell here illustrated and brought out in England, possesses distinct advantages over all former types, chiefly owing to the use of the non-oxidizable grafite in place of copper, gold or platinum for the electrodes bridged over by the selenium.



These cells are claimed to have great stability, and should, with proper treatment, remain effective for many years. As no wire is used in their construction, short-circuiting is excluded. Their efficiency, measured by the useful current obtainable on illumination, is well above that of the best previous types. This claim, put into figures, is as follows:

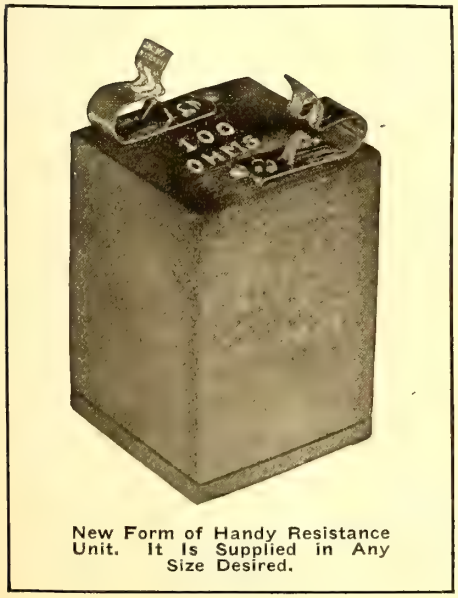
With a sensitive selenium surface of 5 sq. cm., and a voltage of 20, the additional current obtainable at various illuminations is as follows:

1 metre-candle .....¼ milliampere
50 metre-candles .....1 milliampere
500 metre-candles .....2 milliamperes

The cells are constructed under the supervision of Dr. Fournier d'Albe, A.R.C. Sc., the inventor of the Type-reading Optophone, and are made in two standard patterns. Type A, suitable for working relays; resistance about 10,000 ohms. Type B, suitable for use as Photophone Receivers, or for other applications of intermittent light; resistance about 100,000 ohms. Type A has a sensitive surface of 5 sq. cm., and is guaranteed to yield the currents above specified. Type B has a sensitive surface of 0.3 sq. cm., and is guaranteed to detect an intermittent illumination of 25 metre-candles with a sensitive telephone receiver and a battery of 20 volts. Larger patterns are constructed by special arrangement. The size of standard cells is 2x2x1 inches overall and weight 2¼ ounces.

HANDY RESISTANCE UNITS.

Something every electrical man wants at some time is a standard resistance unit. Each resistance unit of the type illustrated is mounted in a block of hard wood with shellac finish. The terminals of the resistance are attached to spring binding posts. The resistance unit blocks are 1¾ inches square and 2½ inches high, and can be arranged together like blocks in various combinations. The resistance wire is wound bifilar on a large diameter spool which is concealed in the block. All units are adjusted to within one-twentieth of one per cent accuracy. Each unit will safely carry a load of 2 watts which will produce a final temperature rise of 50°C.

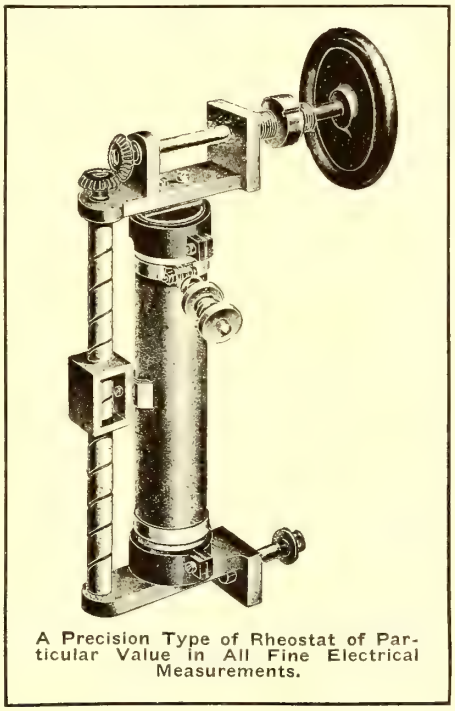


New Form of Handy Resistance Unit. It Is Supplied in Any Size Desired.

These resistance units will be found of great convenience for obtaining any desired resistance value. (The desired value is quickly obtained by series, parallel, or series-parallel combinations of the units); for shunting a galvanometer to make it critically damped, or to reduce its sensibility; making up the ratio coils of a slide-wire bridge or a Kelvin double-bridge; multiplying the scale of a voltmeter or wattmeter by increasing its resistance; building up a "volt box" to use in connection with a potentiometer and for building up resistance combinations to teach students to calculate and measure the same.

A PRECISION TYPE OF RHEOSTAT.

It is often desirable in electrical work, especially when making delicate measurements, to have available a finely adjustable resistance such as the one illustrated. This particular rheostat is of English manufacture and comprises a metal tube covered with insulation and over which many turns of closely wound bare resistance wire are placed.



A Precision Type of Rheostat of Particular Value in All Fine Electrical Measurements.

By means of the usual hand wheel projecting at the right and the geared worm, it becomes possible to move the adjustable spring contact very accurately along the resistance coil. In order that this movement shall not require too many turns of the hand wheel, the pitch of the thread on the worm shaft is made quite long or about one-half inch. The particular precision rheostat illustrated is designed to be mounted on the rear of a switch-board panel and the regulating knob or wheel only projecting thru on the face of the panel. It should prove ideal for all kinds of electrical measuring circuits, as well as wireless circuits.

The new battleship Tennessee will use 27,500 electrical horsepower, enough power to furnish heat, light and power for a city of 100,000 inhabitants.

A VERTICAL TABLE FAN.

The advantages of the new electric table fan shown in the accompanying illustration lie in the fact that it can be used on a dining-room table or a flat top desk without disturbing the papers or articles on the desk's or table's surface. The breeze is distributed in a strata of about one foot above the table level, and has a radius of six to ten feet. Therefore, everyone seated within that radius, receives a continuous breeze instead of the intermittent and often annoying strong blast of the ordinary oscillating fan.



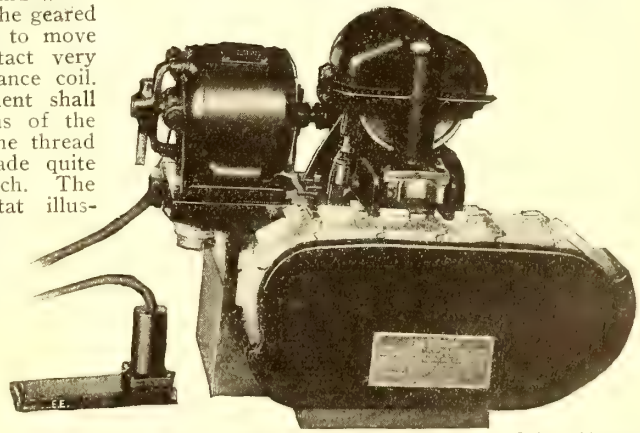
Table Fan for Use on Dining-room or Library Tables to Give All-around Breeze.

ELECTRIC TAG MARKER SAVES TIME.

The marking of price tags in dry-goods, and department stores particularly, is a slow and tedious task if done by hand. The simple motor-driven tag marker shown changes all this. By its use 2,400 tags can be printed in an hour.

The mechanism of this tag marker, which is driven by a 1/20 h.p. motor thru a worm and gear, consists of a set of cams, which move an endless chain of aluminum trays beneath a miniature type chase. The tags are printed as they move along on these trays. The trays are hand fed. A tag is placed in each tray beneath a clip which holds the tag in place from the time it is fed into the machine until marked by a downward movement of the type chase. This insures uniform register of the marking. When the tag is printed it is automatically released from the clip and discharged from the tray at the end of the machine.

The machine will accommodate any size or shape of tag up to 1¾ inches wide, of any thickness from thin paper up to cards 3/32 inch thick. The type chase is adjustable to adapt it to various sizes of type and is capable of marking as many as seven lines with fifteen small characters or nine large characters on a line. The type commonly used is of metal, full twelve point (⅙ inch high). With the usual set up of the chase, it is possible to print both the tag and the stub with the words *Lot, Size, Price* and some other word if needed.



The Electric Tag Marker Prints 2,400 Price or Other Tags an Hour.

This tag marker is compact, portable, very quiet in operation due to the worm drive, and only weighs 45 pounds.



RADIO DEPARTMENT



Notice to All Radio Readers

As most of our radio readers are undoubtedly aware, the U. S. Government has decided that all Amateur Wireless Stations, whether licensed or unlicensed, or equipt for receiving or transmitting, shall be closed.

This is a very important consideration, especially to those who are readers of THE ELECTRICAL EXPERIMENTER, *for the reason that we desire to continue to publish valuable articles in the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have publisht in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools thruout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment.*

Therefore, and in view of the foregoing explanation, we feel sure that every reader will thoroly understand that altho articles on transmitting, as well as receiving, apparatus may appear from time to time in these columns, he is not permitted to connect up any radio apparatus whatsoever to any form of aerial.—The Editors.

Testing Radio Units With Dummy Antenna

By FRANK C. PERKINS

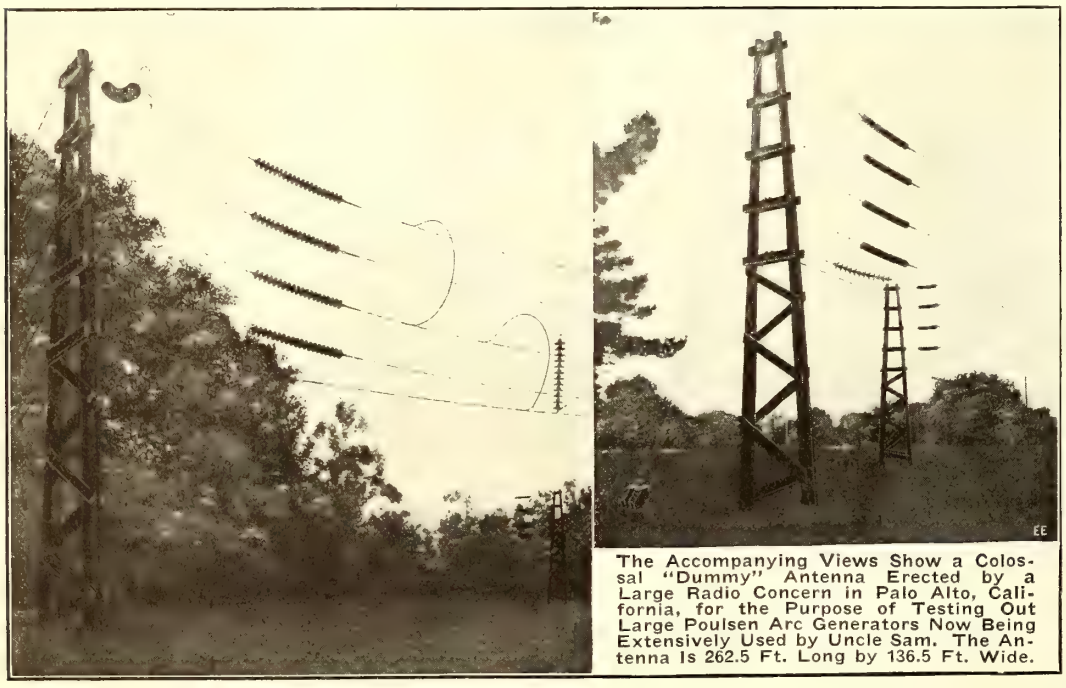
THE accompanying illustrations, figures 1, 2 and 3, show the equipment used for testing radio units of the Federal Telegraph Company with a *Dummy Antenna,* as utilized at the Palo Alto, California, laboratory. It was possible, with this antenna, to reproduce practically any antenna found in commercial radio telegraph stations, and therefore observe the performance of the wireless sets under practical operating conditions.

The Arc Radio Transmitters are now produced for commercial uses in ratings from 5 to 500 kilowatts, and the 350 K.W. unit has an overload rating of 500 K.W.

It is pointed out that when electrical engineers test a dynamo they are not likely to disturb engineering operations in other buildings, or even in other parts of the same building. When, however, they test a radio plant of considerable power they are likely to disturb the *ether* for hundreds of kilometers in all directions. A need arises, therefore, for a *dummy antenna,* or a *radio load* for testing radio generators, which shall not seriously stir up and vex the ether in the vicinity. The problem is to load the generator but to suppress the output beyond a short range. This is a problem in radio inefficiency, and is just the reverse of the ordinary problem of the radio engineer, which is to load his generator as efficiently as possible, so that the effects may be manifested at a great range.

The dummy antenna at Palo Alto consists of a series of horizontal galvanized iron wires in five layers, so arranged as to be capable of forming an air condenser of adjustably variable capacity up to about one-thirtieth of a microfarad. With such a capacity carrying 250 amperes, at 20,000 cycles per second, the voltage, neglecting all losses, would be approximately 64,000. Sixty-four kilovolts driving 250 amperes in quadrature would develop 16 megawatts of reactive power.

It is pointed out that an active power rating of 200 K.W. would thus only demand a little more than 1 per cent of dissipation factor. It is evident that this dummy has large dissipation possibilities. In making radio units of larger capacity than have heretofore been attempted, it was found necessary to provide a dummy antenna which could be used for testing Federal-Poulsen Arc converters of various sizes. Because of the large units contemplated, and since interference with nearby commercial stations had to be avoided, the type of construction shown in the accompanying illustrations was developed.



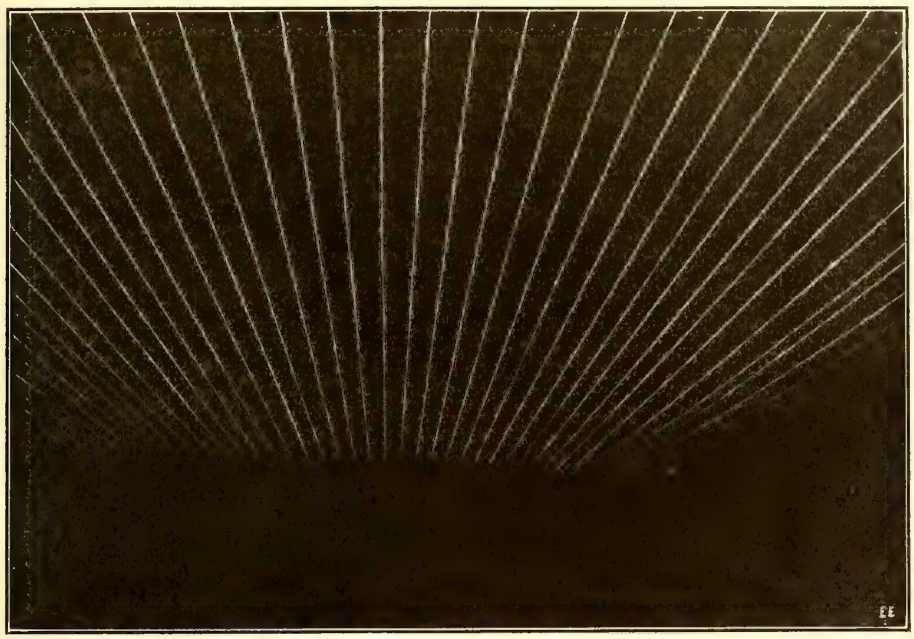
The Accompanying Views Show a Colossal "Dummy" Antenna Erected by a Large Radio Concern in Palo Alto, California, for the Purpose of Testing Out Large Poulsen Arc Generators Now Being Extensively Used by Uncle Sam. The Antenna Is 262.5 Ft. Long by 136.5 Ft. Wide.

It may be stated that this afforded capacities up to 0.031 microfarad, and by being of such construction as to have a low effective height, caused a minimum of interference. The antenna consists of five parallel layers of wires spaced 5 ft. apart vertically. The wires in each layer are 2 ft. apart horizontally and there is a 10 ft. clearance between the ground and the lowest point in the bottom layer. The bottom layer, which is grounded, is 136.5 ft. wide, with a maximum length of 262.5 ft.

It is of interest to note that the other layers, insulated from ground, are 20 ft. shorter and 41 ft. narrower. The insulated layers have fifty-one wires each and the grounded layer sixty-six wires. The two outer wires on each side of the four top layers are size No. 2, because the edge wires are not shielded as well as the others and it was desired to prevent the *corona* which would otherwise appear at the edges of these layers. With this exception, No. 14 galvanized telephone wire was used in all layers, and the wires are fastened at each end to 1-in. stranded cables. Altho galvanized wire is not generally considered good practise in radio work, it was nevertheless used on this antenna because with the large number of wires employed the

resistance could be kept within the usual limits.

For convenience the five parallel layers of the antenna are numbered from the top down. Layers Nos. 1 to 4 inclusive are well insulated, and a long length of halyard



Wonderful Night Photograph of "Dummy" Antenna in Full Activity. Note the Corona Glow on the Wires Caused by a Charge from a 300 K.W. Federal-Poulsen Arc Generator.

between the insulation and the supporting towers was provided in order to permit of putting in more insulation with suitable corona shields in case this became necessary at a later date. Obviously, if this were done, only layers Nos. 1 and 5 could be used, because the large diameter of shields necessary with such a long string of insulators would otherwise interfere, the layers being only 5 ft. apart.

It will be observed that provision was also made for the installation of corona shields on the insulator strings now used, but no trouble of this sort has been experienced thus far and these shields have not been added. Beneath layer No. 5 are two single wires which are normally connected and have a separate lead running into the laboratory. These have a capacity of 0.002 microfarad. By various combinations of these wires with different layers of the antenna, a considerable number of capacities are available, the maximum being obtained when layers Nos. 1, 3 and 5 are connected as the earth side of the system and Nos. 2 and 4 are connected with the two single wires as the high potential side. With this combination the capacity is 0.031 microfarad.

The jumpers used for connecting the various layers consist of 1½ in. copper tube provided with suitable clamps and fittings so that shifting to different capacities is an easy matter. The capacities most commonly used are 0.006, 0.012, 0.017 and 0.024 microfarad. Many others are available. Before deciding upon the exact lengths of the antenna wires, it was noted that with evenly spaced equal loading the 1-in. cables to which the wires are attached would assume a parabolic curve. The lengths of the wires in each layer were calculated accordingly, and thus a uniform tension is secured in the individual wires of each layer without excessive pull on the pole supports.

Previous to the tests, it was desirable to tabulate the length of each wire, which was calculated to the nearest 0.01 ft. A convenient scheme was then devised for cutting the large number of wires to exact length so as to secure the parabolic curve in the 1-in. cables. Two short posts, exactly 200 ft. apart, were set up on the site with several intermediate stakes between. The wire was unwound from the reel near one of the posts and run out with a "come along" grip to the desired length beyond the second post.

There was steel tape with its zero on the second post stretched out beyond it with the wire and the end of the wire was placed at the exact tape reading before signaling. Having the end of the wire held firmly in place on the tape, a man near the reel put steady tension in the wire by means of a "come along" grip until the wire was just raised above the intermediate stakes, and then, upon signal from the man at the tape, the wire was cut with pliers at the first stake. After cutting each individual wire the crew, consisting of two men at each end, proceeded at once to fasten it in place on the 1-in. cable which had been previously stretched, to remove twists, and laid out on the ground in position for hoisting. In cutting the wires, 1 ft. over and above finished dimensions was allowed for connections.

There was then a point 6 in. from each end measured off with a rule, and this point was kept at the inner side of the cable while the end of the wire was given two turns around the cable and sufficient wrapping to secure it. The antenna as a whole reaches the corona point with an undamped high-frequency current of 250 amperes at a frequency of 20,000 cycles. The accompanying night photograph, Fig. 3, shows a layer of the antenna at the corona point during the test of a 300 K.W. Federal-Poulsen Arc generator. The dummy antenna was used at the laboratory for testing the high power apparatus which the company has constructed for the United States Navy at San Diego, Pearl Harbor and Cavite.

RADIO IN PERU AND SPAIN.

Measures have been adopted by the Peruvian Government authorizing the construction of a telegraph line between the cities of Ica and Castrovirreyna at a cost of 6,300 Peruvian pounds ($30,659), and the installation of wireless stations at various points in the basin of the Amazon at a cost of 10,000 Peruvian pounds ($48,665). *El Peruana* also notes that a new telegraphic code has been compiled by the Department of Telegraphs and Mails, and a commission of Government officials has been appointed to examine the code and to make a recommendation as to its adoption.

The new postal building at Madrid, Spain, is to be fitted with wireless telegraph and telephone apparatus of the latest pattern. The transmitter will be of the same type as that which made possible the transmission of the human voice from New York to Honolulu and Paris. From the central tower, 90 metres high, wire will be stretched to the three other posts, of which two are on the front and the other on the back of the building. The receiving apparatus will comprise a certain type of telephonic relay allowing the intensity of the feeble current received to be amplified 500 times.

WOMEN RADIO OPERATORS TO THE FRONT.

The National League for Women's Service has enlisted its first wireless operator. She is Miss Helen Campbell and she is an expert in receiving and sending. She entered the service of the League on May 8th. Women in all parts of the country are taking up the study of telegraph and radio operating in earnest, as these vocations hold undeniable promise for those aspiring to fill positions of responsibility and service to the Nation. Besides, there will be plenty of opportunities after the war for radio and telegraph experts.



Photo by Bain News Service

Miss Helen Campbell Has Successfully Mastered the Intricacies of Radio-Telegraphy. She is an Expert in Sending and Receiving Radio Messages.

HOW THE GOVERNMENT SEALS RADIO APPARATUS.

Uncle Sam's radio inspectors have been extremely busy the past few weeks sealing up all radio apparatus not in actual use by the Government.

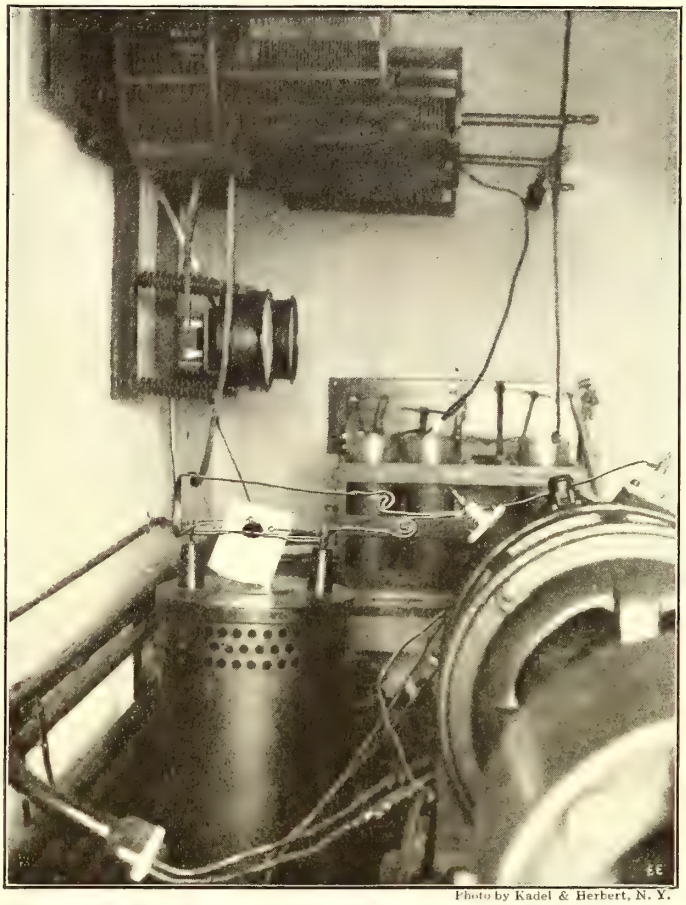


Photo by Kadel & Herbert, N. Y.

Our Uncle Samuel Seals Up Wireless Apparatus Tight When He Does the Job. A Heavy Wire Is Run Thru All the Binding Posts and Sealed as Shown, and Woe Be Unto Anyone Who Maliciously Breaks the Seal.

Heavy wire is wrapt around the poles of the spark gap and the ends of this wire are joined with wax bearing the great seal of the United States of America. Heavy prison penalties are provided for the breakage of this seal. The wire short-circuits the spark gap and makes it impossible to secure a spark. The impression of the great seal is made in red wax on an ordinary piece of paper.

MANUFACTURING WIRELESS APPARATUS FOR SUBMARINE CHASERS.

Radio manufacturers are now working night and day building apparatus for the U. S. Naval vessels. The photo shows quenched spark gaps being machined.

These spark gaps are brass discs with silver centers, and they must be accurate to 1/10,000 of an inch. Measurement is made by the small dial above the pin which shows the accuracy. If the spark gaps are inaccurate they must be sent back to be machined to the proper dimensions. Sixteen of these discs are installed in each set for submarine chasing purposes.

A new radio station has recently been erected at Viacha, near La Paz, Bolivia. Commercial service was established on Oct. 20th.

U. S. CALLS FOR TELEGRAPH AND RADIO OPERATORS.

The war's demand for telegraphic communication has increased so much that an emergency call has been issued thru the War Department for young men and women of the country to present themselves to be trained as telegraph operators. Arrangements have been made with the Western Union Telegraph Company to train 2,500 new operators. These are to enable the Government to handle its war telegraph business without taking any more operators for the Signal Corps from the present railroad and commercial telegraph forces, and without seriously interfering with vital communications.

The War Department's appeal follows:—

"Several thousand young men and women are needed for telegraph service, either in the Signal Corps of the army, or to replace those in commercial work who are leaving positions to join the colors. These young people must be trained. For this purpose the Western Union Telegraph Company has placed its facilities at the disposal of the Government to train twenty-five hundred operators, and the training will be conducted by its experts.

"It is estimated that there are more than 30,000 amateur wireless (sending) operators in the United States. These young men now have an opportunity—perhaps the only opportunity of their lives—to contribute materially to their country's welfare in an hour of need by volunteering for this work. At the same time they will be mastering a trade in which stable employment can almost always be secured in any important city.

"Telegraph operators in the army and navy occupy preferred positions both as to rank and pay. Young men who take up telegraphy, but who do not enter the Government employ will still render patriotic service by relieving those who desire to enlist.

"The tremendous demands upon the operating forces of the country during this period of intense activity—the mobilizing of all the resources and energies of the American people—have taxed the present telegraph forces to the utmost and necessitate the immediate recruiting of hundreds of volunteers for this service. The Government needs telegraph operators for its Signal Corps.

"Amateur wireless operators, women typists, and all other competent young men and women possessing the fundamentals of grammar and high school education and not already employed in service contributing to the national welfare, are urged to apply to the offices of the Western Union Telegraph Company to take up telegraphy training. By so doing they will serve their country in a very practical and patriotic way."

A HUMAN RADIO OUTFIT!



Radio Fiends and Bugs—
Please Take Notice of the Master Incarnated Wireless Vampire. This Photo, Which Came to Us Anonymous—by Wireless of Course—Shows How the Fiend Is Gradually Turning into a Radio Outfit. His Legs Already Are Long Switch Levers, and Before We Go to Press, His Brain Probably Will Have Turned into an Ether Wave! Here at Last We Have a Radio Enthusiast Who Loves His Set Well Enough to Get Married to It!



Photo by Kadel & Herbert, N. Y.

Manufacturing Quenched Spark Gaps in New York City for U. S. Naval Vessels. The Gap Plates Must Be Machined to 1/10,000 Inch Accuracy.

CORRECTION NOTICE!

In the article appearing in the May issue and entitled "Receiving the Marconi 300 K.W. Stations on the Oscillating Audion," by S. Curtis, Jr., an error was made in stating that Dr. White of the General Electric Company's research staff had succeeded in getting an Audion type of oscillator to operate at wave lengths as low as ½ meter. This should have read 6 meters, which wave length of oscillation was only obtained with a perfect non-gaseous bulb.

How Radio Brought the News to the Farm

WEATHER reports, market quotations and world news daily by wireless telegraph, such is the innovation which makes the farm and the work of Archie Banks, of Delmar, Iowa, of more than ordinary interest. The last vestige of isolation and aloofness from the world has been banished from the farm by this young Iowan. Back of his achievements lies a story of determination which should be an inspiration to all.

Eight years ago Archie Banks was a sixteen-year-old boy, living on the farm of his father, a well-known live stock farmer. The boy had always been interested in machinery and mechanical matters, but met with little encouragement along this line from his parents. He might never have had an opportunity to develop his latent talents had it not been for an accident. One day, in working about her household task, the boy's mother knocked off the telephone batteries.

"Central told her how to connect them up again and she did so," says Mr. Banks. "I happened to come in then and she told me what she had done. Of course, I wanted to see if she did it right. I was promptly told to run along and that what I knew about telephone batteries wouldn't bother anyone. Well, I made up my mind I would know something about them, and I set to work studying everything I could get hold of—books, magazines and catalogs. In a year I had the house wired from cellar to garret, and lighted with electric lights run from batteries. Two years afterward I had a small wireless built, but it would not work well. All I could do was to talk to Delmar, a mile away. I determined to do better, and so I set to work again."

This second time the boy was more successful, so that today he has installed in the twelve-room farmhouse, a mile from Delmar and about eight miles from Maquoketa, a complete wireless telegraph outfit, by which he receives weather forecasts and news bulletins twice a day from the wireless stations connected with the Illinois State Agricultural College, at Springfield, and the Iowa State Agricultural College, at Ames. (Prior to the war of course). Weather reports are sent out by these stations every day at noon, while news bulletins and the events of the world are sent twice a day—at noon and again at 8:30 in the evening.

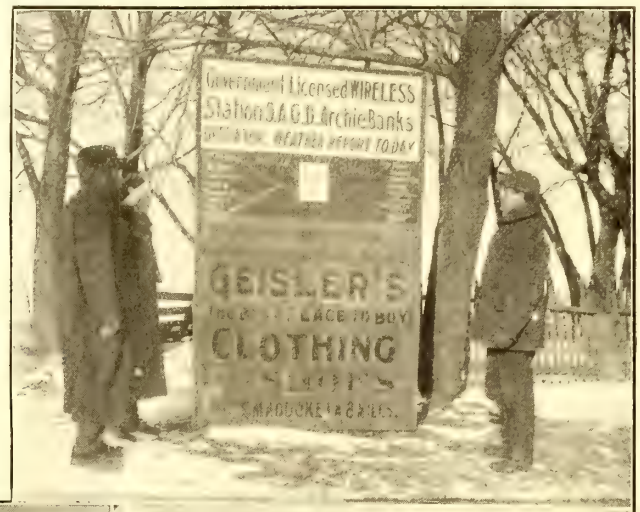
But Mr. Banks did not stop with this. He did not believe in being selfish. He had this news service himself; why not share it with friends, neighbors and passers-by? Accordingly, the weather forecasts and the news bulletin were telephoned from his farmhouse to whoever desired to receive them, the climatic changes being known for a radius of ten or fifteen miles, long in advance, by means of this excellent service. Farmers who live near Mr. Banks did not have to wait for the belated newspaper which the R. F. D. carrier delivered to see what the weather would likely be the next few hours; they were not caught unprepared by any sudden and unpredicted change in temperature; a minute at the rural telephone, to secure proper connections with the Banks farmhouse, and the weather forecast was known by them as promptly as it was known by the man in the city, with the daily paper laid on his desk but a few minutes after it had left the press.

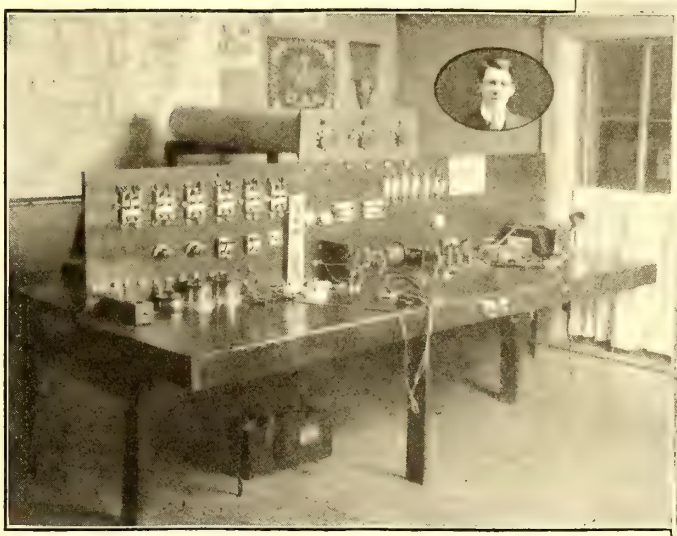
This is not all, however. As one drives toward or from Delmar, along the road which leads by the Banks home, he comes suddenly upon a large sign stretched across the road, a board sign eight feet long and two feet high, upon which is painted, in large words, this placard: "Eat honey, For sale here. Today's weather report by wireless on next curve. Archie Banks." A few rods further on, at the first turn in the road stands the large bulletin board, eight feet high by five feet broad. Upon it Mr. Banks used to post the weather forecasts and the news bulletin, each day, just as soon as they were received. Whoever drove by the Banks' home got the news of the world as promptly and as accurately as the city man got it from reading the bulletin board of the metropolitan newspaper office.

All this is not without its business effect. Mr. Banks (now twenty-four years of age and farming for himself) owns and operates a farm of 160 acres, carrying on a general farming business. He has two particular hobbies, however—electricity and bees. Prior to December 10, he had sold almost 3,000 pounds of honey last year; he could sell much more if he had it, for his honey is of good, uniform quality, and Delmar is in the midst of a rich honey section, many carloads being shipt from there to all points east and west. Passers-by who would stop at the Banks' home to read the bulletin board, or to inspect the wireless plant, bought honey and thus came to be regular customers of the apiary, adding to a sideline income, which has already begun to assume large proportions. There was no thought of the business possibilities of his wireless service when it was first inaugurated, but there is a close connection between the two, without a shade of doubt.

Nor must it be thought that Archie Banks is not a genuine farmer; he is in love today with farm life and with the beautiful farm which he bought of his father, with the big twelve-room house set in its grove of maples and elms 100 feet back from the road, with one room given over to the wireless outfit, which brings that particular farm into touch with all the outside world.

"The wireless station is about as complete as I can make it," says Mr. Banks. "I have copied messages from Darien, Panama; Hanover, Germany; Mare Island, and San Diego, California; Guantanamo Bay, Cuba; Arlington, Virginia; New York City, and all over the world. I received New York messages so loud that the signals could be heard all over my house, which is of twelve rooms."







Now That the Country Is in a State of War and All Amateur Radio Stations Are Closed, Mr. Archie Banks, Owner of the Elaborate Wireless Station Here Pictured, Has Offered His Station and Services to Uncle Sam. Before the War He Used to Receive the Daily Weather Reports and Other News, Which Was Posted on a Bulletin Board in His Home Town—Delmar, Iowa.

Wireless on the American Submarine Chasers

By SAMUEL COHEN

THE greatest task of the United States in the war against Germany is that in overcoming the under-sea monsters, the SUBMARINES, which have proven to be a constant and rapidly increasing menace to both the Allied and American shipping.

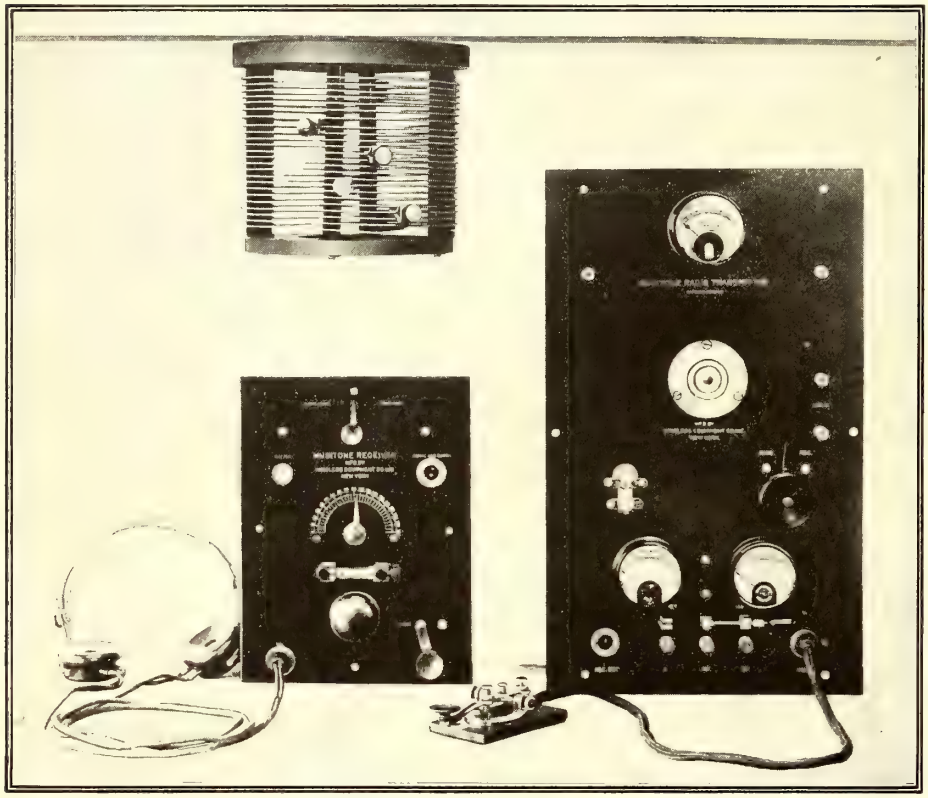


Fig. 1—Space Is at a Premium on the "Submarine Chaser." For Such Radio Service There Is Available the Extremely Light-Weight Transmitting and Receiving Set Illustrated. It Utilizes a Spark Coil with Independent Vibrator for Batteries.

This problem is now in the hands of our most prominent scientists, inventors and marine experts, and one solution to this task seems to have been found in the building of hundreds or even thousands of high-speed armed motor-boats to be used in fighting the U-boats.

One of the most important details in equipping these "submarine chasers" is that of radio-communication apparatus to be used for notifying near-by vessels of submarine attacks and the like. The marked development in the art of radio-telegraphy in recent years has demonstrated that every vessel to be used for the above named work should and can be equipt with a suitable light-weight, yet highly efficient radio transmitting and receiving outfit.

A considerable variety of such apparatus have already been designed and built and we give below descriptions of several types of transmitting and receiving sets which will prove very effective for the work in question. The accommodations offered by submarine chasers are few and for this reason the radio engineer must comply with the accommodations as much as possible before he undertakes the designing of the equipment. Space is a very important factor in consideration, and for this reason the apparatus herewith described have been chosen since they are of the most compact type ever built for the efficiency which they have shown.

The first of these outfits is illustrated at Fig. 1. This set was designed and built by Mr. A. B. Cole, of New York City. The transmitting set is seen on the right and the apparatus comprising the installation consists of the following and all of which are mounted on a Bakelite panel. The source of high tension current for charging the condenser is derived from a special spark coil, stationed behind the panel. An independent vibrator is employed and this is mounted on the panel, and may be seen directly to the left of the antenna switch, which is the right circular knob. A number of important features are incorporated in this independent vibrator, *viz.*, a high-tone, corresponding to a 500 cycle generator, is obtained with a primary excitation of 6 volts, obtained from a storage battery. The current consumed by the primary of the spark coil is indicated by the two lower meters; the one toward the left indicates amperes, and the one toward the right, volts. The simple-pole double-throw switch below the two meters is used to throw in either 6 or 12 volts onto the primary of the coil; the latter voltage must naturally be derived from a 12 volt battery or other generating source. Terminals for the current source are located below the switch. The plug towards the right interconnects a key with the coil as perceived; while the plug on the left is employed for connecting the receiving apparatus with the antenna and ground, thru the change-over switch which is located directly over the voltmeter.

The oscillatory circuit of the equipment consists of the secondary of the induction coil generating the high tension voltage which is used to charge a moulded type condenser, thru an inductance and a quenched gap discharger, the latter being visible in the center. Annular grooves are cut on the surface of the outside plate for rendering greater cooling facilities to the gap. A *radiation ammeter* is also furnished and this is placed on top of the panel.

The receiving equipment consists of a standard cabinet outfit, with crystal detector which can be seen to the left of the transmitting panel. It is comprised of an inductively coupled tuner which has a fixt coupling coil, linked with a variable capacity for tuning to different wave lengths. This condenser is mounted in the center. A *short* and *long* wave change-over switch is employed and this is placed at the center upper corner. The detector is of the mineral type and is mounted below the condenser, while the buzzer, for test work is just below the detector.

The complete outfit has been found to be very satisfactory and efficient and it will no doubt prove to be highly serviceable to Uncle Sam's mosquito fleet.

In addition to the excellent transmitter above described a very efficient and an all-around receiving outfit has been designed and built by Messrs. L. G. Pacent and A. H. Grebe for the submarine chasers, and this outfit is illustrated in Fig. 2. This equipment consists of four units, *viz.*, a main tuning cabinet, loading cabinet, detector

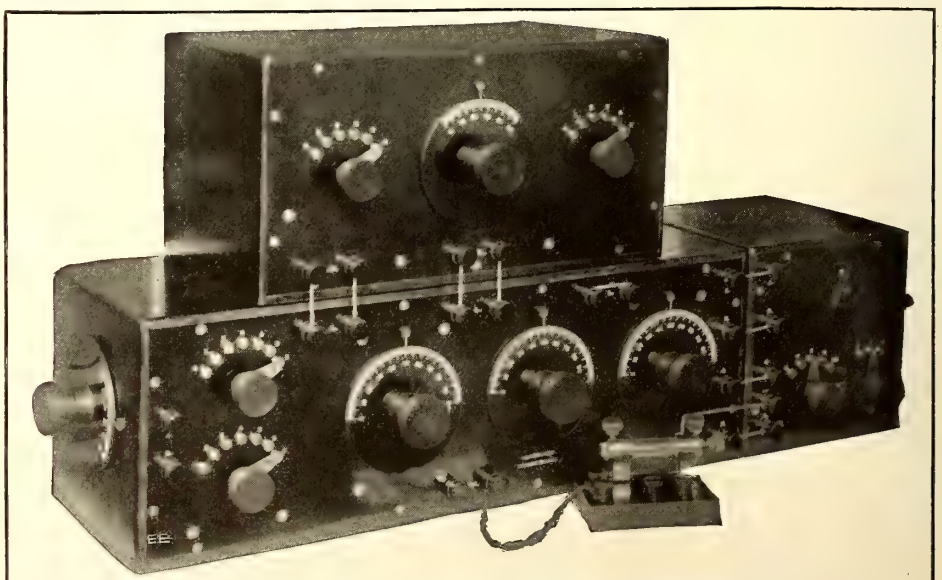


Fig. 2—An Excellent Audion Type Radio Receptor for "Mosquito Fleet" Service. It Is Fitted with "Radiumized" Dials That Glow in the Dark.

cabinet, and an emergency crystal detector. The main tuning cabinet is the largest of the three and comprises an inductive coupler, coupled with variometers, the latter of which are controlled by two handles, while the center one operates a variable condenser linked in the secondary circuit. The handle on the left side is used to control the secondary coupling. The two-point switches are employed for regulating the inductance of the primary of the inductive coupler.

The cabinet on top of this is the loading box which contains the proper coils for aiding the regenerative Audion circuit; the center knob is the coupling handle, while the two side knobs are the inductance control handles. The cabinet to the right is the detector box in which the vacuum detector is housed. An opening fitted with a sliding door is used to note the illumination brilliancy of the detector bulb. The switch to the right is the *filament* switch while the one to the left is the "B" battery control switch. A variable resistance is secured to the side of this cabinet (not shown here) and this is used for regulating the current consumption of the filament. The emergency crystal detector is hooked up to the set thru binding posts at the bottom of the main tuning cabinet.

One of the most striking characteristics of this receiving outfit is that which has been overlooked by all of our radio engineers designing apparatus intended for warfare purposes. This is the application of the wonderful properties possest by radium of giving forth light when mixed with certain phosphorescent materials. All of the graduated dials of this equipment are painted with phosphorescent radium paint which glows in the dark, and which facilitates working operations of the operator when he is ordered to have his den *pitch dark* during certain engagements in war. This will certainly be appreciated by the radio operator who has to operate this receiving set. All connections of the various pieces of apparatus are made by means of square shaped aluminum wire which has been found to be very effective for wiring purposes, as it is easier to wire and at the same time gives a better appearance to the finished instrument. It also reduces the weight.

The illustration, Fig. 3, shows a well-built set designed by Cutting and Washington. This outfit utilizes a new principle in radio transmitter design involving the use of a special spark gap, by means of which powerful oscillations and a hy-note signal are produced in a very simple manner without a transformer. The antenna wave length can be changed with this set by altering the secondary of the oscillation transformer only, the primary remaining fixt.



Fig. 3—Particularly Efficient Radio Set Well Adapted to "Mosquito Fleet" Service.

A Medal of Honor to be Awarded by the Institute of Radio Engineers

The Board of Direction of the Institute of Radio Engineers has decided to award annually a "Medal of Honor" to such persons who have distinguished themselves by unusual advances in the fields of radio-telegraphy and telephony. It has been felt that some way should be found whereby valuable work in these fields of great and rapidly growing importance might properly be recognized by an authoritative engineering society. As is well known, the Institute of Radio Engineers, with more than 1,000 members here and abroad, and with sections in New York, Washington, Boston, Seattle, San Francisco (with others in contemplation), is the leading technical and scientific society in the wireless field. It is therefore recognized that a "Medal of Honor" from the Institute will be a goal worthy of attainment by any investigator.



New "Medal of Honor" to be Presented by the Institute of Radio Engineers Each Year to the Person Who, During the Two Preceding Calendar Years, Shall Have Made Public the Greatest Advance in the Art of Radio-Communication.

The appearance of the medal is as follows: The front is a symbolic representation of electromagnetic waves, indicating the interlinking of the magnetic and electric forces in their rapid path thru the depths of space. The reverse side bears the inscription:

"To ....., in Recognition of Distinguished Service in Radio Communication" (followed by the date), the inscription being surrounded by a laurel wreath.

The medal is the work of the well-known sculptor, Edward Sanford, Jr., of New York.

The award will be made yearly at the April meeting of the Institute to the person who, during the two preceding calendar years, shall have made public the greatest advance in the art of radio-communication. The advance may be a patented or unpatented invention, but it must be completely and adequately described in a scientific or engineering publication of recognized standing and must be in actual, tho not necessarily commercial, operation. However, preference is to be given to widely used and widely useful inventions. The advance may also consist in a scientific analysis or explanation of hitherto unexplained phenomena of distinct importance to the radio art, altho the application may not be immediate. Preference will be given to analyses directly applicable in the art. In this case also publication must be full and in approved form.

The advance, furthermore, may consist in a new system of traffic regulation or control, a new system of administration of radio companies or the radio service of steamship, railroad or other companies, a legislative programme beneficial to the radio art, or any portion of the operating or regulating features of wireless. It must be described publicly in clear and approved form and must, in general, be actually adopted in practise. In all cases, marked preference is to be given to advances made in the preceding year.

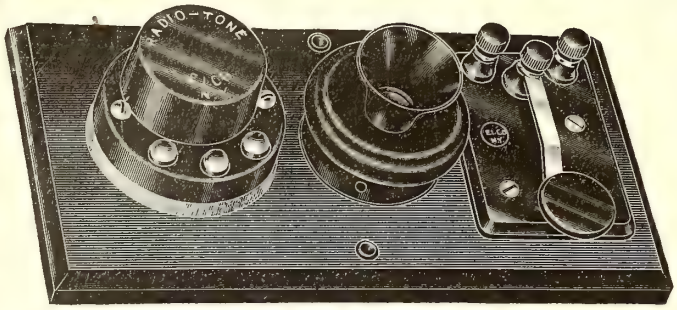
The medal is to be awarded under the following conditions:

At least thirty days before the April meeting the Board of Direction will call from a number of members and fellows of the Institute, whom it may choose to consult, for suggested candidates. This provision will be waived wholly or in part for 1917 only.

In deciding upon the award, the Board at its April meeting, thru those actually present or voting by mail, will nominate at least one, but not more than three candidates, in order of preference for the award. The names of these candidates will then be sent to each member of the board, who will have the privilege of returning a vote for one candidate. Four weeks after the April meeting the ballot will be read, and the candidate receiving the most votes will become the recipient of the award.

The official presentation of the medal to the successful candidate or his representative will occur at the May or June meeting.

"ELECTRO"



AMATEURS! ATTENTION!!

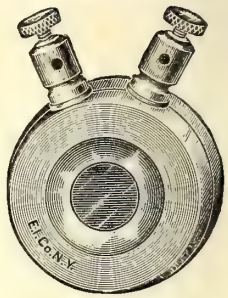
Now that we are for the time being, deprived of using our Radio outfits, it behooves us to become proficient in learning the Wireless Codes. Operators who know the Code are, and will be, in ever rising demand. The army and navy need thousands of operators right now. **Can you qualify?** Can you send and receive at the required speed, when your country calls you?

The **Radiotone Codegraph** is positively the only instrument made that will send such an unbelievably close imitation of a high pitch Radio Station, that it has baffled experts. The outfit replaces the old-fashioned learner's outfit, consisting of key and sounder. The **Radiotone Codegraph** comprises our famous Radiotone High Frequency Silent Buzzer, a special loud talking receiver with horn, and a key all mounted on a base. Operated on one or two dry cells, the phone will emit the characteristic high pitch sound, which while not harsh, is heard all over the room. With little trouble you can learn the code correctly in 30 days—

AND THAT IS NOT ALL:

Connect two of these outfits together for intercommunication work and you and your friend five or fifteen blocks distant can converse over a NO. 36 WIRE, so fine that no one will see it. Or you can use instead of the wire, a metallic fence and the ground. **Or you can communicate over your 110 lighting line,** using no extra wire, only the ground. Full directions how to do this are furnished with the instrument. **DEALERS:** This is the 20th Century instrument that will sell like WILDFIRE. 600 sold in New York in 10 days. Get our proposition today!

Radiotone Codegraph complete as described, each, **$1.95**
IMMEDIATE SHIPMENTS



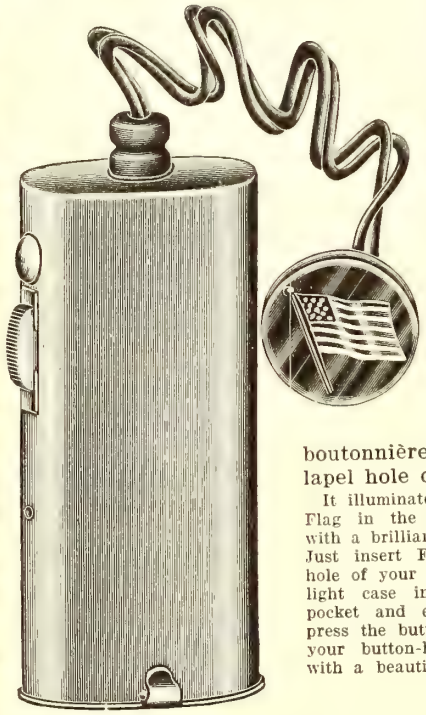
No. FX517

Selenium Cells

Everybody has read about the experiments of telephotography (sending photographs over a wire hundreds of miles) made by Professor Korn and others. It is also known that if the problem of tele-vision is ever solved, the selenium cell will play an important role. At present we are the only concern in the United States selling these cells. They are the most sensitive ones made.

Better send for a cell today and try making an electric dog that will follow a lamp, or an electric burglar alarm. It's very instructive and great fun. (See November, 1916, issue **"Electrical Experimenter."**)

No. FX517 Selenium Cell, each **$6.00**
Shipping Wght., 4 oz.
IMMEDIATE SHIPMENTS



BOYS!

Here Are the Stars and Stripes in All Their Glory.

Be the first one in your town to wear this patriotic emblem. Think of it: An electrically illuminated boutonnière worn in the lapel hole of your coat.

It illuminates our National Flag in the original colors with a brilliant electric light. Just insert Flag in button-hole of your coat, put flashlight case in vest or coat pocket and every time you press the button, the flag in your button-hole flashes up with a beautiful color effect.

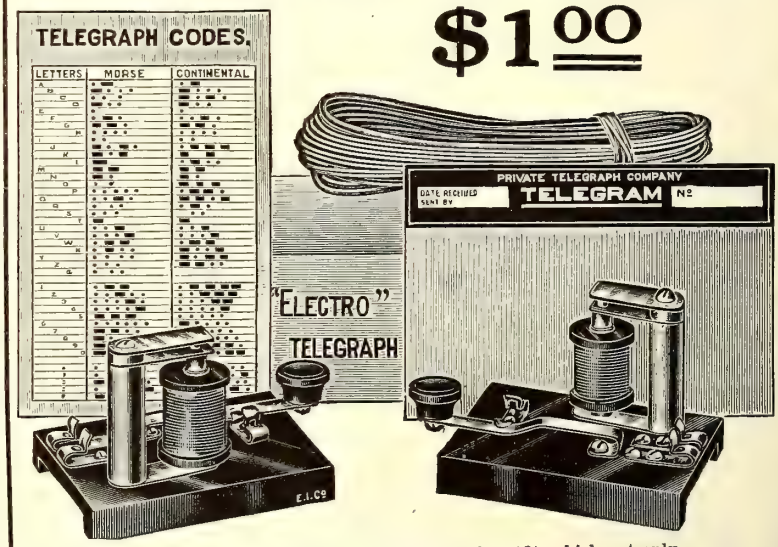
Illuminated flag, cord and plug (to be connected to any 2 cell flashlight), **$.60** (postage 10 cents).

Illuminated flag, flashlight case and battery, cord and plug, complete as per illustration, **$1.10** postage 15c).

DEALERS: Write for our proposition today.
IMMEDIATE SHIPMENTS

THE "ELECTRO TELEGRAPH"

$1.00



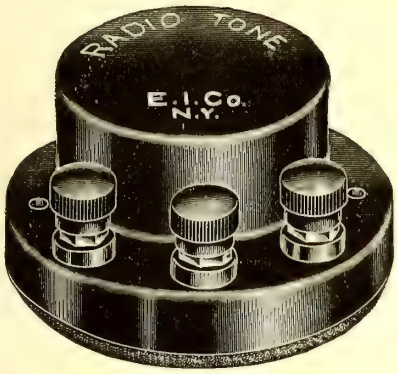
is not a toy, but a practical, honestly built telegraph outfit, which not only sounds but works like the big commercial instruments. By studying the code for 30 days you can become a first-class telegraph operator. Such operators are in big demand now. Outfit consists of TWO complete telegraph instruments each measuring 3½x2½x2¼. All metal parts are highly nickel plated, including key lever. Note hard rubber knob. Telegraph Code Chart, telegraph blanks and connecting wire comes with set, but no batteries. Outfit works on 2 dry cells (one cell for each instrument). The "Electro" is the ONLY Outfit that works both ways, each station can call; no switches, no extras. Nothing to get out of order. Guaranteed to please you or money back. **$1.00**

Price Complete as illustrated.....

At all good dealers and department stores. If your dealer cannot supply you send us $1.00 for outfit and add mailing charges for two pounds, otherwise we ship express collect.

THE ELECTRO IMPORTING CO.

NEWS



No. HK 1800

The "Electro" Radiotone

HIGH FREQUENCY SILENT TEST BUZZER

The RADIOTONE is NOT a mere test buzzer, it is infinitely more. Mr. H. Gernsback who designed this instrument labored incessantly to produce an instrument which would imitate the sound of a high power Wireless station as heard in a set of phones. This actually has been achieved in the RADIOTONE. This instrument gives a wonderful high pitched MUSICAL NOTE in the receivers, impossible to obtain with the ordinary test buzzer. The RADIOTONE is built along entirely new lines; it is NOT an ordinary buzzer, reconstructed in some manner. The RADIOTONE has a single fine steel reed vibrating at a remarkably high speed, adjusted to its most efficient frequency at the factory. Hard silver contacts are used to make the instrument last practically forever.

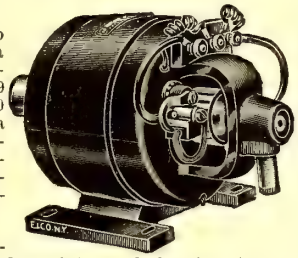
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You will be astounded at the wonderfully clear, 500 cycle note, sounding sharply in your receivers, when operated on one dry cell. **To learn the codes, there is absolutely nothing like it.** With the radiotone, a key and one dry cell and ANY telephone, a fine learner's set is had. Two or more such sets in series will afford no end of pleasure for intercommunication work. Particularly now that we cannot use our Wireless sets, the **Radiotone** is already in wonderful demand. All the interesting things as described with our **Radiotone Codegraph,** elsewhere on this page, can be performed with the **Radiotone,** a key, a dry cell and a phone.

Radiotone as described.....each **$.90**

IMMEDIATE SHIPMENTS

HERCULES DYNAMO



The Electro Hercules is a dynamo generating 12 Volts, 9 Amperes (100 Watts) and a marvel of electrical or mechanical efficiency and simplicity.

It is especially designed for lighting and charging storage batteries; will run 18 twelve volt lamps simultaneously. Can also be used as a powerful motor developing nearly ⅛ H.P. Machine is shunt wound; size 7 in. high, by 11⅜ in. long and 6½ in. wide. It is the cheapest Dynamo for its output on the market.

No. AGEK 1209. Electric Hercules Dynamo; shipping weight, 40 lbs. Price....**$17.50**

We carry these machines always in stock and can make immediate shipment.

The "Electro" Rheostat-Regulator

(Porcelain Base)

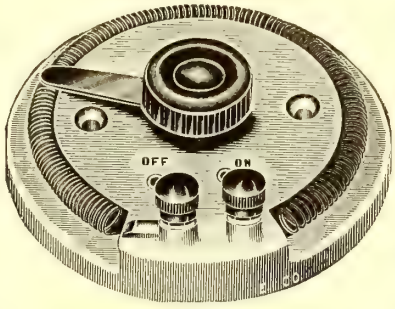
This illustration represents our little current regulator which is used everywhere to regulate battery current. It will prevent the burning out of your battery lamps, or will regulate the speed of your small motors, and scores of other uses.

It makes an excellent automobile lamp dimmer, where it can be used to cut down the glare of the headlights. This little instrument is impossible to get out of order. It is constructed **ENTIRELY OF PORCELAIN,** metal and hard rubber.

The resistance of our Rheostat is 10 ohms, the capacity 3 amperes continually, size is 4 inches in diameter; thickness of **porcelain** base is 13/16 ins.

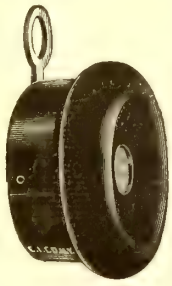
No. FK5000 Rheostat Regulator. Price **$.60**
Shipping weight, 2 lbs.

IMMEDIATE SHIPMENTS



No. FK 5000

"Electro" Pony Receiver



No. EK 1024

Our Pony receiver is without doubt the best article for the money to-day.

Points of superiority: Hard rubber composition shell beautifully polished. Powerful permanent steel magnet, soft iron core, fibre coil heads, very thin diaphragm, brass posts inside. Hanger can be unscrewed and receiver will then fit our No. AX8077 headbands.

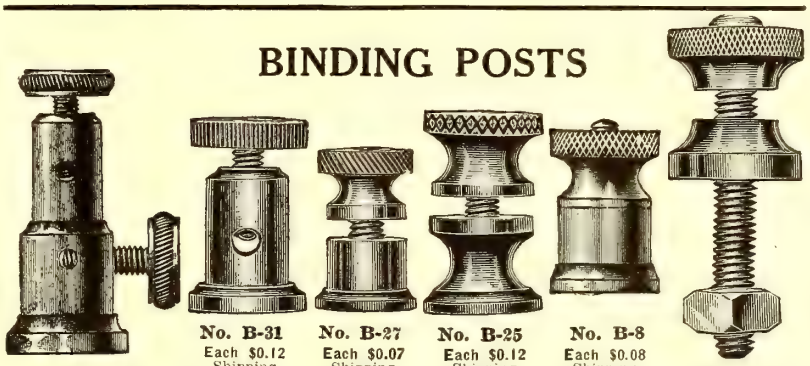
SOME USES.—For all telephone work. Also for making the small testing outfits for repair men in circuit with only one dry cell or flashlight battery. When connected in parallel with your house telephone receiver, you have a double receiver, an invaluable acquisition to those who phone in noisy places or to people hard of hearing. It can also be used for wireless though its low resistance won't permit of such good results as a higher resistance phone.

This receiver is single pole; 2¼x1⅛ inches; wgt. 4 oz.; resistance, 75 ohms. IF TWO OF THESE RECEIVERS ARE USED, IT IS POSSIBLE TO SPEAK AT A DISTANCE OF 150 FEET WITHOUT USING BATTERIES, ONE WIRE BEING SUFFICIENT IF GROUND IS USED.

No. EK1024 Pony Receiver, 75 ohms.... **$0.50**

IMMEDIATE SHIPMENTS

BINDING POSTS



No. B-2
Each $0.15
Shipping Weight
2 lbs. per doz.

No. B-31
Each $0.12
Shipping Weight
1 lb. per 12.

No. B-27
Each $0.07
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No. B-25
Each $0.12
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Each $0.08
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No. B-7
Each $0.10
Shipping Weight
2 lbs. per 12.

IMMEDIATE SHIPMENTS

These binding posts are furnished either nickel plated or gold lacquered. They are made of first quality brass; holes are accurately bored, well fitting set screws, and highly polished. Each post is furnished with a ¾ in. machine screw and washer (not shown in illustrations). Engravings are full size.

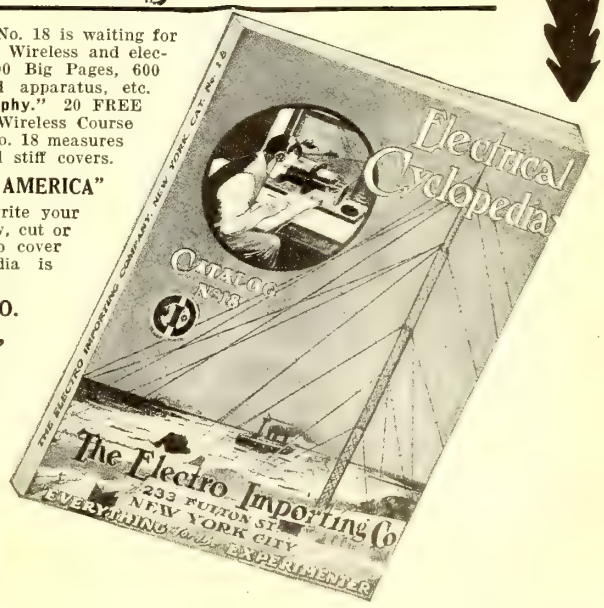
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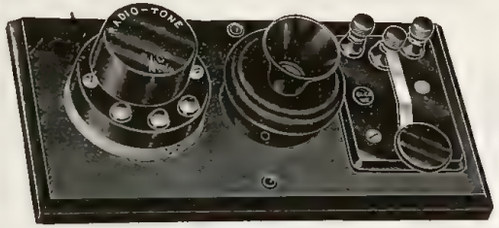
Now before you turn this page write your name and address on margin below, cut or tear out, enclose 6 cts. stamps to cover mail charges, and the Cyclopedia is yours by return mail.

THE ELECTRO IMPORTING CO.
231 Fulton Street, New York City,



231 FULTON ST., NEW YORK, N.Y.

"ELECTRO" NEWS



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No. FX517

Selenium Cells

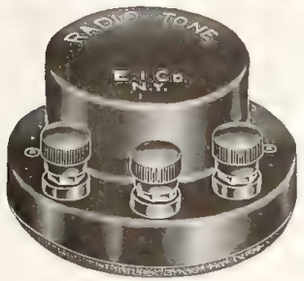
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IMMEDIATE SHIPMENTS

Patents:
No. 842,950 Feb 5, 1907
No. 902,069 Oct 27, 1908
No. 948,275 Feb 1, 1910
No. 951,788 Mar. 8, 1910
No. 961,855 June 21, 1910
No. 978,999 Dec 20, 1910
No 988,456 April 4, 1911
No 988,767 April 4, 1911
No 1,016,138 Jan 30, 1912
No 1,033,095 July 23, 1912
No 1,057,820 April 1, 1913
No 1,124,413 Jan 12, 1915
No 94,990 Jan 20, 1914
8 Patents Pending in Patent Office

E. I. Co. Patents



No. HK 1800

The "Electro" Radiotone

HIGH FREQUENCY SILENT TEST BUZZER

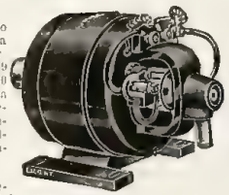
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(Porcelain Base)

This Rheostat represents our little current regulator which is used everywhere to control current. It will prevent the burning out of any kind of lamps, as well as the wearing out of small motors, etc., etc. Other uses.

It makes an excellent automobile lamp dimmer, where it is desired to control the current of the headlights. This little instrument is capable of carrying 3 Amperes. It is mounted **ENTIRELY OF PORCELAIN,** metal parts being entirely absent.

The resistance of our Rheostat is 10 ohms, the capacity 3 amperes continuously, size is 4 inches in diameter, thickness of porcelain base 1 inch.

No. FK5000 Rheostat Regulator Price **$.60**
Shipping weight, 1 lbs.
IMMEDIATE SHIPMENTS



No. FK 5000

"Electro" Pony Receiver



No. EK 1024

Our Pony receiver is without doubt the best article for the money to-day.

It is of superior quality. Hard rubber composition shell beautifully moulded. Powerful, permanent steel magnets. Iron core, fibre coil boards, very fine diaphragm, brass posts inside. Finger can be unscrewed and receiver will then fit our No. AX8977 headgear.

SOME USES — For all telephone work. Also for making the small testing outfits for repair men in circuit with only one dry cell or flash light battery. When connected in parallel with your home telephone receiver you have a double receiver, an invaluable acquisition to those who phone in noisy places or to people hard of hearing. It can also be used for wireless though its low resistance won't permit of such good results as a higher resistance phone.

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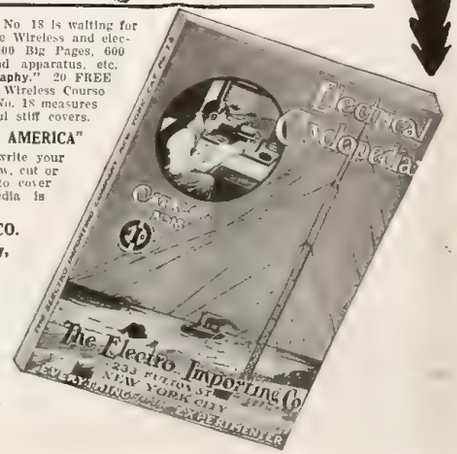
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It illuminates our National Flag in the original colors with a brilliant electric light. Just insert Flag in button-hole of your coat, put flash-light case in vest or coat pocket and every time you press the button, the flag in your button-hole flashes up with a beautiful color effect.

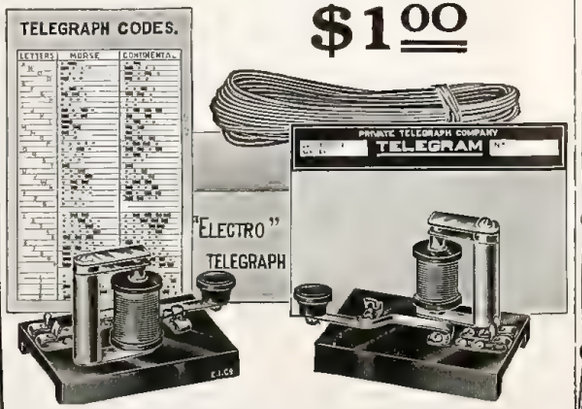
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Price Complete as illustrated..... **$1.00**

At all good dealers and department stores. If your dealer cannot supply you send us $1.00 for outfit and add mailing charges for two pounds, otherwise we ship express collect.

THE ELECTRO IMPORTING CO.

231 FULTON ST., NEW YORK, N.Y.

THE CONSTRUCTOR



An Improved Burglar Alarm Utilizing the "Stick Relay."

By ALBERT H. BEILER

MANY electrical experimenters have at one time or another installed a burglar alarm in their homes. Most of the burglar alarms constructed by amateurs are of the *open-circuit* type, and have therefore several disadvantages, the most important of these being, that, whereas the opening of a door or window causes the alarm to ring, the closing of the door or window will *stop* the alarm again. To keep up a steady ringing requires a different type of circuit than that usually employed. This may be of either the *closed* or *open* type. In the former, the current flows continuously and the opening of the circuit causes a relay to release its armature which touches the rear contact thereby ringing the alarm. The latter type is seen in the continuous ringing bell, with which most of us are no doubt familiar. There is another open-circuit device, however, which is less known, called a *stick relay* arrangement. It is this last one which we shall consider in detail.

The *stick relay* is used extensively in the interlocking machines for railway signaling. Its mode of operation insures the following result:—a circuit may be closed at a switch but not opened again at the same point; it may be opened at a second switch but not closed at this latter point. To illustrate this a little more clearly, let us refer to Fig. 1.

When the main switch M is closed, but the open circuit door or window switch O kept open, no current can travel thru the relay, and its armature will be drawn away from contact C by a retractile spring. If switch O is now closed, either by opening the door or the window, electro-magnet R will draw its armature towards it. A then touches C, and the current has two paths to travel, *i.e.*, one by way of the open-circuit door switch, and the other by branching off at B, going thru contact C and the armature, thru the magnet and back to the positive main. Should O now be opened, it will have no effect on electro-magnet R, since R still has a path by which it obtains its source of current. The current can only be shut off by main switch M, but it will be noticed that once M is opened, its subsequent closing *will not energize* the relay again, unless O is closed.

Fig. 2 shows how this principle is used in the burglar alarm. The relay instead of having only one front contact has two, one for keeping its own circuit closed as just described, and the other to close a circuit for ringing an alarm bell. The relay, which by the way, is only wound to 4 ohms, operates on 110 volts in series with a lamp or lamps, which are connected in parallel with one another. Thus when the alarm starts, not only will the bell ring, but the lamps will light and assist friend burglar towards a hasty departure. The relay may be made to operate from batteries if the builder desires to dispense with the lamps; indeed the same source of current that rings the bell may be used to operate the relay.

Since double contact relays are rather expensive, a good substitute that will cost very little, will now be described. Secure a telegraph sounder (or the equivalent parts from a large electric bell; also the parts may be easily made), one wound for 4 ohms is best if the lamps are to be used, also a piece of 5/16" square brass, 2½" long, and two pieces of ⅜" brass rod 1" long. The two pieces of rod should each have a hole drilled and tapt about half-way thru them longitudinally. The 5/16" square brass should have holes drilled and tapt as indicated in Fig. 3. Now temporarily remove the entire armature from the telegraph sounder and file the end down halfway. (Fig. 3.) Drill and tap a hole as indicated. Screw the piece B, on to it so as to form a half lap joint. Insert adjusting screws with lock-nuts into the end holes of B, and then replace the armature in its frame.

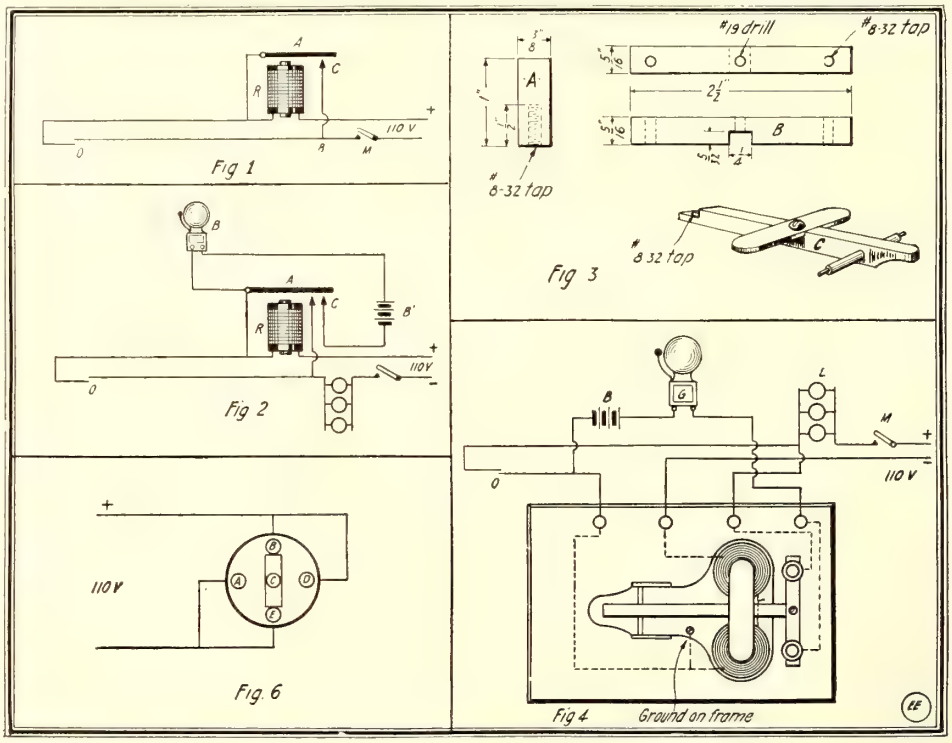
The small brass pillars A, should be screwed onto the base in such a position that when the armature is pulled down, the adjusting screws hit the centers of the pillars. The screws must be exactly adjusted so that each makes contact with its pillar. If one is screwed down too far, the other will not touch its pillar or front contact. This should be thoroly tested by an electric circuit. The magnets when energized should draw the armature down so that *both* front contact circuits are closed. Lamps or bells may be used to test the continuity of the circuit at the contacts.

Two additional binding posts will be needed as shown in Fig. 4. The wiring on the instrument proper is made as indicated.

The reader will see the advantage of this type of burglar alarm over the continuous ringing bell, because the alarm may be immediately shut off by a switch, and be ready for another alarm an instant later, whereas with the continuous ringing bell an armature must be lifted by hand and the alarm reset.

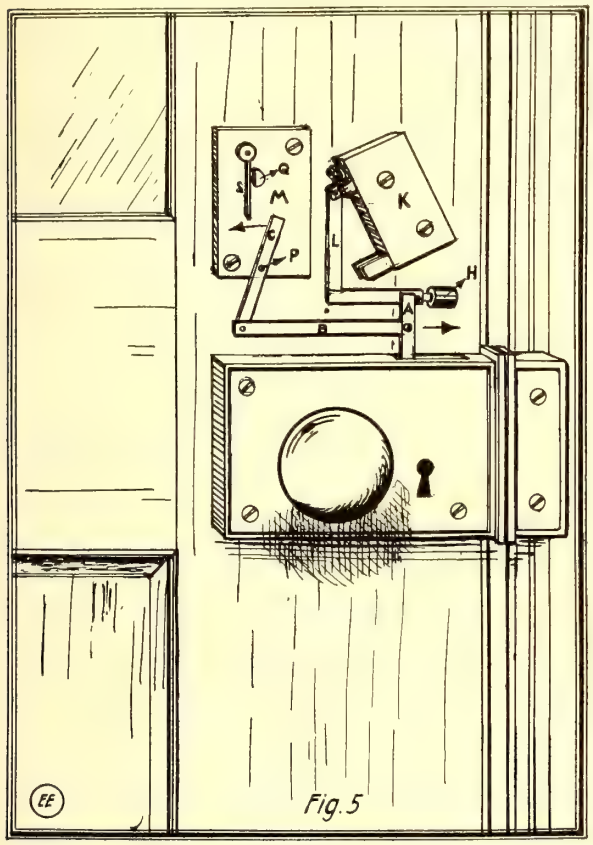
A few auxiliary contrivances may also be made in connection with the burglar alarm. The simple burglar alarm may be set from inside the house. When a person leaves, and opens the door it will ring, but stop when he closes it. This, of course, cannot be done with the alarm described herein, and a means must be employed to set the alarm *after* the person has closed the door and is outside. The main switch may be put outside the house and closed when leaving, but this is sometimes undesirable where there is no good means of concealment.

The author has devised a little contrivance wherein the alarm is set from the outside *when the key is turned in the lock,* in conjunction with another device which rings



Working Drawings and Diagrams for Constructing a Really Reliable and Particularly Effective Burglar Alarm Apparatus, Employing the "Stick Relay" Principle. Many Other Applications of This Relay Will Suggest Themselves to the Experimenter.

the alarm as soon as the key is again turned in the lock to open the door. Thus not only will the alarm ring when the door is actually opened, but the turning of the key will start it. The reader can arrange to ring the alarm by so much as inserting a key in the lock, if he has a contact insulated from the lock frame, and which will touch the frame by means of a circuit thru the key. This latter is simple, but the two formerly mentioned are slightly more complicated.



Special Arrangement of Interlocking Switches for Controlling "Stick Relay" in Burglar Alarm System Here Described.

The bar A (Fig. 5) is pivoted to B, B is pivoted to C, while C is fastened to a base M by pin P. If A moves to the right or left B moves to the right or left. The movement of B causes C to travel in an arc of a circle. The upper part of C engages a stiff spring S, in its travel, but only for a moment; for when A has moved as far to the right as it can, C will be in a position to the left of S, and S, which will have ceased engaging C, will spring back to normal. When A is moved to the left, C will turn clockwise, again engaging spring S and carrying it to contact Q, causing it to touch Q. This closes the alarm circuit; only for an instant it is true, but long enough for the stick relay to operate.

The part A is rigidly attached to the lock lever of the lock, so that when the latter moves, A will move with it. When the door is locked by the key, C moves counter-clockwise and engages S so that S does not touch Q. Upon opening the door, however, S touches Q and the alarm is rung. These parts should, of course, be firmly covered over with a steel junction box attached with blind screws.

The method for closing the main circuit by means of the door key will now be described. In Fig. 5, it will be seen that the upper part of A engages a bar which is attached to the lever of a switch, K. When A moves to the right it will carry this lever along with it, closing the main switch for setting the alarm*. When the door is opend by the key, A will move to the left without carrying the switch lever with it, thus insuring the continuity of the circuit. The knob H is used for pushing the knife back against A, when the door has been opened.

When the author installed his alarm the greatest difficulty was to get people to set it.

To prevent anyone forgetting to close the main switch, a very simple but effective device was finally resorted to, so that the alarm is *always set*, can be shut off when it rings, and still, a moment after having stopt ringing, it is set again. The main switch, instead of being a knife type, is a two-way snap switch, connected as illustrated in Fig. 6. When the alarm rings and it is desired to shut it off, the switch need only be turned once. For an instant—the time it takes for the piece C, to snap from contacts BE to AD—the circuit will be opened, which is enough time for the stick relay's armature to be raised. The switch is immediately closed again which, however, does not start the alarm as previously explained.

The reader can, with a little ingenuity, arrange to have even the turning of the door knob start the alarm. This should have a separate switch, however, so that it may be put in operation only at night, whereas the rest of the alarm may be in operation all the time.

Since no circuit is directly opened or closed at the pillars and since consequently no arcs are formed, the use of platinum contacts is unnecessary.

** The switch need not necessarily be the main switch; it may be any switch in series with the line.*

A ½-TON LIFTING MAGNET.

An electro-magnet that is capable of lifting about 1,000 lbs., may be easily made. Its current consumption is about 5 amperes on 110 volts.

The body of the magnet consists of a circular piece of wrought iron or steel 7¾ inches in diameter and 2 9/16 inches thick. The bottom of the body should be machined true and a circular groove turned out in it to fit the magnet coil. The outer end of the groove is counterbored 1/16 of an inch deep by 1¾ inches wide, to fit a brass ring which keeps the coil in place. The ring is held in position by eight small flat-head screws. When fastened in place, the screws and brass plate should be slightly below the surface of the magnet body.

To support the magnet, three screw eyes of 3/16 inch stock should be provided and fastened in three tapt holes equally spaced in a 5 in. diameter circle, or one ⅜ inch stock screw-eye may be placed in the center as shown. For winding the wire coil, a wooden form or spool must be provided. It is made with a cylindrical core 3½ inches in diameter by 1½ inches long and slightly tapered, so that the coil may be easily removed when finished.

The flanges of the spool are 7⅛ inches in diameter wooden disks fastened on the cylindrical piece so as to be easily removed. The spool is mounted on an axle or between both centers, to allow it to rotate while winding the coil. About a dozen strips of insulating tape are equally spaced around the spool and tied or pasted in place, fitting length-wise with the spool centers and up along the inner side of both flanges.

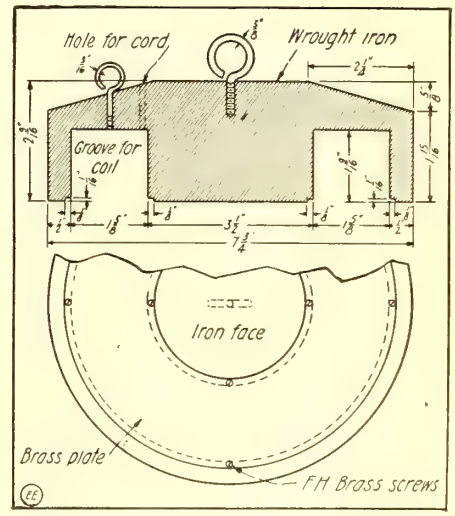
The coil (for 110 volts D.C.) will require about 7 lbs. of No. 20 gage wire, single cotton covered, or 7 lbs. of No. 23 gage wire for 220 volts, D.C.

In starting, about 1 ft. of wire must be allowed for a magnet lead which is past thru a hole near the center of one of the flanges. Each layer should be insulated with a heavy coat of thin shellac. When the winding is finished, about 1 ft. of wire must be left for the other lead. The strips of tape can then be brought over and pasted together to hold the coil in shape and insulate it from the magnet body. Several turns of the tape are then wound around the outside of the coil. The coil may then be left in a warm oven for about a day to let the shellac harden.

The magnet leads are spliced to a piece of heavy lamp cord. A ⅜ inch hole should be drilled in the top of the magnet casting for the cord and bushed with a fiber insulating tube. The coil should then be placed in the magnet body; if it has any play, several extra layers of tape can be wound on the coil to keep it sufficiently tight. The brass plate is then fastened in place.

To suspend the magnet, three equal lengths of chain are attached to a supporting ring; the loose ends are fastened to the screw eyes to keep the magnet level. The cord is then attached to a plug to make a connection with a 110 volt direct current circuit. It is not adapted for operation on alternating current circuits.

Contributed by J. LWAK.



Something Everyone Finds a Need for at Some Time Is a Good Lifting Magnet. Here Are the Details for Building an Efficient ½-Ton Electro-Magnet for Use on D.C. Circuits.

FLY PAPER.

Resin	8 parts
Castor oil	6 "
Glycerin	3 "

Dissolve the resin into the other two ingredients by the aid of heat. When they become a liquid spread on parchment paper by means of a brush.

"MOSQUITO CHASERS."

Oil of pennyroyal	1 oz.
Castor oil	3 "
Alcohol	6 "

Mix together and apply to parts of body exposed to the mosquitoes and they will not bite or come near it.

Contributed by ROBERT THOMPSON, Jr.

More About the "Perpetual" Electric Clock

By HOWARD W. LEWIS
Chairman Stanford University Branch of A. I. E. E.

THERE appeared in the June, 1916, ELECTRICAL EXPERIMENTER, a description of a proposed perpetual electric clock and, in August of the same year, an explanation of why the same would not operate indefinitely. That the plan is entirely feasible, provided a small amount of energy be supplied from some outside source, may be seen from the following description and illustrations of a similar device recently constructed at Stanford University.

In connection with some research work in Aerodynamics, need arose for an instrument which would close a battery circuit momentarily at *one second intervals.* As a substitute for a standard *seconds* pendulum, an electro-magnetically actuated clock was built which is capable of performing the desired service very satisfactorily.

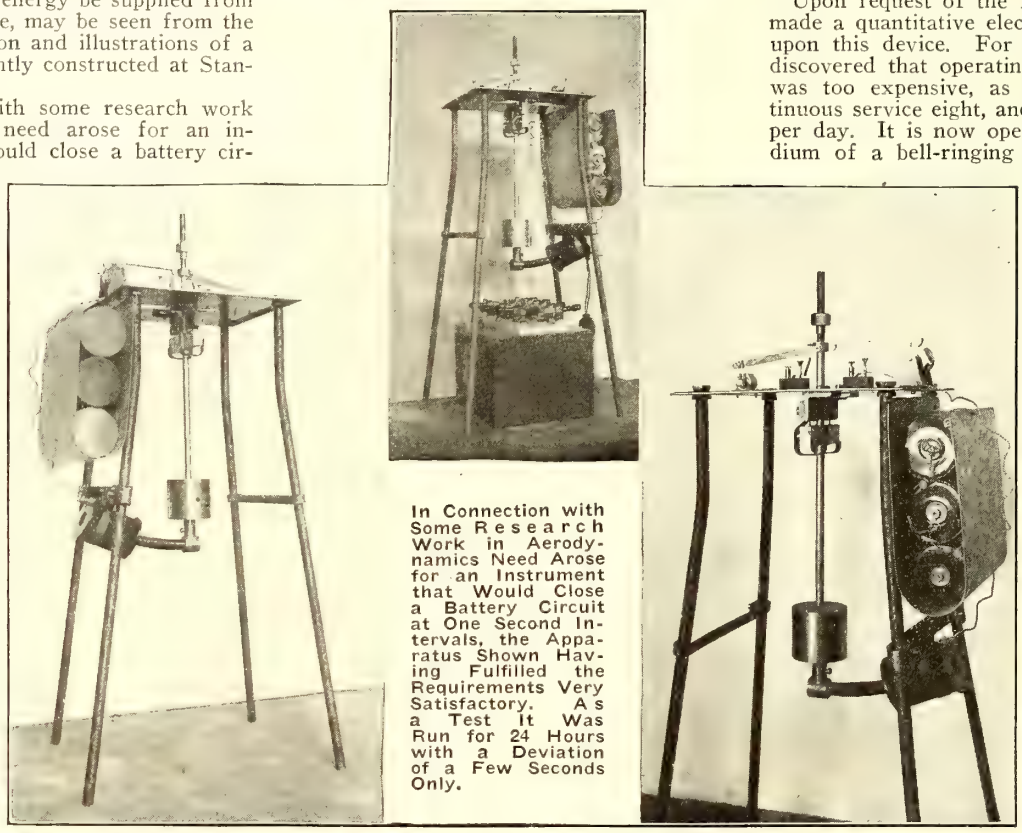
The photographs show the construction clearly. The details may be seen from the drawing. The frame is of small iron pipe and the table of thin steel plate. The pendulum consists of a round steel rod with two attached weights. It is hung on thin flexible steel springs from the short piece of angle iron shown, thus being free to swing with a minimum of friction.

The period, that is, the time of one swing of a pendulum, depends upon its length and the distribution of its weight. Near the bottom of the pendulum rod is a large iron cylinder (part No. 7) which may be moved up or down. The upper end of the rod is threaded to receive the nut, 16. Coarse or fine adjustment of the periodicity is thus secured by shifting one or the other of these weights.

On top of the plate is mounted a Veeder stroke counter, actuated thru links from the pendulum rod. This device, together with a stop watch, facilitates the calibration and adjustment of the clock.

A solenoid consisting of 2,700 turns of No. 26 B. & S. gage insulated copper wire is attached to the lower part of the frame. To the bottom of the pendulum is fastened a bundle of closely bound iron wires. This curved plunger moves in and out of the solenoid as the pendulum swings. The coil is energized from either the 110 volt lighting circuit with a lamp in series therewith, or from 3 dry cells without the lamp.

It is necessary, of course, to have some arrangement which will close the circuit thru the solenoid when the plunger is moving toward it, and open the circuit when the plunger is moving away. Accordingly, a six-tooth ratchet-wheel is fitted on a short horizontal shaft, and a commutator having the same number of brass and of fiber segments of equal width, is placed beside it. The shaft is mounted in plain bearings on top of the plate. To the pendulum rod is attached a flat link with a hook on its outer end, which engages with the ratchet-wheel and turns it one-sixth of a revolution for each alternate stroke of the pendulum. A copper leaf brush bears against the commutator from below. When the plunger is moving away from the solenoid and the hook is consequently reaching forward to pick up the next tooth of the ratchet-wheel, this brush rests on a fiber segment and the circuit thru the coil is open. On the return stroke, however, the hook pulls a live (brass) segment under the brush and current flows into the coil, which thus exerts a powerful pull on the plunger. Before the plunger reaches the end of its travel, a dead (fiber) segment rolls under the brush, the solenoid releases its pull on the plunger, and the pendulum swings back to repeat the cycle. The relative positions of the ratchet-wheel and commutator are adjustable on the shaft, so that the time of excitation of the solenoid can be placed at any desired point in the stroke of the plunger. An adjustable condenser of several microfarads' capacity is used to eliminate the spark between commutator and brush.



In Connection with Some Research Work in Aerodynamics Need Arose for an Instrument that Would Close a Battery Circuit at One Second Intervals, the Apparatus Shown Having Fulfilled the Requirements Very Satisfactory. As a Test It Was Run for 24 Hours with a Deviation of a Few Seconds Only.

The secondary circuit, for whose operation this clock was built, is closed once each cycle between a phosphor bronze spring and the pendulum. The duration of the closure of this circuit can be adjusted by turning the screw (see details, part No. 19).

Considerable time and attention was given to designing this mechanism along correct principles and it has been very carefully constructed. The results attained justify the trouble involved. After a preliminary adjustment, a continuous run of 24 hours' duration showed a deviation of only *a few seconds* from a standard clock. Furthermore, it closes the secondary circuit at regular intervals, quite as well as a standard *seconds* pendulum *costing several hundred dollars.*

The original design of "Perpetual Motion" Clock involved the action of a swinging permanent magnet, which, as it swung into the coil, was supposed to develop sufficient energy to keep the clock going forever.

Upon request of the Editors, the author made a quantitative electrical measurement upon this device. For one thing he soon discovered that operating it upon batteries was too expensive, as it is now in continuous service eight, and often more hours per day. It is now operated thru the medium of a bell-ringing transformer. The secondary circuit which it operates is energized by batteries, however.

The point was raised as to the magnitude of the induced current in the coil.

In order to answer this question the author made a simple test which convinced him that the transient phenomena referred to are inappreciable compared with either the normal current thru the solenoid, or the current in the secondary (battery) circuit. These experiments were as follows:

(A) Solenoid entirely disconnected from the source, then connected directly to the terminals of D. C. milli-ammeter. No effect was produced on ammeter needle when the plunger was rapidly moved in and out of the solenoid. Same absence of effect noted when telephone receiver was used as current detector. Very slight deflection when sensitive ballistic galvanometer was used as current detector.

This is exactly what might be expected, since there is no field produced by the solenoid, as there is no exciting current thru it. I take it that what small current there is induced in the solenoid is due to the rapid motion thru it of the minute remanent field in the plunger. However as this is composed of a bundle of fine, *soft iron* wires, this residual magnetism is very small.

(B) Solenoid connectly directly (without ratchet wheel or commutator) to D. C. source; current in the circuit as indicated by milli-ammeter was 0.26 amp. Plunger rapidly moved in and out of the solenoid by hand. Effect: When plunger was forced *in,* current *decreases,* while the plunger was moving, about ½ milli-ampere. When the plunger was drawn *out,* current *increased, while the plunger was moving* about ½ milli-ampere. As soon as the plunger was stopt from moving, or as soon as it had moved out of influence of the solenoid, this transient current increment or decrement stopt and the current returned to its normal value in the circuit, as determed by Ohm's law, *i. e.,* 0.26 amp.

This again is exactly in accordance with the theory involved, that is, when the

plunger was moving into the solenoid the flux threading the latter was increasing at a rapid rate, due to the decreasing reluctance of the magnetic circuit, the magnetomotive force meanwhile remaining constant. This change of flux induced a voltage in the turns of the solenoid which tended to oppose the E.M.F., which was forcing the current thru the coil; in other words it is the well-known law $L = \frac{di}{dt}$.

It is exactly analogous to the similarly induced counter E.M.E. which arises in a coil to oppose the flow of current therein when the coil is first connected to a source of continuous voltage. Due to the fact, however, that the movement of the plunger could not under any conditions compare in rapidity with the rise of current in an inductive circuit, this counter E.M.F. is undoubtedly very much smaller than it would be if the solenoid permanently surrounded the core and the current were then establisht in the coil.

A moment's reflection will explain the observed phenomena when the plunger was drawn out of the solenoid along a very similar line of thought. It is exactly analogous to the arc that follows the opening of a switch in an inductive circuit. The collapsing magnetic field induces a voltage in the coil which tends to maintain the current.

[*Of course if the moving core had been of steel, powerfully magnetized, the effects noted would have been much more pronounced.*—Ed.]

WHAT TO DO WHEN ACIDS ARE SPILLED.

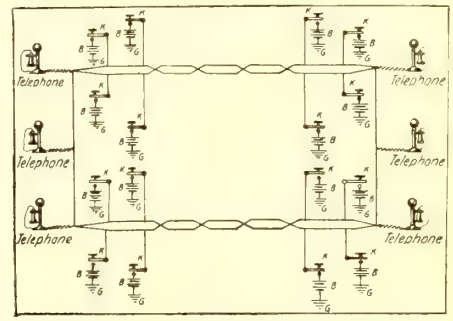
The safest course is not to spill the acid; the next best is to apply an alkaline solution at once, or cover with chalk. It is a good plan to keep a jar of strong washing soda solution always ready in case of emergency. The reason for using a jar instead of a bottle is that the solution can be poured over the spilled acid more quickly. A loose cardboard cover—the lid of a box—will serve to keep out dust, and more water can be added when necessary to make up for evaporation. A cocoa tin containing crushed chalk should also be kept handy in case any quantity of strong acid is spilled.

Contributed by H. J. GRAY.

MULTIPLE TELEPHONE AND TELEGRAPH "PHANTOM" SYSTEM.

By L. R. W. Allison, Assoc., A. I. E. E.

The complementary relation between the telephone and telegraph system is particularly interesting and instructive. The accompanying diagram shows the method of wiring for multiple telegraphy as arranged by the American Telephone and Telegraph Company, indicating two telephone circuits, totaling four wires, which provide for the transmission simultaneously of a maximum of *three* independent telephone conversations and *eight* distinct telegraph messages without any interference with each other.



Schematic Diagram Showing How Three Telephone and Eight Telegraph Messages Are Transmitted Simultaneously Over Two Telephone Circuits. The A. T. and T. Co.'s Method.

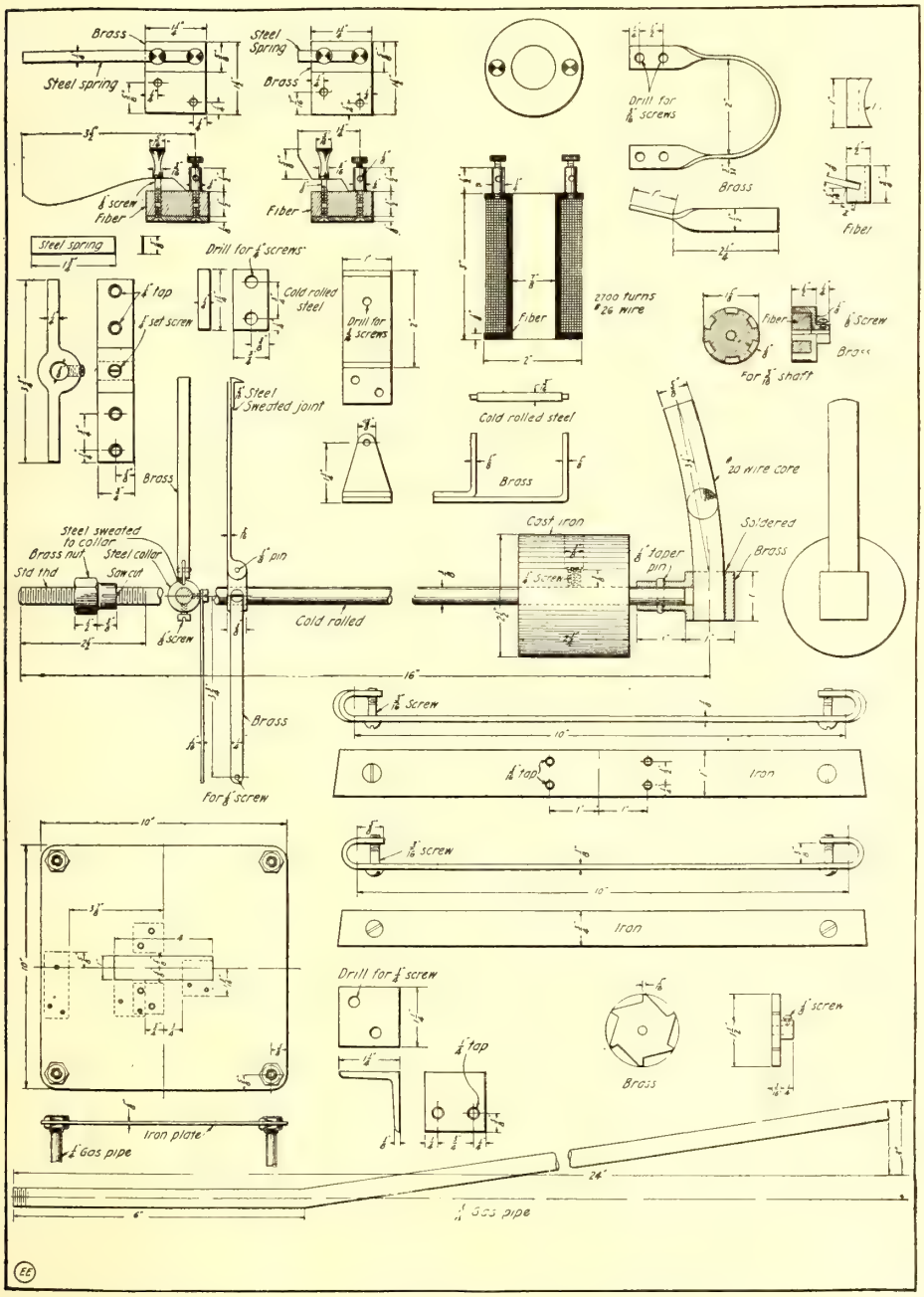
The telephone circuit consists of two copper wires of approved construction, arranged in specific relation to each other and transposed at frequent intervals to reduce the inductive effects to a minimum. This pair of wires forms a metallic circuit, equipped with auxiliary apparatus, loading coils, etc., connected with a switchboard. As will be noted from the diagram, one wire of each pair is employed to form the third telephone circuit.

The telegraph circuit comprises one wire, grounded to the earth to make the necessary return, and which may be divided into several distinct circuits for the transmission of messages.

Each of the four telephone wires is capable of providing for a telegraph circuit at the same time the lines are being used for telephone service. The telegraph circuit is thus superimposed, and can be divided into a duplex system of two, four or eight working telegraph circuits, each of which may be employed for the transmission of telegraph messages. The telephone circuit proper can only be used for telephonic purposes by the two parties in direct communication, during the period of connection, as will be readily understood.

This complementary relation between the telephone and telegraph shows that telephone toll and long-distance lines may be used for telegraph purposes, but existing telegraph lines cannot be employed for telephone service until reconstructed and arranged in the manner indicated in the diagram.

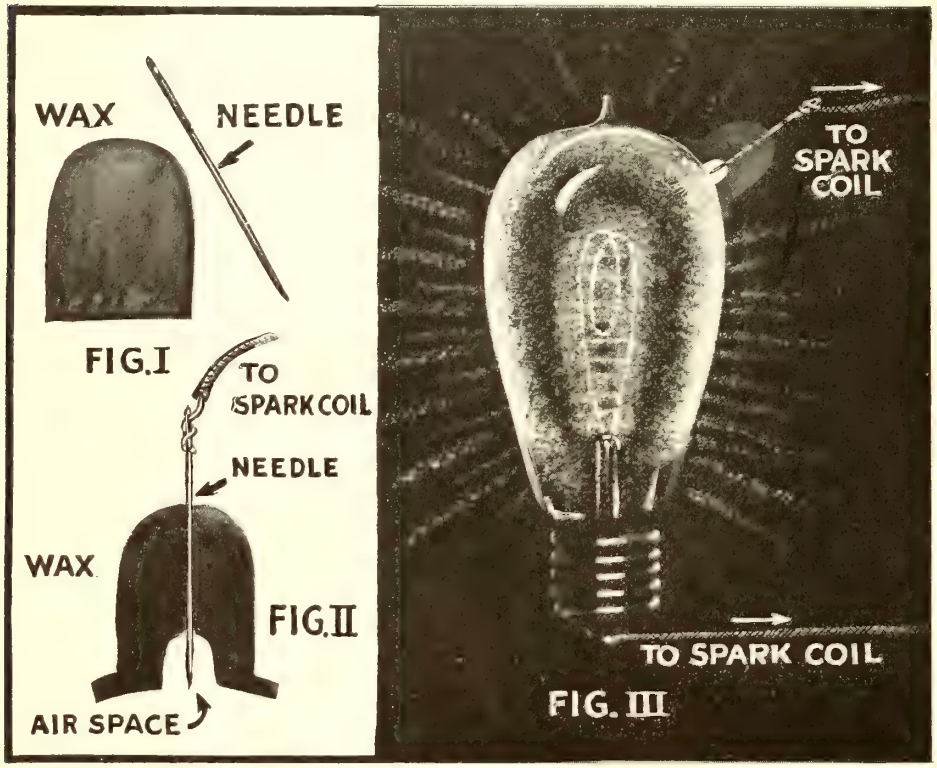
In connection with this effective wiring arrangement it is interesting to note that this possible interchange of system and service brings about greater economy in the use of joint facilities of both telephone and telegraph plants, including both lines and terminal stations. Quite naturally, there are great advantages to be derived thru the use of a joint "wire plant," utilizing for both telephone and telegraph the operating facilities that would ordinarily be employed for a single purpose only.



Details of All Parts Necessary to Build a Standard Seconds Pendulum for Use in Closing a Secondary Circuit at Exact Intervals, Et Cetera.

A "GEISSLER TUBE" EASILY MADE.

Now that Geissler tubes are hardly procurable at any cost, I think that this article will prove of interest to all who have wanted a Geissler tube. Below are full



Details for Making a Home-Made Geissler Tube from an Incandescent Lamp and Appearance of Completed Bulb When Excited from Even a Small Spark Coil.

directions for making such a tube from a burned-out lamp bulb, providing the vacuum is not destroyed.

Take a piece of sealing wax and soften it so that it can easily be prest into a shape somewhat like that in Fig. 1. Then hollow out the center as in Fig. 2. Stick a needle thru the wax and while still soft and hot press the wax firmly against the side of the bulb as in Fig. 3, taking care that the wax is air-tight. Then connect one terminal of a 1 inch spark coil to the needle in the wax and the other terminal to the base of the lamp. Turn on the current and the spark will puncture the glass and the effect produced will be that of a high grade Geissler tube. The purpose of the hollow space in the wax is as follows:

This space is filled with air and when the spark punctures the glass, the air in this space rushes inside the bulb; in this way regulating the amount of air in it. Different colors are obtained with different air holes, that is, the larger the hollow space in the wax, the more air in the bulb.

When inserting the needle thru the wax, take care that it just touches the glass of the light bulb.

I have used this method of making Geissler tubes for years and I have found that it never fails to produce the desired results; as good as any tube I have bought. As the cost of each tube is very slight, and every tube made produces a different color, I have found it very interesting to make a great number of them.

Contributed by DAVID GOODMAN.

ELECTRIC IGNITER FOR FIRING A CANNON.

After having some experience with firing a cannon by fuses, lighting paper, and several other methods used, and getting a taste of powder at one time, I decided to make something which would be entirely safe and sane.

This apparatus costs but little, to which is added the fact that it is safe. It is a good thing to be used at a camp when firing a cannon for the raising and lowering of the flag, and is a safe way in which to fire a cannon on July 4th.

The apparatus can be placed as far as 75 yards away from the cannon. The things needed would be 1 push button, 3 dry cells, 2 binding posts, a small (¼" spark) spark coil, about 4 square feet of ½ inch poplar or pine, some shellac, screws and wire. I would recommend a section of a Ford coil which can be bought for a reasonable amount.

The inside measurement of the box should be 13½" by 8¼" by 3", the compartment for the batteries A, A, A, being 8¼" by 6½" by 3" separated by a partition, and then a compartment 6½" by 3½" by 3" or any suitable size for the spark coil which you have. The bottom and top should be made about ½" larger than the outside size of the box for the sake of appearance. When putting the box together all joints should be made by painting them with shellac and before it dries screw it down tight so it will be water-tight and damp-proof. When connecting the batteries leave plenty of wire for connections. The push button C, which is to complete the primary circuit to operate the coil, should be fastened on the cover above the compartment which has nothing in it.

The secondary binding posts "F" in the diagram should be fastened on the cover above the spark coil, and be sure the wires are carefully insulated from each other. After the box is made and put together give it about 5 coats of shellac to make it damp-proof. Shellac both inside and outside.

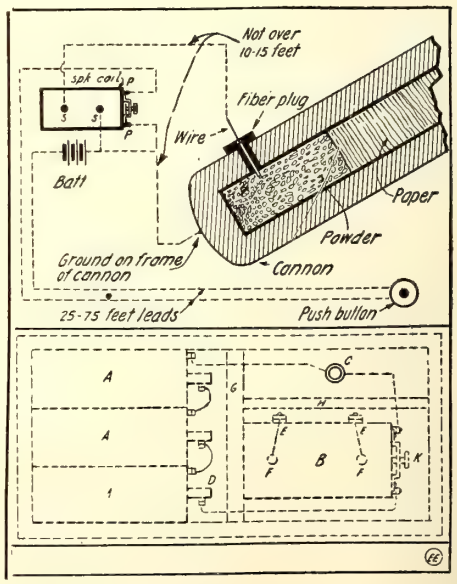
Before fastening the spark coil in the box be sure the coil is adjusted to its best secondary output when connected to the batteries which are to be used.

Up to about 75 yards this will fire a cannon with one side of the secondary grounded and the other secondary wire run through the air. This wire is supported by insulated wood sticks stuck into the grounds. Have the cannon grounded and the end of the wire about ⅛" from the one side of the fuse hole with powder around it. Then if everything is arranged as described, when the button is presst the powder will go up in smoke. For firing a cannon more than 75 yards from apparatus run one wire along on the ground and the other through the air. Connect the ground wire to the cannon. Fix the air wire as described before. This you will find is a very safe way to fire a cannon.

Code to Drawing: A, batteries; B, spark coil; C, push button on top of cover; D, primary circuit; E, secondary circuit; F, secondary binding post on top of cover; G, partition separating batteries; H, partition separating spark coil; K, spark coil vibrator.

In using this apparatus to fire a cannon with, make it a rule not to have the secondary leads over 20 to 30 feet long. These spark leads should be well insulated (at least one of them) and the primary push button wires can be of any length desired up to 50 or 75 feet, but 20 feet is usually sufficient.

Some constructors make their cannon to accommodate a standard gasoline engine spark plug at breech. Others arrange an insulated wire as shown in the accompanying sketch. This apparatus has been used very successfully by the Erie Y. M. C. A. and the Erie Boys' Club of Erie, Pa.



An Electric Igniter for the Toy Cannon Which Will Save Fingers, Mis-Fires and Premature Explosions.

Contributed by

GILBERT CROSSLEY.

HOW TO MAKE IT



This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

AN EFFICIENCY PLIER KINK.

Nature provides for average conditions only and she supplied us with a reasonably thick skin where it is called upon to do extraordinary amount of work or wear, but one of the spots neglected by bountiful nature is on the back of the index finger, between the first and second joints of the right hand. This is the spot that is charged with the duty of opening "diagonals," "long-nose," "goose-bill" and the common, ordinary, everyday pliers, and on this spot more blisters can be raised to the square inch than on any other spot on our anatomy.

The photograph clearly shows how to "save your skin" and while it will save more time than skin, it is our skin that we are most considerate of.

The spring that holds the legs apart should be made of spring brass, phosphor



Do You Want to Save Your Skin and Your Temper? Then Simply Fit Your Pliers with a Steel or Bronze Spring Like That Shown and Your Worries Will Be Over.

bronze or German silver and it is soldered to one leg, or if soldering offers any difficulty the spring may be riveted to the leg.

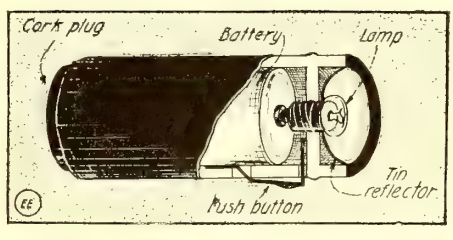
This kink is particularly useful in telephone exchanges in trimming terminal racks or cable and relay work, where it is necessary to cut and trim wires by the hour and which operation wears off considerable "bark." The kink also allows the use of all fingers for pressure on the legs.

Contributed by
FRED'K J. SCHLINK.

A "BAMBOO" FLASHLIGHT NOVELTY.

A distinct and useful novelty in electric flashlights is here shown and described. To make it, first secure a battery for a tubular flashlight. A piece of bamboo with an inside diameter the same or nearly the same as that of the battery is then obtained. The length of the bamboo is slightly greater, say an inch and a half, than the battery. The bamboo must have a joint about a half inch from one end. A hole is bored thru the center, just large enough to permit the flashlight bulb to fit tightly. A piece of bright tin, shaped right, is placed around the bulb to act as a reflector. A cork is placed at the bottom to keep the battery from falling out. The contact is made as shown in the diagram, by means of the brass spring.

Contributed by EDMUND ANGLIN.



A Distinct Novelty in Flashlights—It's Made of Bamboo and Will Make a Very Attractive Gift or Favor for Parties and Dinners.

AN EMERGENCY FUSE PLUG.

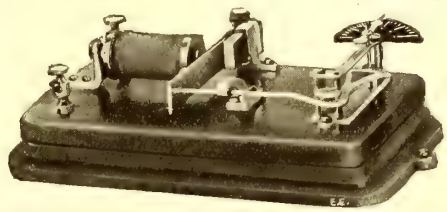
Here is a little idea of my own on an "Emergency Fuse." Take an ordinary attachment plug and connect the terminals with a small piece of common screen wire. A single strand of wire will pass about 3 amperes; 3 strands 6 amperes, and 6 strands about 10 amperes.

Contributed by HUBERT YEAGER.

SECOND PRIZE, $2.00

A GAGE THAT INDICATES RELATIVE MAGNETIC ATTRACTION OF METALS.

The experimenter may often want to test the effect of different metals under mag-



With This Simple Home-Made Testing Device the Amateur Can Make Interesting Investigations of the Relative Magnetic Attraction of Various Metals, Both Ferric and Non-Ferric.

netic influence and an instrument, constructed by the writer, to determine this particular effect is shown in the accompanying illustration. The action of the apparatus as shown in the photo is very evident. As soon as a current is past thru the electro-magnet, the metal strip to be tested is either attracted or left neutral. In some metals as iron or steel, the armature or testing strip, will be moved considerably, but other metals like copper, lead, zinc are not affected at all. The effect of the magnet upon these latter metals can, however, be easily detected by so constructing the indicator that it will register the least perceptible movement of the armature. It is quite evident that the slightest movement of the rod will move the pointer over a considerable distance. By passing AC thru the magnet coil the relative magnetic repulsion of metals may be tested.

The indicator arrangement may be constructed from an old steam gage or clock works. The pivot block can be obtained from an old bell. Care must be used in making the instrument so that there is very little friction in the pivot rod support or in pinion and gear of the indicator.

Contributed by MARK SLABODNIK.

THIRD PRIZE, $1.00

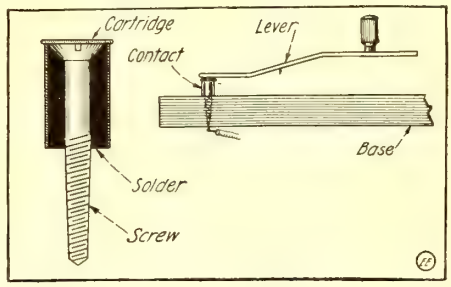
A SUBSTITUTE FOR SWITCH CONTACT POINTS.

When in need of switch contact points, old used .32 or .25 caliber cartridges come in handy. The "Radio-bug" with a lean pocketbook can construct these at practically no cost.

First clean the inside of the cartridge shell from all dirt, by using a small penknife or half-round file. Next take a common brass wood screw that will fit inside the cartridge and place it inside one which has been cleaned. Now pour solder in and you then have a serviceable contact point. It is perhaps better to put a drop of zinc chlorid on the inside of the cartridge to make the solder stick better.

If screws are used which will come thru on the rear of the base, wires may easily be soldered to them.

Contributed by G. GRANT WAITE.



Save Your Cartridge Shells, Boys. They Make Good Switch Points, if a Wood or Machine Screw Is Firmly Embedded in the Shell by Means of Solder. The Leads May Be Soldered to the End of the Screw.

A PECULIAR STATIC ELECTRICAL PHENOMENON.

I am a stenographer, employed in an architect's office, and my duty is to write specifications, ten copies at a writing. In writing, a static charge is generated on each of the carbon papers, which is separated from the next by the white paper. On separating the carbons from the white papers, which is done by pulling the ends of the carbons, which protrude beyond the white papers, with one hand and the white papers themselves with the other hand, some of the charges are neutralized on separation; sharp crackling being indicative of this. I usually place all of the carbons onto the machine, after which I draw quite a long spark from any part of the machine into my knuckle.

At first I received the shock unexpectedly after bringing my hand near the charged machine, as I had formed a habit of placing the carbons onto the machine after each writing. After investigating the matter, I found that the mysterious "what-is-it" was developed in the machine.

Contributed by WM. LESKY.

Where the Radio Amateur Fits in the U. S. Naval Reserve

By M. B. WEST, RADIO GUNNER, U. S. N. R. F.

THE amateur has at last an opportunity to be of real service to the Government, and one that will not in any way interfere with his career in civil life. The argument that the amateur would be of inestimable benefit in time of war has so often been made that it has at last been recognized. Yet it is clear to anyone who gives it a moment's thought, that without at least some preliminary training most amateurs would fail miserably if suddenly placed in charge of a large radio station.

It is with the intention of remedying this situation, that the Class 4, Naval Reserve, has been created. In as far as possible, it is hoped that amateurs enrolling in the reserve will at once ask for a short period of active duty so as to become familiar with the requirements of the radio work of the navy. Then they will return home, and it is hoped will join one of the drill routes that have been organized in connection with the Naval Stations. The purpose of these drill routes is to perfect these amateurs in handling radio business according to the rules of the navy.

And think what a difference it would make in amateur working conditions if all amateur business was handled in an orderly and thoroly efficient manner!

These drill routes will be placed under the direction of an officer of the naval reserve, and every effort will be made by them to assist amateurs in solving the many puzzling problems that arise in connection with their stations.

It is not necessary to enroll in the reserves, to join in the drill, but it is earnestly hoped that all will do so. So far this feature has been worked out more completely in the Middle West in connection with NAJ, the naval station at Great Lakes, Illinois.

The Class 4, Naval Reserve, is a very liberal organization, and creates an opportunity that seems especially adapted to amateur needs. To enroll, you must be an American citizen, be able to send and receive at the rate of ten words per minute, and be able to pass the usual physical examination. On enrollment members will receive a yearly retainer fee of $12.00, until such time as they have perfected themselves sufficiently to be able to handle their work in a manner on a par with regular naval practise. After such time they will receive an annual retainer pay equal to two months' pay of their corresponding grade in the regular navy. In addition they receive traveling expenses to and from place of training—uniforms, meals and lodging and the regular pay from the time they leave their homes until they return to them. This is all clear money, and should be particularly attractive to students and others, as it gives an opportunity for training and also saving during vacation period.

One feature that is especially liberal is that a member of the reserves will be discharged at any time during peace at his own request. Active service is not compulsory, and orders to active duty are only issued at the request of members themselves, and will be arranged so as to interfere as little as possible with your regular business. The only time the reserves can be called for active duty, is in time of war, and it is intended to use them at the less important land stations so as to relieve the regular officers and men for their active war duties. Information in detail can be secured from the nearest naval recruiting officer, who will be glad to give you any information you may require.

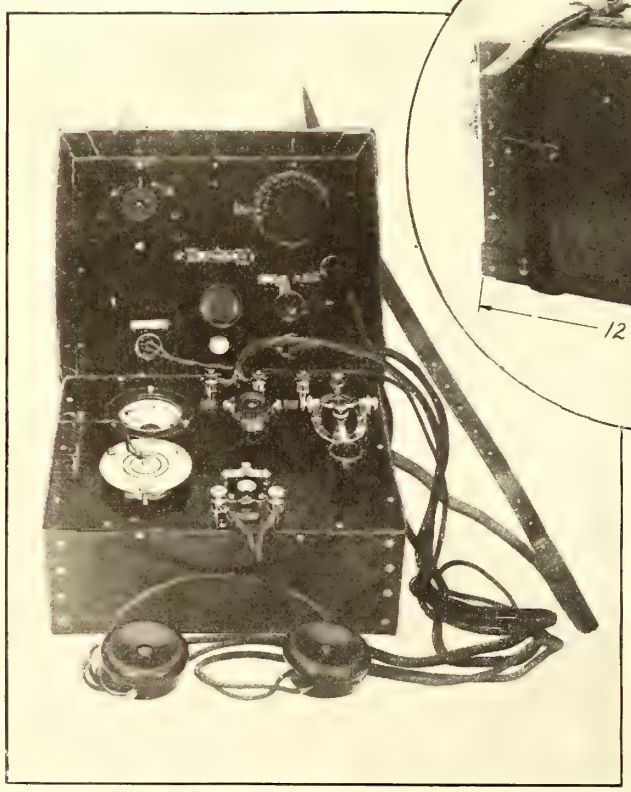
Here is an opportunity to prepare yourself so as to be of real assistance to the Government, and at the same time be well paid while doing so.

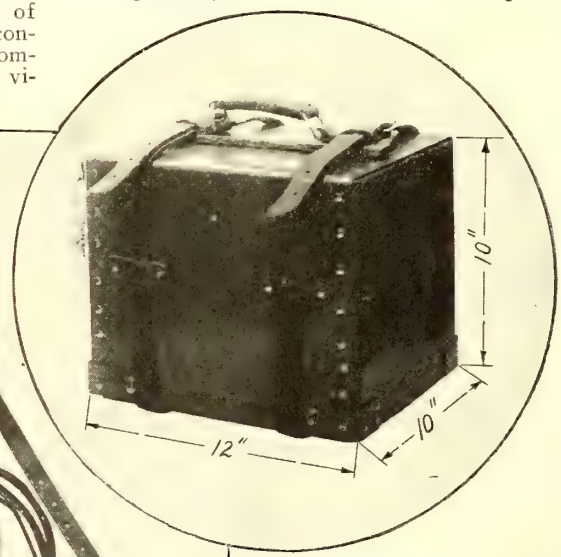
As it is the first appeal to the amateur, if we are to live up to the reputation that has been made for us we should respond gladly and willingly. We can assure you that you will be pleased with the treatment you receive while on active duty and will return home with a much more friendly feeling towards "Uncle Sam" and his navy.

AN EXTREMELY LIGHT-WEIGHT RADIO TRANSMITTER AND RECEIVER.

The illustrations herewith show one of the latest types of portable light-weight, radio transmitter and receiver, adaptable for both military and civilian duty.

This outfit was designed and built by Mr. A. B. Cole, a prominent radio engineer of New York City. The transmitter is stationed in the main compartment while the receiving outfit is placed in the cover of the case, which is a substantially built fiber affair measuring 10 x 10 x 12 inches. It is equipt with heavy carrying straps. The transmitting set comprises the following:—A high tension spark coil placed within the case and which is used to charge a condenser thru a special quenched spark gap. This gap is seen on top of the panel, indicated by the horizontal circular disc. This gap is of the quenched type and is composed of two perfectly parallel plates. The top electrode is connected to the helix by a flexible conductor. A special independent vibrator is connected with the primary of the induction coil and this is located behind the forward binding posts. It is an essential feature that the frequency of the emitted wave have a high pitch, musical tone and with the aid of this vibrator this is readily accomplished, which was heretofore impossible, due to forced action of the spring constituting the common form of vibrator.





One of the Latest Compact Radio Sets Designed Especially for Field Military Service. It Has a Powerful Transmitter Operating on a Storage or Dry Battery.

The tuning inductance consists of a number of turns of wire placed on a frame, the size of which is equivalent to that of the inside of the dimensions of the box, so that it does not interfere with any of the other inclosed instruments. Taps are led off at four different positions, and are terminated in four plug receptacles which are placed at the left of the panel. A flush type hot wire ammeter is also secured to the Bakelite control panel. The antenna change-over switch is shown in the background and the transmitter key at the right.

The receiving apparatus is mounted on a separate Bakelite panel and contained in the case as illustrated. This receiver comprises an inductive coupler, with a fixt secondary and tuning is accomplished by means of a secondary variable capacity. This latter is controlled by means of a graduated handle noted at the upper right hand corner. An enclosed mineral detector is employed with this set; it is placed in the center of the cabinet. The round instrument below the detector is a high frequency buzzer used for testing purposes, and the button directly beneath the buzzer is used to start the buzzer. The plug to the left of the push button inter-connects the telephones with the set, while the plug to the right interlinks the antenna and ground thru the sending apparatus. The switch to the left of the sending key connects the antenna with either the sending or receiving instruments; by turning to the left, the receiving instruments are connected, and to the right is for transmitting.

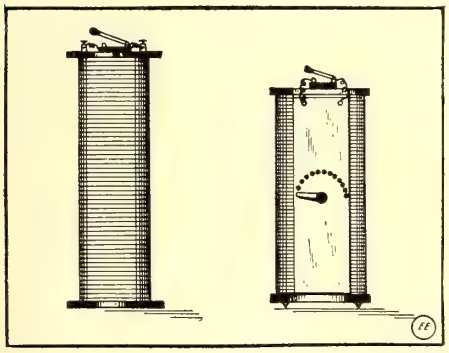
Amateur and Experimental Radio Research

By RAYMOND FRANCIS YATES

PART I.

OF all the present-day fields of scientific endeavor, there is probably none more promising or productive than that of wireless. It is hardly correct to say that wireless is in its infancy, but the art has by no means reached any reasonable degree of perfection and the work yet to be done is unbelievably vast and important.

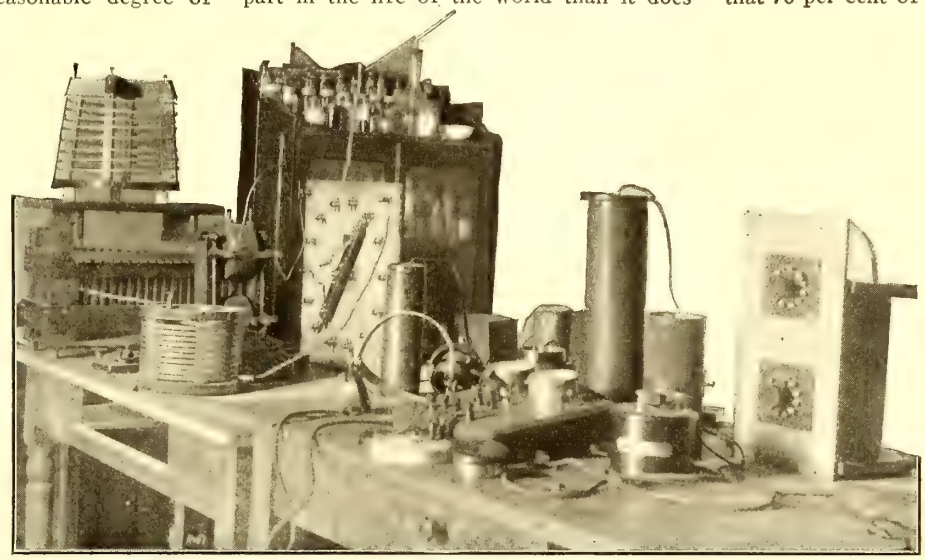
Of the multitude of wireless amateurs in the United States, there is a surprisingly small number of serious-minded experimenters who have really entered the field for anything more than an interesting hobby. Many experimenters are inclined to think that wireless research entails such a great expense and involves such costly apparatus that it is quite beyond their means. It is the purpose of this paper to disprove this erroneous opinion and explain how it is possible for every amateur to exercise his inventive talent in the great field of radiocommunication. There seems to be a lack of real, scientific enthusiasm among the amateurs of the United States, especially in regard to the perfection of the art, and it is the object of the author to try and offer a few suggestions with the hope that these amateurs will regard their work in a more serious attitude with the intention of developing something original. I have talked to many experimenters who thought that they had conceived a valuable idea, but either they did not possess the courage to develop it or they thought it was beyond their ability. If de Forest had had the same attitude, we would not have the Audion; if Marconi had lacked unflinching inspiration and courage, probably de Forest would not have needed to invent his Audion detector at all. Among the 400,000 and more radio experimenters in the United States, there are undoubtedly many Fessendens, Marconis and de Forests, who either lack courage or enthusiasm to enter research work.



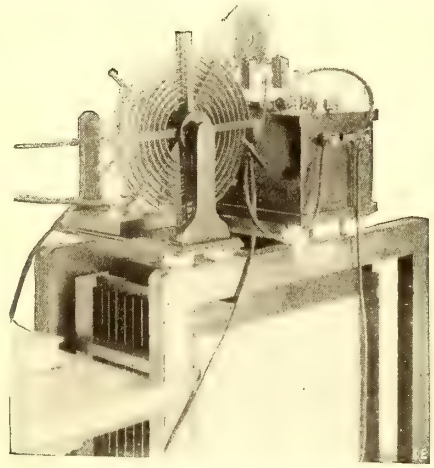
If You Make Up Loading or Other Inductances, Take the Trouble to Either Measure or Calculate the Inductance in Micro-Henrys or Centimeters. It Always Pays.

Possibilities of the Field.

The possibilities of development in wireless are limitless. We have just entered a new era—the *Wireless Era*. We must remember that the application of wireless is not necessarily limited to the transmission of intelligence. In the future this will constitute the smallest part of it. We have seen the birth of developments that tell us in no uncertain terms that the science of radio is destined to play a far greater part in the life of the world than it does today. The wireless transmission of power, radio control of mechanisms (radio tele-mechanics), the development of radiotelephony, directive communication, the perfection of the high frequency alternator, and the elimination of interference, are but a few, a very few, of the problems to be solved. There will be a day, in the not far distant future, when an audience in New York may sit and listen to a concert being played in Paris *via radio*. Nikola Tesla tells us that within 25 years we will be sending radio controlled boats to any port of Europe without a man on board! We may put much faith in statements made by Tesla, as his accomplishments are many and great. If it is possible to control vessels via radio, why will it not become possible to control airships, trains and automobiles? It would indeed be a superficial observer who would conclude that radio is anything but a fruitful field for those who desire to enter into penetrating and productive investigation.



A Typical Radio Experimental Laboratory Equipt with a Variety of Condensers and Inductances, as Well as Other Supplementary Apparatus with Which Many Valuable Researches Can Be Made.

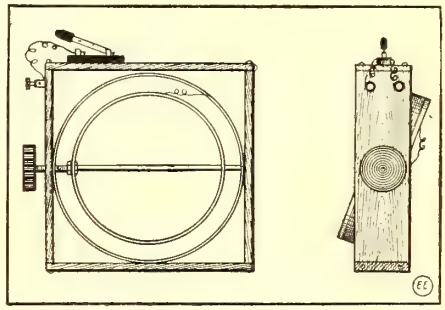


A Good Type of Experimental Radio Transmitter Which May be Used with a Phantom or "Dummy" Antenna.

Knowledge Necessary for Research Work.

Contrary to the general opinion possest by experimenters, it is next to impossible to successfully enter into research work without an elementary understanding of the fundamental principles of radiocommunication. It is indeed a deplorable fact that 70 per cent of the radio experimenters in the United States can not thoroly explain the theoretical basis of operation of one of their instruments. True, they can tell you that a variable condenser is used to tune with and to reduce "static," but the real "how" of its operation is hopelessly beyond them. These statements do not necessarily infer that to enter research work it is imperative that one be a radio expert or graduate engineer. Quite to the contrary. It is only necessary that one be familiar with the elementary theory under which the various elements of radio receptors and transmitters operate. This knowledge is absolutely essential and even then it is not necessary to go real deep at the start. It is not necessary to be able to explain in theoretical detail the unilateral conductivity of crystal rectifiers or the mathematical physics of the expanding hot-wire meter. One should be familiar, however, with inductance, capacity, resonance, damping, resistance, impedance, etc. One should know *why* a variable condenser will alter the wave length by changing the capacity of the circuit; why the inductance of a tuning transformer has the same effect, and why the quenched gap has a tendency to set up sustained oscillations. It is surprising how many suggestions present themselves when a working knowledge of the various instruments is acquired. Ideas then come fast and numerous. The moral here is—study! Read every article and book you can get hold of. If you don't understand it the first time, read it again. It would probably take you several years to work out the law of $W.L. = 59.6\sqrt{L \times C}$, but by reading the up-to-date magazines on the subject and elementary books such as the "Wireless Course" by Gernsback, Lescarboura and Secor, you can learn just why, for a given wave length, that when C is decreased, L must be increased, etc. None are so blind as those who won't see!

(*Continued on page* 218)

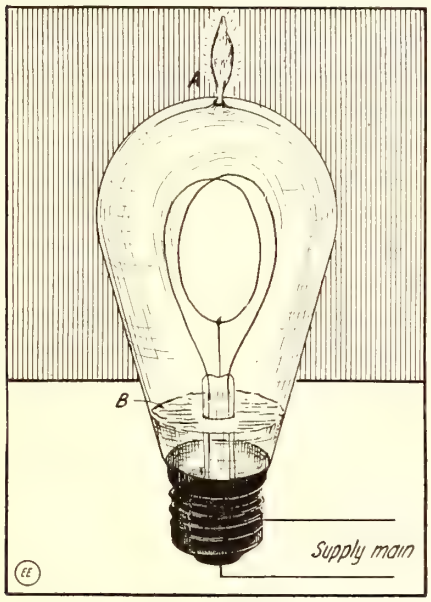


The Radio Student and Investigator Should Provide Himself With a Number of Variometers of Different Sizes and Known Inductance Values.

A PECULIAR EXPERIMENT WITH A LAMP BULB.

A curious experiment can be made with a 110 volt, 16 candle power carbon lamp. Anyone who has seen the tip broken off an electric lamp while burning has noticed that it soon becomes brilliant, then goes out.

For this paradoxical experiment, now break the tip A off as small as possible, but enough to let the air in, then fill up to B with gasoline. Connect the lamp in circuit to 110 volts, and the lamp will burn about ½ candle power. Now, tho this is only a 110 volt lamp and ordinarily in perfect condition, it would burn out in a very short time on a 220 volt circuit; connect it to a 220 volt circuit, and it will apparently burn at the same candle power or ½. When the lamp has burned for about three minutes on either voltage, place a match at the opening and a small and very white light will burn like a candle,



A Novel Experiment with an Incandescent Lamp Which Is Filled Up to "B" with Gasoline. When Connected to Live Circuit Gas Is Generated and May Be Ignited at A by a Match.

becoming stronger as long as the gasoline lasts, same depending on the size of the tip, but as soon as you open the switch, the light and flame go out.

Place the lamp in a horizontal position and the lamp acts the same as tho you had broken the tip while it was burning. It will only behave in this paradoxical manner while vertical, tip up and base down.

Contributed by
GEORGE C. MACLEAN.

FORMULA FOR WOOD'S METAL.

This silvery fine-grained alloy fuses between 151 and 162 deg. Fah., and is adapted to soldering, and mounting crystals as galena, silicon, etc., for wireless work.

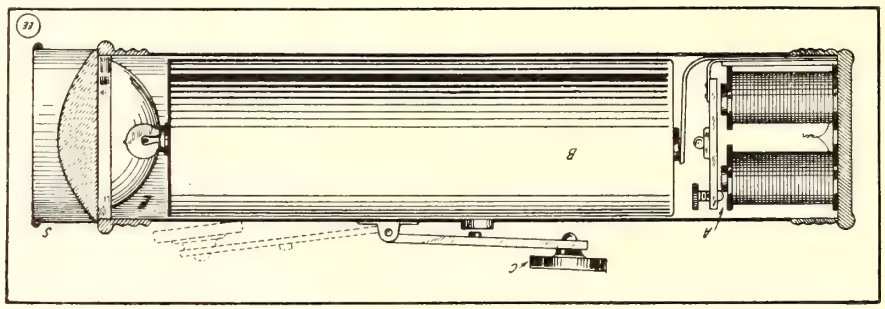
Tin	2 parts
Lead	4 parts
Bismuth	5 to 8 parts

Contributed by
ALBERT W. WILSDON.

Due to the advent of the war, we are particularly desirous of obtaining manuscripts describing original and practical "Electrical Experiments."

MILITARY SIGNAL LIGHT AND BUZZER.

A very compact and serviceable arrangement of military signal light and tell-tale buzzer is shown in the accompanying illustration. It was developed by R. C. Avery, and is said by him to be particularly efficacious for flashing light signals at night; the tell-tale buzzer sounding for each dot and dash as they are sent out by the transmitting key or switch on the side of the battery case.



The Boy Scout Signal Corps Divisions Will Find This Combined Buzzer and Signal Light Outfit Very Light and Serviceable. Be Sure You Have a Good Lens to Start With, and a Parabolic, Well Polished Reflector.

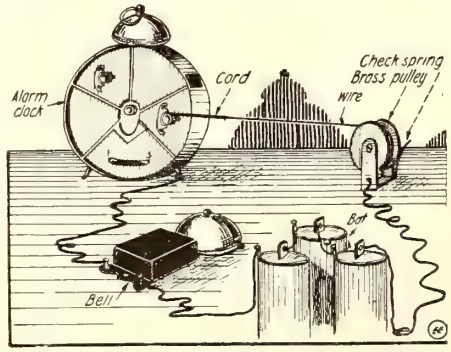
This idea should prove very useful to the signal corps division of the Boy Scouts. The present signaling device was found very efficacious compared to the acetylene lantern previously used in the United States Army signaling work, the electric lantern here illustrated having signaled over a distance of 5 miles at night and 2 miles in daylight.

The instrument as developed by its inventor measures 10½ inches in length by 2¼ inches extreme diameter. The transmitting key folds over so that when carried in the pocket it cannot accidentally close the circuit.

HOLY SMOKE! ANOTHER ELECTRIC ALARM CLOCK.

The illustration shows an electrically operated alarm clock of new design. One terminal of the battery is connected to a metal standard, holding a brass pulley, on which is wound a few turns of fine copper or brass wire. One end of the wire is fastened to a piece of cord, the other end of which is tied to the alarm winding key. The second terminal of the battery is connected thru a bell to one foot of the alarm clock.

The mode of operation is as follows: The circuit is open at the cord due to its non-conductivity. When the alarm rings, it winds the cord on it until the wire is drawn on to the key. This completes the circuit and operates the bell or any other device. The magnet wire is of course long



What! Ding-bust-it, if Here Ain't Another "Electric" Alarm Clock. The Inventor Arranges a String and Wire So That When Clock Key Turns, the Wire Is Finally Grounded, Closing the Bell Circuit.

enough so that when the alarm key has turned its full rotation there is still some wire wound around the pulley. Both the clock and the standard should be securely fastened to a suitable baseboard.

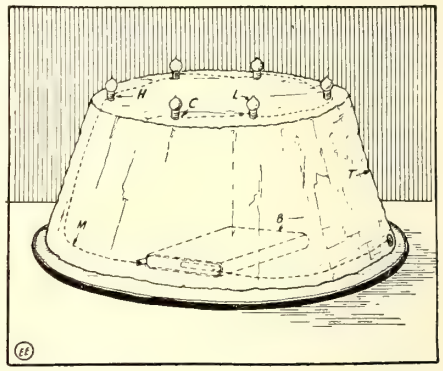
Contributed by A. H. BEILER.

AN ELECTRIC BIRTHDAY CAKE WITHOUT THE DOUGH.

The materials required for this stunt are a tin pan, about ten inches in diameter and four inches high, a number of miniature-base colored lamps, and a source of current. After obtaining these, proceed as follows:

Mark off on the bottom of the tin pan, the desired positions of the lamps, and punch holes, H, at these points. The holes must be of such size that the screw base, C, of the lamps, L, will just fit in them. This done, turn the pan over and solder the No. 20 wires, M, to all the center connections of the lamps, and continue this wire to the source of current, which may be a flashlight battery or two, B, placed under the pan. If the source of current is a storage battery or a step-down transformer, the wires going to the same should be concealed. The hardest part of the work is now finished.

The icing is now to be put on the "cake" and in order to make it stick, paper should be pasted on the pan. The icing is spread



For Birthday Parties an Electric Cake Is Always Welcome. This One Is Made from a Tin Pan Iced Over. The Battery Is Placed Within the Pan.

smoothly over the paper up to and touching the lights. When hardened, this novelty will have all the appearances of a genuine iced cake with lights mounted in the top.

Contributed by VICTOR DE FLORIN.

TO TRANSFER PICTURES TO WOOD.

Dissolve salt in soft water; float your photo print on the surface, picture-side up; let it remain about an hour. The wood should be of bird's-eye maple, or other light-colored hardwood. Varnish with the best copal or transfer varnish.

Take the picture from the water; dry a little between linen rags; then put the engraving, picture side down, on the varnished wood, and smooth it nicely. If the picture entirely covers the wood after the margin is cut off, so that no varnish is exposed, lay over it a thin board and heavy weight; leave it thus over night. If you wish but a small picture in the center of the wood, apply the varnish only to a space the size of the picture. Dip your forefinger in salt and water, and commence rubbing off the paper; the nearer you come to the picture, the more careful you must be, as a hole would spoil your work.

Contributed by V. C. McILVAINE.

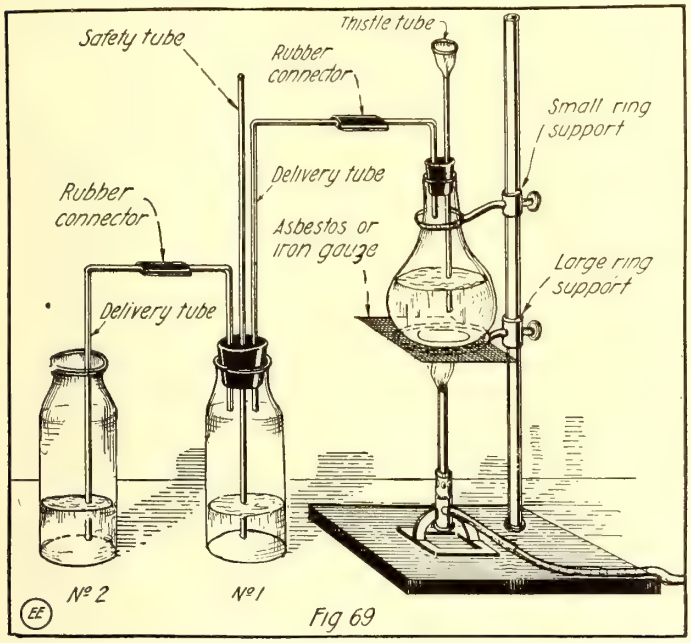
Experimental Chemistry

By ALBERT W. WILSDON

Fourteenth Lesson

HYDROCHLORIC ACID.

BASIL VALENTINE in the 15th Century first described the preparation by a process similar to the one now in use. He called it "Spirit of Salt." That which escaped from anything easily in intangible form was called a "Spirit." Thus *Spirit of Wine, Spirit of Wood,* etc., are indication of the crude theory of spirits so long in vogue. Hydrochloric acid being a gas which is liberated from salt when it is treated with Sulfuric acid, it was naturally regarded as a *Spirit of Salt.*



Experimental Apparatus Set Up for the Preparation of Hydrochloric Acid in the Laboratory.

Glauber prepared this gas in the 17th Century by treating Sodium Chlorid [Common salt, Na Cl] with sulfuric acid.

Priestly, in 1772, first obtained it in pure condition. He called it "Marine Acid Air."

Upon the theory introduced by Lavoisier, that all acids necessarily contain oxygen, Hydrochloric acid was for a long time believed to contain oxygen.

About 1810, Davy established the elementary nature of Chlorin, and hence the true nature of its hydrogen compound, Hydrogen Chlorid [Hydrochloric acid]. The correctness of his results became generally recognized shortly after. Many facts lead to the conclusion that Hydrochloric acid gas is composed of Hydrogen and Chlorin in such a ratio that its composition may be represented by the formula, HCl.

1. Hydrogen burns in chlorin, the only product being Hydrochloric acid gas.

2. When hydrogen chlorid [Hydrochloric acid] is decomposed by an electric current, equal volumes of hydrogen and chlorin are evolved.

3. When a mixture of equal volumes of hydrogen and chlorin is exposed to the direct sunlight, or to the action of an electric spark, the gases combine with explosive violence, and Hydrochloric acid gas is formed with no residue. Furthermore, the volume of the resulting gas equals the sum of the volumes of hydrogen and chlorin used.

4. When a given volume of dry hydrochloric acid gas is treated with sodium amalgam, the chlorin is withdrawn by the sodium in the amalgam, and a volume of hydrogen remains which is half the original volume.

5. No derivative of Hydrochloric acid is known which contains less hydrogen or less chlorin in a molecule.

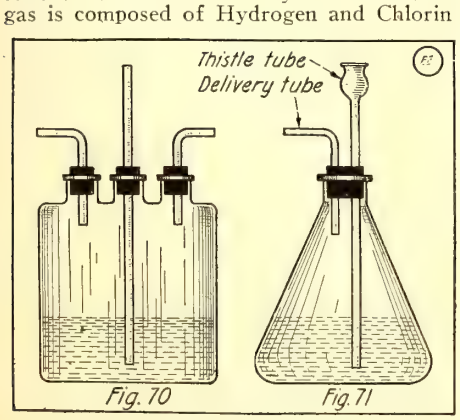
6. The ratio by weight in which hydrogen and chlorin combine is 1 to 33.45. Hence, the lowest molecular weight of Hydrochloric acid is 36.45, a number which has been verified by several different methods.

OCCURRENCE:

The free occurrence of Hydrochloric acid in Nature is rare, as its affinities are too strong. It occurs from the exhalations of active volcanoes, as Vesuvius and the fumaroles of Hecla. It is also a constituent of some streams and rivers which have their origin in volcanic mountains. It is found in the waters of certain South American rivers that have their source in the volcanic districts of the Andes.

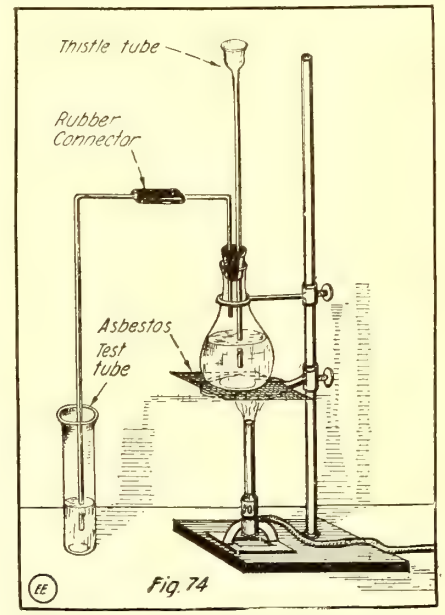
The series of salts, derived from Hydrochloric acid, are widely distributed and of great importance. In general, they are crystalline, stable, and soluble [except Silver], tho some are decomposed by water, especially if evaporated with it. Common salt, Sodium Chlorid [NaCl] is the most important of the chlorids, and in fact is the parent substance from which almost all chlorin and its compounds are made, as well as all of the sodium compounds.

In the manufacture of Sodium Carbonat by the process in most common use, Salt is first treated with Sulfuric acid, by which it is converted into Sodium Sulfate. In this stage of the process, Hydrochloric acid is necessarily formed in large quantity. Formerly this was allowed to escape into the air, but the injurious effects which it had upon vegetation, caused laws to be enacted whereby the manufacturers were compelled to prevent the escape of this gas. The waste gases are now caused to pass thru towers filled with bricks so arranged as to present a maximum of surface, over which water is kept constantly passing. The gas dissolves in the water quite readily, and the solution thus obtained, which is sometimes somewhat colored, is the Hydrochloric or Muriatic acid of commerce. The discoloration is due to the presence of impurities, such as Iron and organic substances.



At Left—A Wolff Bottle With Three Necks: At Right—Erlenmeyer Flask Which May Be Substituted for the Florence Flask Specified.

Hydrochloric acid forms a part of the digestive fluids of the stomach. The acid is supposed to be secreted in what is known as the *Border Cells,* whose exact functions are still unknown. The gastric juices of the stomach in normal condition contain about 0.33 per cent of free acid. Aside from the aid which Hydrochloric acid gives in peptic digestion, its presence is important, in that it destroys the germs of fermentation and disease, and probably dissolves some mineral salts. Its action in destroying germs permits the food to be stored in the stomach for some time without undergoing decay.



Method of Collecting Hydrochloric Gas By the Downward Displacement in a Dry Test Tube. See Experiment 79.

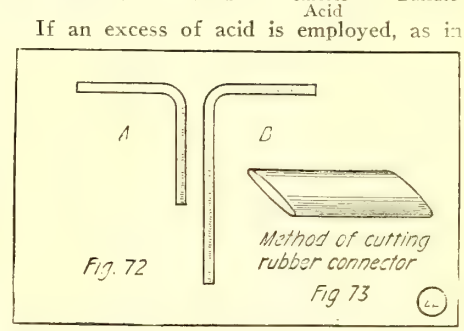
PREPARATION:

The method generally used in the laboratory is to treat common salt, Sodium Chlorid [NaCl] with Sulfuric acid. The reactions which may take place are:

[1] $NaCl + H_2SO_4 = HCl + NaHSO_4$
(Sodium Chlorid; Sulfuric Acid; Hydrochloric Acid; Hydrogen Sodium Sulfate)

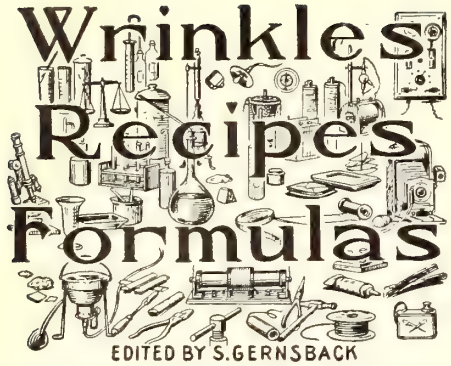
[2] $2NaCl + H_2SO_4 = 2HCl + Na_2SO_4$
(Sodium Chlorid; Sulfuric Acid; Hydrochloric Acid; Sodium Sulfate)

If an excess of acid is employed, as in the first reaction, a moderate heat is required, and a readily soluble salt, Hydrogen



Shape of Glass Tubes Used to Connect Up the Apparatus Here Illustrated and Method of Cutting Rubber Sleeves Diagonally to Make Them Slip On Tubes Easier.

(Continued on page 220)



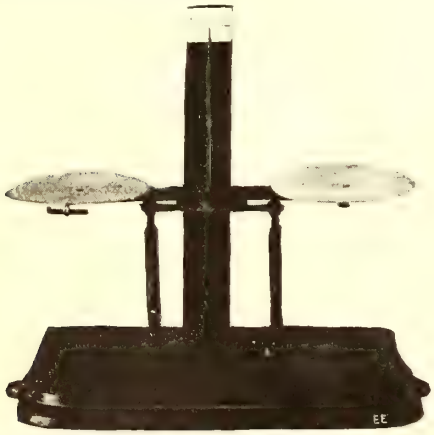
EDITED BY S. GERNSBACK

Under this heading we will publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter which will be duly paid for, upon publication, if acceptable.

HOW TO MAKE A CHEMICAL BALANCE.

The accompanying photo illustrates a chemical balance constructed by the writer While not being extremely accurate it nevertheless will measure quantities to the degree of accuracy generally demanded in an amateur's shop or laboratory. It is not difficult to construct and ordinary care being used, it can be made to weigh within a gram.

The illustration is self-explanatory, but a few words may not be amiss. To make it, first obtain a telephone ringer set as that shown in figure. It is not necessary to purchase a brand new one, but go to some electric or telephone repair shop where you may secure a ringer for less than fifty cents or even for nothing, possibly. Proceed to rearrange the different pieces so as to appear, after adding other parts, like that shown below. On the armature, solder or bolt a strip of metal, preferably aluminum, ½" x 7" and on the ends of this "beam" attach two circular 4" pans. Below one of the pans place a right angle strip and adjusting screw, in order to be able to make pans balance. Back of the instrument, after fixing on base, place a strip for an indicator.



Every Experimenter Needs a Small Balance for Weighing Chemicals On. Here's One Made from a Telephone Ringer Frame Fitted with a Set of Pans and a Scale.

Finished with shellac, this instrument will make a neat looking and useful little piece of apparatus for chemical or photographic work.

Contributed by MARK SLABODNIK.

"PER CENT" SOLUTIONS.

A table giving the weight in grains [avoirdupois] of any chemical substance required to make a per cent solution from 1 per cent to 50 per cent, based on the weight of one gallon of water at 40° F. = 8.33888 lbs. [avoirdupois], or one fluid ounce of water weighing 456.03 grains [avoirdupois].

For each fluid ounce of water take

For a 1 per cent solution	..	4.66	grains
2 " "	..	9.38	"
3 " "	..	14.10	"
4 " "	..	19.00	"
5 " "	..	24.00	"
6 " "	..	29.10	"
7 " "	..	34.30	"
8 " "	..	39.60	"
9 " "	..	45.09	"
10 " "	..	50.67	"
15 " "	..	80.48	"
20 " "	..	114.00	"
25 " "	..	152.00	"
30 " "	..	195.44	"
35 " "	..	245.56	"
40 " "	..	304.02	"
45 " "	..	373.10	"
50 " "	..	456.03	"

It should be noted that the above table applies to water, percentage solutions for other liquids would necessarily have to be figured on the weight of the particular liquid.

Percentage solutions are also, sometimes, made up from a saturated base. This method is incorrect unless it is so designated in giving the formula, that is, by stating in the formula *saturated solution base*. Such percentages are made by placing in the liquid used more of the chemical than the liquid will carry in solution; this resulting solution is filtered to remove the excess chemical and then used as a base. For example, to make a 10 per cent solution, 10 per cent of the base is used and 90 per cent of the pure liquid, or in other words, 1 ounce of the saturated solution to 9 ounces of the liquid.

Contributed by ALBERT W. WILSDON.

TO PETRIFY WOOD.

Equal quantities of gem salt, rock alum, white vinegar, chalk and Peebles' powder. This solution will petrify wood or any other porous substances if put in after the ebullition is over.

A Stone Coating for Wood: Forty parts chalk, fifty of resin, four of linseed oil, melted together; to this should be added one part of oxid of copper and then one part of sulfuric acid. This last should be added very carefully. Apply with a brush while hot.

To Imitate Dark Woods: The appearance of walnut may be given to white woods by painting or sponging with a concentrated warm solution of permanganat of potassium. The effect varies for different kinds of woods, some becoming stained rapidly, others requiring more time. When stained wash thoroly with soft water. After the wood has dried it may be varnished, and will be found to very closely resemble the natural dark woods.

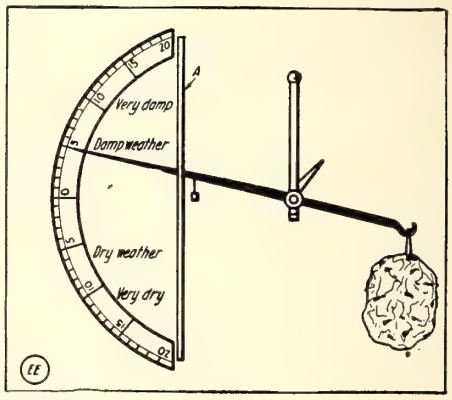
To Polish Wood: Only a very few experimenters who make their own cabinets know how to put a good polish on their woodwork. The following is a very good method. Take a piece of pumice stone and water, and pass regularly over the work until the rising of the grain is cut down; then take tripoli and boiled linseed oil, and polish to a bright surface.

Contributed by V. C. McILVAINE.

HOW TO MAKE A HYGROMETER.

The hygrometer is an instrument to measure the degrees of dryness or moisture of the atmosphere. There are various kinds of hygrometers; for whatever body either shrinks or swells by dryness or moisture, is capable of being formed into an hygrometer, such as woods of most kinds, particularly ash, deal, poplar, etc. The following is the most lasting and convenient mode of construction for an instrument of this description.

Take a very fine balance, and place in it a sponge, or other body which easily absorbs moisture, and let it be in equilibrium with a weight hung at the other end



A Simple Hygrometer Which Can Be Made at a Cost of a Few Cents, from a Sponge, a Paper Scale and a Lightly Pivoted Lever.

of the beam. If the air becomes moist, the sponge, becoming heavier, will preponderate; if dry, the sponge will be raised up. This balance may be contrived in two ways, by either having the pin in the middle of the beam, with a slender tongue, a foot and a half long, pointing to the divisions of an arched plate, fitted on it, or the other extremity of the beam may be so long, as to describe a large arc on a board placed for the purpose.

To prepare the sponge, it may be necessary to wash it in water and, when dry, in water or vinegar, in which sal ammoniac or salt of tartar has been dissolved and let it dry again; then it is fit for use. The instrument can be hung against the wall; and, in that case a bit of steel, as at "A," should be placed before the needle, to keep it straight.

Contributed by WILL M. DUFFIE.

COLD SOFT SOLDER.

Everyone at sometime or other has had occasion to solder two pieces of metal, which because of their composition, or because of attached parts, could not be raised to the temperature that even soft solder flows at. The following solder meets that demand, as it can be used without heat.

Precipitate some copper from a copper solution, such as copper sulfate or copper nitrat by means of zinc or iron filings. Into a mortar pour some mercury and the copper precipitate. Add a few drops of dilute sulfuric acid and grind until the copper has united with the mercury. Wash the amalgam with water till bright and clean. Put into a cloth to dry and by means of a twisting motion, like grapes are strained, squeeze out the excess of mercury until the copper amalgam is just workable by the fingers. Rub well into the surfaces to be joined, and press together over night. Some of the mercury penetrates the surfaces, and some of the copper crystallizes out, and the compound becomes very hard. Strange to say, this compound is silver white. By using more mercury, a pliable metal is obtained that hardens slowly. If the solder is too hard, grind up with more mercury. Keep gold and silver jewelry, etc., out of the way, as mercury destroys them.

Contributed by H. V. PFEIFFER.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

$15.00 Cash in Prizes. Get Busy, Boys!!!

Here is your chance to win a cash prize for a few minutes' brain work. The big question now confronting every radio amateur is—"What can I do with my wireless apparatus?" To help the more than 400,000 loyal radio students and enthusiasts to apply their knowledge and, most important of all, to utilize their instruments for some practical electrical or communication purpose **other than wireless,** we shall pay two prizes—one of $10.00 and one of $5.00 respectively, for the best suggestion as to "what to do with your radio set during the war." Be brief; 100 to 200 words should tell your story. Remember—it's the "idea" that counts. Get busy at once, boys, as we want all suggestions in by July 25th, at the latest, so that the results can be announced in the September number of THE ELECTRICAL EXPERIMENTER. And don't forget we must have thoroly "practical" ideas. Address the Editor, Radio Problem Contest.



A GROUP OF REPRESENTATIVE AMERICAN AMATEUR RADIO STATIONS.

$3.00 Prize This Month Awarded to Amateur Radio Station of 8—Parker Wiggin, Kansas City, Kan. 1—William P. Aldrich, Westfield, Mass.; 2—Radio station of Orney Dunnum, Hannaford, N. D.; 3—N. W. Lockwood, East Orange, N. J.; 4—Lucas Tylekens, Jr., Kansas City, Mo.; 5—Walter Reimer, Milwaukee, Wis.; 6—Lester S. Fawcett, Independence, Iowa; 7—Ole B. Ritchey, Lake City, Mich.; 9—Lovell H. Cook, Mexico, N. Y.; 10—Henry W. Hall, Beeville, Tex.; 11—Otto Vandell, Brooklyn, N. Y.; 12—Hubert F. Jordan, Evanston, Ill.; 13—Palmer Reist, Dayton, O.

Some More Representative American Amateur Radio Stations.



ALL RADIO AMATEURS ATTENTION!

As all of you know the United States is now in a state of war with Germany, and as true-blood American citizens, we are, each and every one of us, duty bound to obey the mandates of the U. S. Government officials. The Navy Department has been delegated by our President to close all amateur or experimental radio stations, no matter whether equipt for transmitting or receiving, licensed or unlicensed, and therefore we shall all have to abide by this decree, whether we like it or not.

Therefore, beginning with the next issue of "THE ELECTRICAL EXPERIMENTER," we will endeavor to feature the **Electrical Laboratories** in preference to any radio stations in the awarding of the monthly prize of $3.00 in this department. Now is the time to get busy and freshen up your electrical apparatus, and incidentally improve your understanding of electrical matters, which perhaps you have unwittingly slighted to a large degree in your pursuit of radio-telegraphy. Let her go, boys!

14—Radio Station of Louis Falconi, Fort Stanton, N. Mex.; 15—Lessesne R. Allison, Statesville, N. C.; 16—Frank O. Walsh, Jr., Augusta, Ga.; 17—Geo. Anderson, Dorchester, Mass.; 18—James B. Armstrong, Ithaca, N. Y.; 19—L. C. Herndon, Portsmouth, Va.; 20—Allen B. Du Mont, Montclair, N. J.; 21—Morris Pollack, Chicago, Ill.; 22—H. Muyskins, Jr., Lynden, Wash.; 23—Geo. M. Bends, Utica, N. Y.; 24—Earl McClure, Van Wert, O.; 25—Butswick Brattland, Ada, Minn.; 26—Geo. E. Meldrum, Jr., Carrollton, Ill.; 27—Clyde R. Battin, Athens, Ohio.

THE MARVELS OF RADIO-ACTIVITY.

(*Continued from page* 171)

of the leaves being indicative of the amount of Radium in a certain amount of sample.

Rutherford showed that the discharging effect is due to the production of *ions* or *charged particles* of the gas thru which the radiations pass. In an electric field, positive ions travel to the negative electrode and vice versa; thus causing the discharge of an electrified body. If a sufficiently strong field is used, the ions are all swept to the electrodes without appreciable loss. The rate of discharge then reaches a maximum, which is not altered by an increased voltage, this maximum current being called the saturation current. The ions produced are in every way identical with those produced by X-rays. This phenomenon of *ionization* is the basis for the conductivity of gases caused by radioactive substances.

Radium

Radium has been definitely determined as an element, atomic weight 226.2 (Mme. Curie). It imparts a brilliant red color to a flame and red predominates in its flame spectrum. The production of Radium is in this country largely from the ore carnotite, an Uranium oxid, found in Colorado and Utah. The Radium is extracted by chemical means from the ore together with Barium, from which it is separated by fractional crystallization. The bromid salt of Radium is slightly less soluble than that of Barium, so on cooling a solution, crystals richer in Radium than in Barium separate out first. After six or eight successive operations, pure crystals of Radium bromid are obtained, which are then ready for the market.

The prominence attained by Radium is due more to its ease of production and the amount of easily secured ore than to any exceptional properties it possesses over many of the other radioactive elements.

Besides the radiations given off by Radium, there is produced in addition a gas, known as "emanation." This gas is about a hundred thousand times as active as Radium itself. When introduced into a glass tube it causes a bright glow. This glow increases to a brilliant illumination when substances which phosphoresce, as zinc sulfid, are put into a tube containing emanation. Fig. 2.

By means of this emanation a finer estimation of amounts of Radium than by the ordinary electroscopic method can be made. The emanation is driven off by boiling and conducted into a suitable electroscope and the rate of collapsing of the leaves noted as compared to a standard. Quantities of radium as small as .000,000,000,001 gram can be detected and determined. This emanation method is used to determine the amount of Radium in rocks and minerals.

Another method for quantitative measurements of small amounts of Radium, when not less than 1/100 of a milligram is present, is to place the tube containing the Radium some distance from a lead screen and measure the rate of discharge of an electroscope, as compared with the rate caused by a standard amount of radium similarly placed. The material being investigated must be at least a month old, in order that the emanation be in equilibrium with the Radium (due to decay and recovery, as explained later). This method is simple and direct, as the tube need not be opened nor the material weighed.

The radioactive substance, Actinium, also gives off an emanation, whose activity dies in a few seconds. Polonium likewise undergoes a series of changes, there being considerable evidence that the final product is *lead*. Polonium is much more active than Radium, but occurs in smaller quantities. Marckwald obtained three milligrams from fifteen tons of pitchblende residue. The amount of Polonium in a Radium mineral is 1/5000 of the amount of the Radium.

Another body, known as "Ionium," has been recently separated with similar radioactive properties. Ionium compounds are several thousand times as active as those of Uranium. The especial interest in Ionium is that its decomposition product is Radium, altho its period of transformation is much longer than that of Radium.

It has been found that Uranium, Ionium, Radium, Actinium, Thorium—all break down, some giving off emanation, into new substances which in turn break down again into others, and so on thru the series. This phenomenon is nothing more or less than a spontaneous commutation of matter.

Perhaps the ancient Alchemists' ideas were not entirely wrong!

(*To Be Continued*)

NIKOLA TESLA RECEIVES THE "EDISON MEDAL."

Nikola Tesla, the famous electrical wizard, who was awarded the seventh Edison medal on December 13, 1916, "for meritorious achievements in his early original work in polyphase and high-frequency electric currents," received the medal at a presentation made at the annual meeting of the American Institute of Electrical Engineers, on May 18.

The Edison Medal was established upon the initiative of a group of friends and associates of Thomas A. Edison, for the purpose of recounting and celebrating the achievements of a quarter of a century in the art of electric lighting, with which the name of Edison is imperishably identified. It was decided that the most effective means of accomplishing this object would be by the establishment of a gold medal, which should, during the centuries to come, serve as an honorable incentive to scientists, engineers and artisans to maintain by their works a high standard of accomplishment.

The Edison Medal was, therefore, established and endowed with a trust fund, under an indenture dated February 11, 1904, whereby the American Institute of Electrical Engineers agreed to award the medal annually. It is awarded each year by a committee consisting of 24 members of the Institute to a resident of the United States of America and its dependencies, or of the Dominion of Canada, "for meritorious achievement in electrical science or electrical engineering or the electrical arts."

B. A. Behrend said:—

"By an extraordinary coincidence, it is exactly twenty-nine years ago, to the very day and hour, that there stood before this Institute Nikola Tesla, and he read a description of his great discovery of the generation and utilization of polyphase alternating currents. He left nothing to be done for those who followed him. His paper contained the skeleton even of the mathematical theory.

"Three years later, in 1891, there was given the first great demonstration, by Swiss engineers, of the transmission of power at 30,000 volts from Lauffen to Frankfort by means of Mr. Tesla's system. A few years later this was followed by the development of the Cataract Construction Company, under the presidency of our member, Edward D. Adams, and with the aid of the engineers of the Westinghouse Company. It is interesting to recall here to-night that in Lord Kelvin's report to Mr. Adams, Lord Kelvin recommended the use of direct current for the development of power at Niagara Falls and for its transmission to Buffalo.



Nikola Tesla, Prince of Electrical Inventors, Who Was Recently Awarded the "Edison Medal."

"The basis for the theory of the operating characteristics of Mr. Tesla's rotating-field induction motor, so necessary to its practical development, was laid by the brilliant French savant Prof. André Blondel, and by Professor Kapp of Birmingham. It fell to my lot to complete their work and to co-ordinate—by means of the simple 'circle diagram'—the somewhat mysterious and complex experimental phenomena. As this was done twenty-one years ago, it is particularly pleasing to me, upon the coming of age of this now universally accepted theory—tried out by application to several million horse-power of machines operating in our great industries—to pay my tribute to the inventor of the motor and the system which have made possible the electric transmission of energy. His name marks an epoch in the advance of electrical science. From that work has sprung a revolution in the electrical art."

ELECTRIC RESISTANCE OF SELENIUM CELLS.

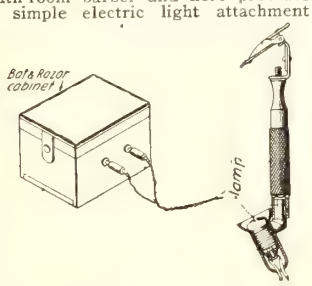
According to Professor H. Greinacher of Zurich, selenium cells of the original Shalford Bidwell type, which he studied together with Mr. C. W. Miller, behave with respect to alternating currents as they behave when exposed to light, and show polarity when traversed by continuous currents. Communicating his observations to the German Physical Society, Greinacher stated that the resistance of the selenium cell rose when direct current flowed in the dark, that this increase in resistance was different for positive and for negative currents and increased with the time, and that selenium cells acted in a certain sense like current rectifiers. These statements are questioned by Dr. Robert Furstenau of Berlin, who, in experimenting with hundreds of selenium cells with similar bridge arrangements as Greinacher, had never noticed any of these effects. Furstenau suggests that Greinacher's cells had been of peculiar kind. That selenium cells are very sensitive to moisture, and that the electrode material may have peculiar puzzling effects, is fairly well understood, and these features may explain some of the controversial statements made from time to time.

LATEST PATENTS

Electric Light for Razors

(No. 1,223,305; issued to Katherine E. Allport.)

At last an inventor has come to the rescue of the long-suffering bath-room barber and here provides a simple electric light attachment

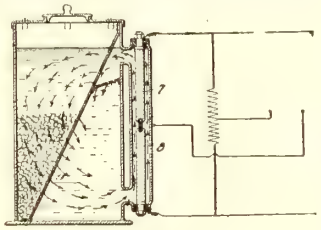


so that one may see at all times on any part of the face, which is usually difficult with the ordinary source of illumination, due to shadows. She also provides a neat combined razor and battery cabinet, the lower part containing a suitable dry battery, with a flexible cord to connect the miniature lamp with the battery. A new battery may be quickly placed in the cabinet by means of a sliding bottom. The device would seem of extreme value to all military and traveling men.

The Electrolytic Rectifier

(No. 1,223,114; issued to Charles C. Ruprecht.)

An improvement in the design of electrolytic rectifiers which conduces to the thoro circulation of the electrolyte solution, as the ar-

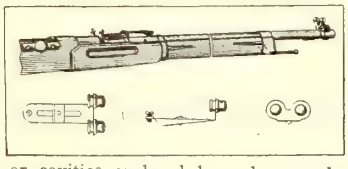


rows in diagram illustrate. The metal electrodes 7 and 8 are placed in a small chamber which communicates with the main circulating chamber thru two ports, the solution continually rising, due to heating, and passing thru the salts deposited in the lower part of the pocket formed by diagonal grid as indicated. The inventor claims that the solution will thus be kept saturated at all times and that heating is reduced to a minimum, with increased efficiency in consequence.

Night-Sight for Firearms

(No. 1,225,592; issued to Britannio Solaro.)

A clever invention of particular value at this time and involving the use of special back and fore-sights for rifles or other firearms, each sight being provided with chambers

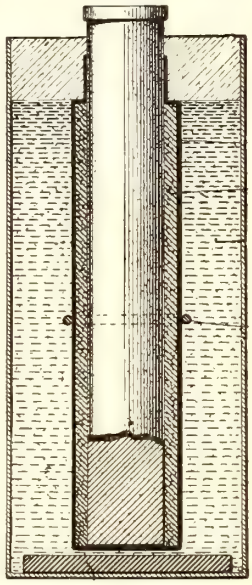


or cavities enclosed by a lens, and adapted to contain a salt of radium which will emit rays of light, these being concentrated as a spot of light by the lens in each case. When the back-sight and fore-sight are applied to a rifle, as shown, it becomes evident that the ordinary sights of the rifle will not be obstructed.

Galvanic Cell

(No. 1,221,062; issued to Morduch L. Kaplan.)

New design of miniature dry cell as used particularly for flash-lights. Use is made in this cell of a higher oxid of manganese, which apparently consists of manganese in two or more stages of oxidation, and in a peculiar form whereby extremely satisfactory depolarizing action is secured, and whereby it becomes possible to concentrate and compact finely-divided grafite or other suitable form of conducting carbon with such a quantity of the depolarizing

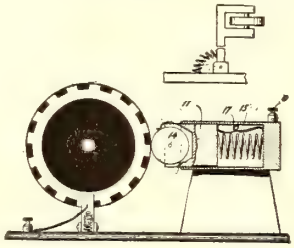


compound that long life of the cell is assured. The inventor has found that a lower oxid is desirable in combination with the higher oxid, to assure a novel and pronounced depolarizing action. He claims by this means a certain measure of transference of oxygen from the interior to the exterior of the cell, so that depolarizing efficiency does not depend merely on surface exposure, but also on the gross amount of the manganese compound.

Electric Interrupter

(No. 1,224,570; issued to Stuart Sandreuter.)

An electric interrupter intended

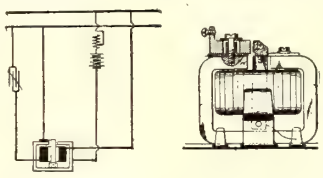


for low frequencies and comprising an insulating disc which carries a ring of conductive material provided with a plurality of radial extensions between which are mounted insulating strips or segments. The disc shaft may be driven by a motor or other device in order to rapidly rotate the same. Contact with the rapidly rotating segmented metal ring is effected thru a spring actuated rolling wheel. Connection is made with the segmented perifery of the rotating disc by means of a suitably proportioned metal wheel 14. This is pivoted in a sliding metal block 11, constantly pushed forward by a spiral spring 15, and connected with binding post 10 by flexible conductor 17.

Alternating Current Rectifier

(No. 1,221,981; issued to Thomas A. Edison.)

A simplified form of vibrating rectifier for charging storage batteries, etc. It involves a permanent

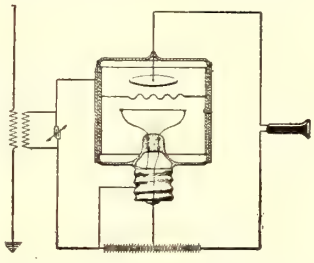


steel polarizing magnet, a set of vibrating reeds and an actuating magnet coil. The contacts on the vibrators and fixt electrodes are of special carbon to cut down arcing and sticking of contacts. By connecting the rectifying contacts in parallel a large current capacity is obtained; in series a relatively high potential current can be handled. The amplitude of movement of the vibratory contacts is small—about 10 thousandths of an inch.

Ionized-Chamber Device

(No. 1,222,916; issued to Clifford Dudley Babcock.)

A clever arrangement for ionized-chamber detectors or amplifiers of the de Forest type, and here shown in a de Forest radio receiving circuit. The inventor simplifies the construction and gains the advantage of having a finely adjustable variable condenser incorporated in the device itself, by means of two

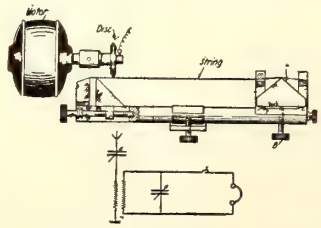


metal sleeves placed inside and outside of the tubular glass bulb. The inner sleeve supports the usual grid and is charged thru the glass dielectric from the outer sliding metal sleeve, connected in the circuit as shown.

Undamped Wave Receiver

(No. 1,224,343; issued to James O. Watkins.)

The "tikker" apparatus comprises a suitable base and upright members of small size, and which serve to support adjustably a metal wire or string. The tension of this string is adjustable by raising or lowering

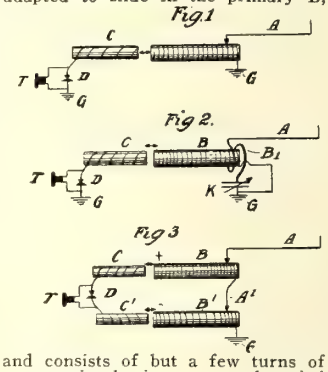


a pointed tension block A, by means of thumb screw B. The string is vibrated at radio frequency by means of a smooth-edged disc mounted on the shaft of a motor.

Radio-Telegraph Receptor

(No. 1,224,499; issued to Greenleaf Whittier Pickard.)

An improved method of receiving radio-telegraphic or telephonic signals wherein (Fig. 1) the secondary coil C has only one side connected to the receiving apparatus D-T, which may be grounded. Fig. 2 shows a like arrangement except that the coupling between aerial A and primary B is made inductively. Fig. 3 is similar to Fig. 1, except that two primaries B and B1 are used. T may be a telephone receiver, and D a crystal rectifying detector. Coil B is of sufficient length to cause its natural period to be equal to the shortest desired wave length. The secondary C, is adapted to slide in the primary B,

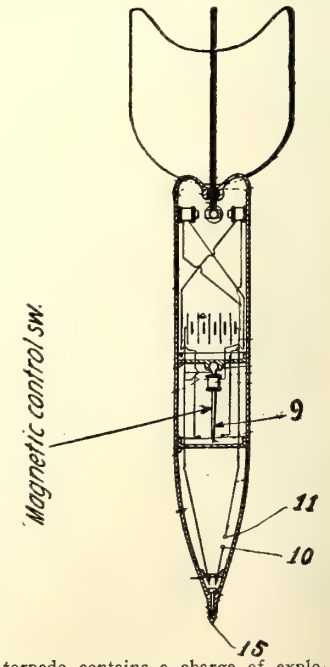


and consists of but a few turns of coarse wire having a natural period much smaller than the shortest desired wave length.

Aerial Torpedo Steering Device

(No. 1,222,630; issued to Lemuel John Husted.)

A unique idea involving the use of "magnetic attraction" to actuate a special rudder control switch so as to cause an aerial torpedo or similar projectile to unfailingly reach its target when the latter is composed of a steel or iron shell structure. The lower part of the



torpedo contains a charge of explosives to be detonated by an electric fuse 10-11, operated by switch 15, when the missile strikes its target.

The inventor provides an "attraction" electro-magnet 9, suspended to swing in any direction.

COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c EACH

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Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for the entire universe.

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No. $\left(\frac{\text{M. I. L. K.}^{\circ}}{H_2O}\right)$

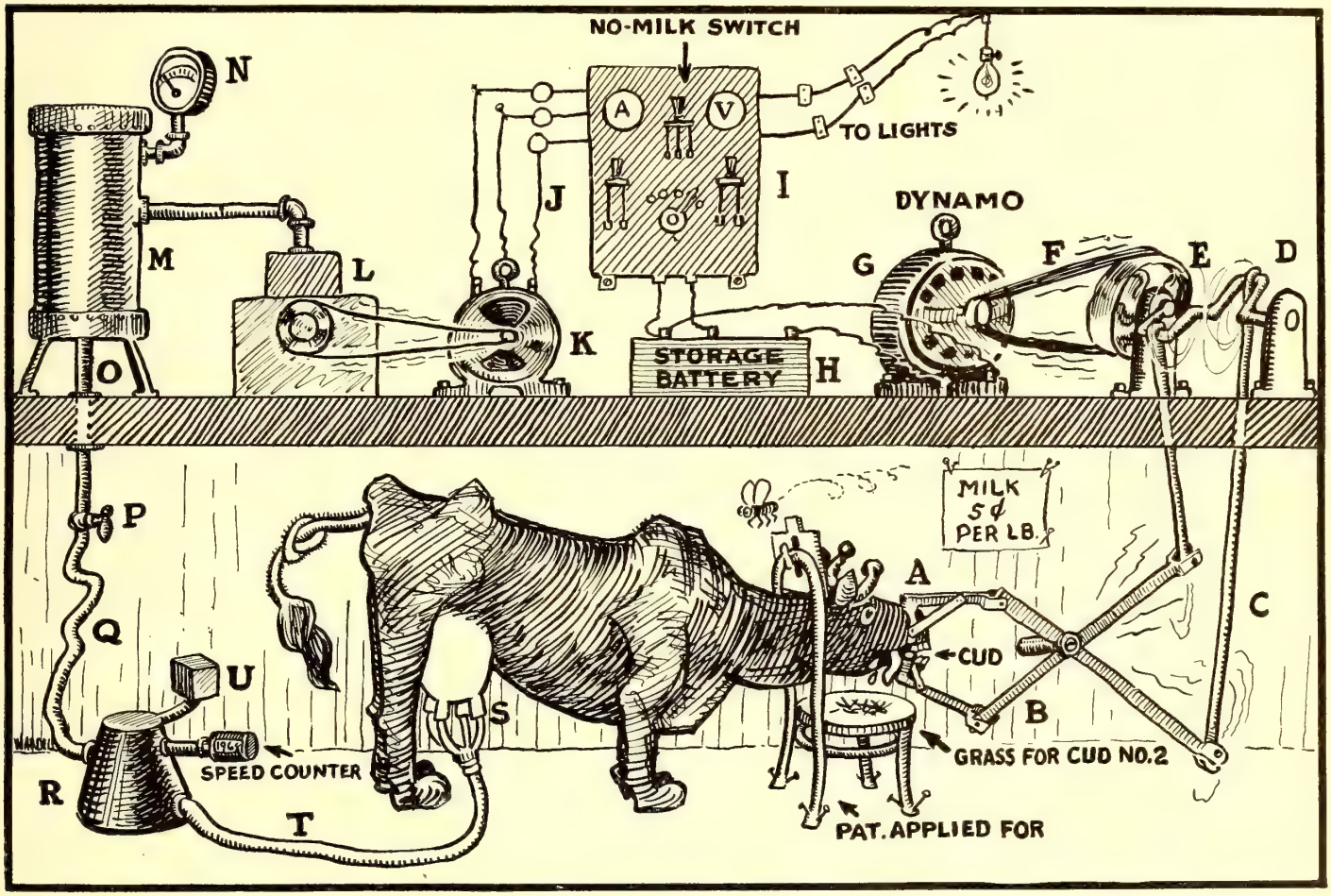
Lapup Cowjuce of Milkshake, N. D.

Patent Appraised

CUDOMOTOR

To Whome It May Constern:

Be it appraised to all cows, calves, dairymen, dairymaids, dairyouths, dairywomens, and all others interested in the lacto industry, that I, Lapup Cowjuce of the City of Milkshake, in the State of Nervous Depression, have at the risk of my decaying sanity, invented and designed a world-upheaving device, whereby it is made possible at last for cows to milk themselves, automatically without cost or expense.



"... I, Lapup Cowjuce of the City of Milkshake, N. D., Have at the Risk of My Decaying Sanity, Invented and Designed a World-Upheaving Device, Whereby It Is Made Possible At Last for Cows to Milk Themselves Automatically By the Surplus 'Cow-Power' Developed By Their Constant Cud-Chewing."

As is universally known among cows and dairypeople, cows continually "chew their cud." Here we have a constant form of energy, which has been calculated to represent about 9¾ cow-power per day. It has also been calculated that the cow to chew the cud efficiently only requires 5¾ cow-power. This leaves a net wastage of 4 C.P. per day. This totally wasted energy I have now at last harnest, in as simple as it is efficient manner. Not only do I use this energy to milk the cow itself, but I use it also to light the house, run the butterchurner as well as the buttermilker.

First the cow is secured properly to a simple mechanism to keep her from backing away (patent applied for). To her jaws are now attached jaw clamps A. These in turn are attached to a scissor-mechanism B, pivoted on silk ball-bearings as shown. It becomes apparent that as the cow chews, the scissor mechanism is given a reciprocating movement. This motion is transmitted thru lateral zinc rods C, connected in turn to brass cranks D. By means of soft rubber pulley E, the wooden belt F now transmits the resulting energy to the selenium pulley of Dynamo G. This latter on account of the oscillatory moving jaws of the cow, generates an oscillating alternating current, which then charges the alternating current storage battery H. This resulting current oscillates thru the Tungsten switchboard I, and thence thru the connecting platinum cables J. The current then drives the bashful motor K which now operates the anaemic hot-air compressor L. The resulting comprest and perfumed air is then stored free of charge in the leather tank M. Hot wire ammeter N is used to observe too high a temperature. The air is now conveyed thru glass pipe O, thru Galena stop-cock P, thence thru flexible cast iron supply pipe Q. Galena is used on the stop-cock because it is very sensitive. The oscillating air next flirts into the quartz pulsator U, from which it escapes to liberty. This creates a pulsating vacuum in the scanatory Bakelite milk can R. But as the latter is connected by means of a flexible hard-rubber tube T, to the cow's teats, by means of teat-cups (not tea-cups) it follows that the milk is drawn rapidly into the can R.

What I claim is:

1st—An automatic cow-milk dispenser, dispensing with all milkmaids.

2nd—A cow-milker operated by the cow's own cud-chewing.

3rd—A motor attachable on all ruminators and other rummies.

In memoriam henceforth and hencewith I have therefore caused and by these presents do hereby depose upon this legal instrument my south-western uppermost backhoof, this 3rd day of our Grace, in the 149th year of the French Revolution.

Fitnesses:
A. Heluvaguy,
A. W. Dryup,
S. O. Mecrust.

LAPUP COWJUCE,
By his attorney:
LEONARD SARVER,
Enid, Okla

QUESTION BOX

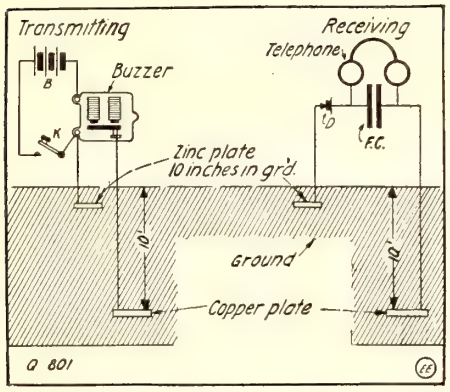
This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink; no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the question entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

BUZZER TELEGRAPH SYSTEM.

(801.) O. M. Warren, Detroit, Mich., asks:

Q. 1. Would it be possible to use the following scheme to telegraph a distance of a block or two?



An Effective "Buzzer" Telegraph System Which Employs Two "Ground" Plates at Each Station, Each Plate Buried at a Different Level. A Radio Detector, Fixt Condenser and Telephone Receiver Are Used at the Receiving Station.

A. 1. Yes. You will have no trouble in transmitting considerably more than the distance you mention.

Q. 2. If possible would a tuning coil or loose coupler connected in the receiving circuit improve it?

A. 2. A tuning coil or loose coupler should not be used with this system, as it is impossible to tune any distant signal with this ground telegraph system, speaking generally.

ADHESION PHENOMENON.

(802.) Betram Wertheim, N. Y., writes us:

Q. 1. Whenever, after typing carbon copies, I find that a strange phenomenon occurs. The papers, including the carbons, are charged with static electricity and they all adhere to each other. The most peculiar thing about this phenomenon is that all the papers seem neither to be charged negatively or positively, but neutrally. No matter how I change their positions to each other, they always attract. I therefore come to the conclusion that they must be charged neutrally, or by some new form of static electricity.

A. 1. The peculiar phenomenon which you have observed with the paper sheets is due directly to the adhesion properties of air when it comes in contact with paper and when the papers are separated, they stick to each other. A similar experiment can be demonstrated by placing a sheet of paper on a flat table and quickly lifting it up; you will observe that the paper will tend to stick to the table. This is due to the adhesion properties of air; also a partial vacuum is usually created. There is nothing electric about it.

OXYBENZYLMETHYLENGLY-COLANHYDRIDE.

(803.) Harold Betts, Sacramento, Cal., wishes to know:

Q. 1. What is the chemical symbol for "Oxybenzylmethylenglycolanhydride" (Bakelite)?

A. 1. At the present time there is no chemical symbol to the Bakelite as the chemical decomposition of phenol, which is the ingredient used in the making of this compound is still a puzzle to the modern chemist. It is one of the most difficult problems of the chemist to obtain the symbol of an organic compound, and Bakelite is one of these.

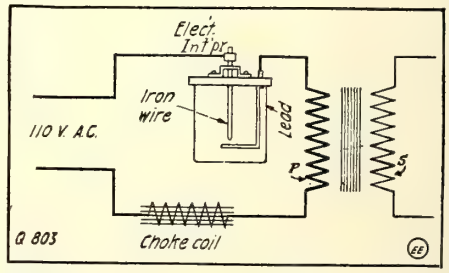
Q. 2. Which is the best, an aerial of two wires fifty feet long, or an aerial of one wire one hundred feet long? Why?

A. 2. As to whether the antenna is to be used for receiving or transmitting, the two wires 50 feet long are better for the latter purpose, as the antenna must have as much capacity as possible in order to obtain the maximum efficiency therefrom, and when combining the two conductors, the capacity is increased. A single wire 100 feet long is desirable for receiving purposes, as the capacity of such antenna is uniformly distributed and at the same time the inductance is increased, which permits finer tuning of received signals.

Q. 3. Is it possible to make an electrolytic interrupter for a spark coil operating on 110 volts A. C., and if so, how?

A. 3. Yes. An electrolytic interrupter for this purpose can be made by placing a lead electrode in a container and adding a solution composed of one part of sulfuric acid and nine parts of water. A second electrode, made of small diameter iron wire is placed perpendicularly to the first electrode, as shown, taking care that they do not touch each other. It is preferable to enclose the iron wire or electrode of smaller surface within a porcelain tube having a small orifice at the lower end, which will just pass the wire. With the iron wire relatively very small as compared to the surface of the lead electrode, and with the applied potential and current critically adjusted, as well as the inductance and capacity of the circuit properly balanced, an interruption action can be effected.

The interrupter is then connected in the usual way and the wiring diagram herewith gives the proper connections. The choke coil which is connected in the primary circuit should consist of an iron wire core one inch in diameter and 12 inches long. Two layers of No. 14 D.C.C.-magnet wire are wound on it. This coil should invariably be used, as considerable trouble is encountered in running electrolytic interrupters on alternating current.



Simple Electrolytic Interrupter for Use on Alternating Current Circuits with Spark Coils or Open Core Transformers.

AUDION CIRCUIT QUERY.

(804.) Oscar F. Miller, Milwaukee, Wis., says:

Q. 1. I have a receiving apparatus composed of the following:—Audion detector, 4,500 meter loose coupler, 6 volt—60 amp. hour storage battery, Brandes' 'phones, an aerial 150 ft. long, 4 wires, which gave very poor results. The Audion (de Forest tubular type) has been tested and is O.K. I am sending a diagram of my set. Kindly advise me what you think my trouble is.

A. 1. The trouble is with your wiring

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As to what to photograph: Well that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 *to* 150 *words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.*

To give some idea of the freak photos we like—refer to page 188.

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, *233 Fulton Street, New York City.*

diagram, and the only way to remedy it is to connect the filament terminal with one leg of the secondary of the coupler, and disconnecting the "B" battery terminal with the leg of the secondary, as you have it at present.

BOOKS.

(805.) H. H. Bales, Halifax, N. F., wants:

Q. 1. The prices of the following text books: "Alternating Current Electricity and Its Applications to Industry"—By W. H. Timbie and H. H. Higbie, 729 pages, Second Course, 1916. Also "Practical Electricity." Latest edition, published by the Cleveland Armature Works.

A. 1. The price of "Alternating Current Electricity and Its Applications to Industry," is $3.00, and "Practical Electricity" is worth $2.00. These books, as well as any others, can be obtained thru our "Book Department," by sending amounts stated.

TELEPHONE MAGNETS.

(806.) A Reader, Otsego, Michigan, wishes to know:

Q. 1. How can I magnetize telephone magneto magnets?

A. 1. The magneto magnets can be re-magnetized by employing an electro-magnet consisting of two poles; the distance between these poles should correspond to the distance between the magneto magnet poles. By passing a current thru the electro-magnet and holding the same against the poles of the steel magneto magnet, so as to permit the magnetism to flow into the poles of the permanent magnet, the latter will be revitalized. The N. pole of the electro-magnet should be placed against the S. pole of the magneto-magnet.

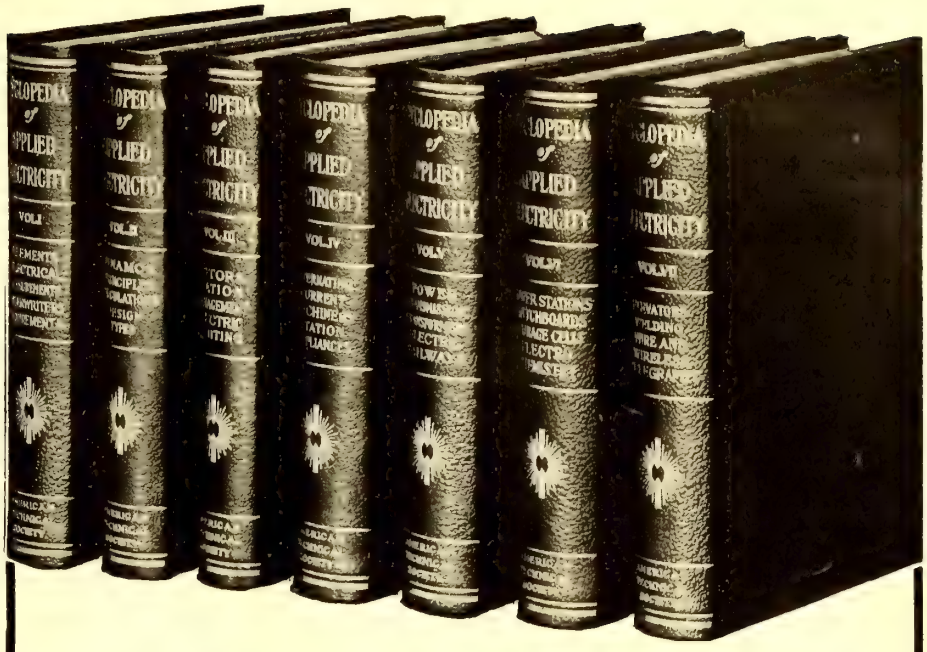
Q. 2. What is the approximate voltage of my telephone magneto and also the amperage? It is a two-bar double magnet type.

A. 2. It is impossible for us to give you the voltage and amperage developed by your magneto, as the required data such as speed of armature, number of conductors on the armature and the flux density is not given; we are thus unable to answer your query and if you will enlighten us on the above-mentioned points, we will be pleased to help you out in this respect. Telephone magnetos as a rule develop between 200 and 300 volts A. C. The amperage is about 1/10 to 1/8.

Q. 3. My radio receiving set consists of a twenty-seven hundred meter tuner, single slide, and a six-hundred meter tuner used as *loader*. I have a silicon detector, fixt condenser and 1,000 ohm receiver. My aerial was a "T" type and comprised a single "Antenium" wire with lead-in 75 ft. long. Ground of iron pipe driven into hard clay. I never heard anything but static; can you tell me what the cause of this is? I have never heard a signal. If it is some minor trouble and if I remedied it, could I receive Arlington and N.A.R. (Key West), with it?

A. 3. The trouble is undoubtedly with your *ground*, and this can be remedied by placing a copper sheet about 6 feet square in the ground. This should be placed 10, or even 15 feet deep, in the earth, covering the same with pulverized charcoal and impregnating the total mass with salt water, which will improve the ground conductivity considerably.

In regard to the reception of Arlington time signals with your present equipment, we are very much in doubt as to whether it can be done, but by the employment of an Audion detector, a variable condenser shunted across the secondary of the inductive coupler and a pair of 2,000 ohm 'phones, you should have no trouble



All About Electricity

Anything you want to know about electricity can be found in these seven thick volumes. Every line is written in plain language—language that everyone can understand. The 1916 edition—**just off the press**—covers the generation and use of electricity for power, light, transportation and communication, including the construction and operation of dynamos and motors. Also covers central station engineering and telephone work, as well as **wireless telegraphy and telephony** and land and submarine telegraphy. Valuable alike to the electrical experimenter, experienced electrician and electrical engineer.

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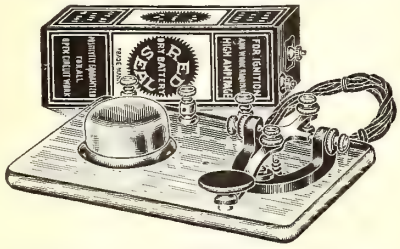
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Mesco Wireless Practice Set

For Learning the Wireless Code



The Practice Set comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

The key and buzzer are mounted on a highly finished wood base, and three nickel plated binding posts are so connected that the set may be used for five different purposes, as illustrated on page 24.

For the beginner, the set is of exceptional value, for it may be used for individual code practice or for operation of a two party line, which is an excellent method of quickly learning the code. After the beginner has mastered the code, the set may be used in his wireless outfit for setting the detector in adjustment, and also the key may be used to control the spark coil.

Recommended for schools, as it gives excellent service for class instruction in code work. Full directions with each set.

The main object of the set is to enable the beginner to master the wireless code, and the buzzer reproduces the sound of the signals of the most modern wireless stations perfectly.

Every beginner needs one of these sets, and as it is the equivalent of five different sets, the price is very low.

List No.		Price.
342.	Wireless Practice Set, with Battery and Cord	$2.25
344.	Wireless Practice Set only, no battery or Cord	2.00

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STROMBERG - CARLSON RADIO HEAD SET $8.25

Stromberg - Carlson Telephone Mfg. Co.
Rochester, N. Y.

in receiving Arlington or N.A.R. But bear in mind that during the war, no wireless outfits can be operated by anyone.

WIRELESS TELEPHONE CONNECTION.

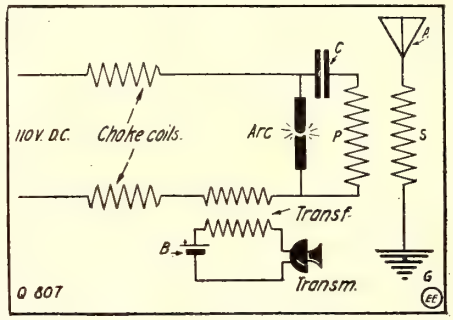
(807.) Ivan Bulock, Fairmont, Minn., writes:

Q. 1. Which is the best way to connect an ordinary carbon grain transmitter on 110-volt., 6 amp. d.c., for wireless telephony?

A. 1. The accompanying wiring diagram shows the best way of connecting such a transmitter.

Q. 2. Could an ordinary one-inch spark coil be used as a transformer for wireless telephony?

A. 2. No. The current obtained from the secondary of a one-inch spark coil is so small that it does not warrant its use.



Hook-Up for Wireless Telephone Arc Circuit with Microphone Inductively Connected to Control Oscillations.

WHAT IS SYNCHRONISM?

(809.) H. Somerfelt, Butte, Mont., asks:

Q. 1. What is meant by synchronism?

A. 1. This term may be defined as the simultaneous occurrence of any two events. Thus two alternating currents are said to be in synchronism when they have the same frequency and are in phase.

Q. 2. For what service are the 25-cycle and 60-cycle currents adapted?

A. 2. The 25-cycle frequency is used for conversion to direct currents, for alternating current railways, and for machines of large size; the 60-cycle frequency is used for general distribution for lighting and power.

Q. 3. How must an alternator be constructed to generate two-phase current?

A. 3. It must have two independent windings, and these must be so spaced out that when the E.M.F. generated in one of the two phases is at a maximum, the E.M.F. generated in the other is at zero, *i. e.*, they are 90 degrees apart, vectorially speaking.

SOLDERING QUERIES.

(810.) Paul Johnson, Poughkeepsie, N. Y., wants to know:

Q. 1. What is *hard solder?*

A. 1. An alloy composed of copper and zinc, or copper, zinc and silver. Hard

(*Continued on page* 213)

BACK TO THE DAYS OF VOLTA.

(*Continued from page* 172)

Volta was one of the most prolific inventors of all times. He invented a greater amount of basic electric apparatus than any other living scientist with the exception of Faraday. In Fig. 3, at the left is shown a clever apparatus which when energized by static electricity produces imitation hail. Fig. 3 (at right) shows his apparatus for exploding a mixture of oxygen and hydrogen by means of an electric spark.

LIGHTNING—HOW TO PROTECT YOURSELF FROM IT.

(*Continued from page* 175)

are *dry*. But let the hand be wet with water or with perspiration, or let the person stand on damp floor or ground, then enough current may pass thru the heart to paralyze it, and death will occur suddenly. Most fatalities from industrial currents come from those at 500 volts to 5,000 volts pressure. People who have received shocks from a 10,000 volt current have lived.

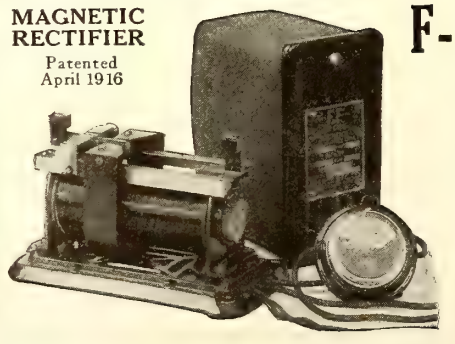
At low voltages the alternating current is three to four times as dangerous as the direct current, but at high voltages the direct current is the more dangerous. It is safe to pass a current at several hundred thousand volts pressure thru the body if there are over 10,000 alternations per second. Three-tenths of an ampere causes death at low rate of alternations but three amperes can safely be taken if the alternations are half a million per second. With wet hands and feet the resistance of the human body may be from 1,000 to 1,500 ohms. This is not much of a resistance for the lightning at its greatest pressure to overcome. A person standing isolated on moist soil makes an attractive target for the lightning.

There is a superstition that *lightning figures,* found on the skin of a person struck by lightning, are mysterious photographic reproductions of trees, landscapes or objects in the neighborhood at the time the person was struck. But the various figures produced doubtless show the distribution of the high potential electricity in passing along a poor conductor and the consequent burning along a ramifying path.

The telephone instruments and users to a large extent are protected by use of a device—*the lightning arrester.* This consists of a ground wire coming close to the telephone wire but not quite touching it. The gap between is enough to prevent the current used in telephoning from passing across to the ground, but when the wire receives a high charge from lightning, the potential is so high that the charge easily jumps across the gap and passes to the ground instead of passing thru the instrument and finding some other passage to the earth. You will observe that telephones properly installed in your homes are not placed where a person in using them could at the same time make contact with a register, radiator, or water-pipe.—"G. S. Q."

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QUESTION BOX.

(*Continued from page 212*)

solder is sometimes erroneously called *spelter*.

Q. 2. What necessary relation must exist between solder and the metals with which it is to unite?

A. 2. The solder must have a lower melting point than the metals to be joined to it. The melting point should approach as nearly as possible that of the metals to be joined, so that a more tenacious joint is effected.

Q. 3. What does *soft solder* consist of and for what purpose is it best adapted?

A. 3. There are two classes of soft solders, viz., common or plumber's, and medium or fine. These consist chiefly of tin and lead, altho other metals are occasionally added to lower the melting point. Those containing the most lead are the cheapest and have the highest melting point. Common or plumber's solder consists of one part of tin or two parts of lead, and melts at 441° Fah. It is used by plumbers for ordinary work, and occasionally for electrical work where wiped joints are required; for instance, in large lead-covered cable work. Medium or fine solder consists of equal parts of tin and lead, or half and half, and melts at 370° Fah. This solder is used for soldering joints in copper conductors, and for soldering lead sleeves and lead-covered wires.

ELECTRO-THERAPEUTICS.

(811.) Thomas Holdstern, Little Creek, Mich., asks:

Q. 1. What is the true definition of the term "electro-therapeutics"?

A. 1. The term electro-therapeutics is defined as the treatment of disease by electricity; it embraces the laws, principles and doctrines of such treatment. Electricity is of special value in the treatment of various forms of nerve tension. The kinds of electricity used may be classed as follows:

1. So-called static, generated by Wimshurst machines.

2. Current, which is derived from two sources, namely, primary batteries, which current is technically called galvanic current and second the faradic currents (produced by secondary induction coils).

3. Radiant energy, which is generated by radio-active substances such as radium and radium ores, and X-rays. We may also add the curative powers of radiant energy generated by our distant sun.

Q. 2. What is meant by an interrupterless transformer as used in X-ray work?

A. 2. This is nothing more than a high-tension rectifier which converts the high-tension alternating current generated by the transformer into a uni-directional current which is fed to the X-ray tube. This rectifier is a four-electrode wheel rotating on the shaft of a synchronous motor, and the direct current is obtained from two fixt electrodes stationed near the revolving disc.

GOVERNMENT INSTALLS LAMPS TO PROTECT OHIO RIVER BRIDGES.

The Federal Government has purchased ten searchlights for use in illuminating approaches to the bridges over the Ohio River at Louisville, Ky., all of which are under guard. Another of the same lamps has been installed on the roof of the City Hall in Louisville and is used to illuminate the flag at night.



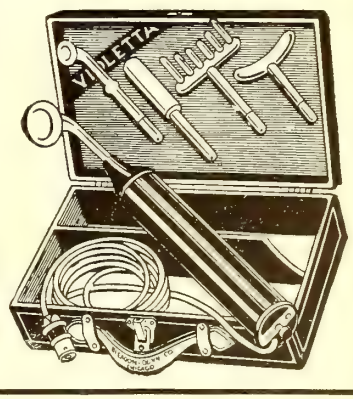


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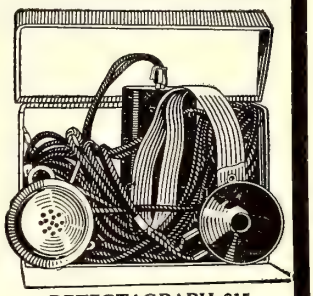
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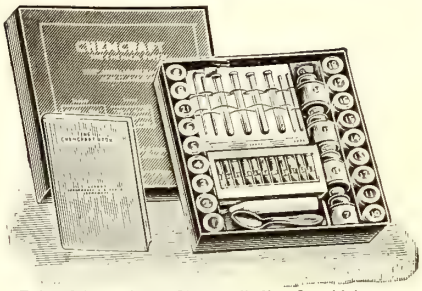
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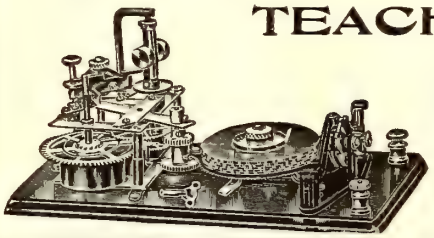
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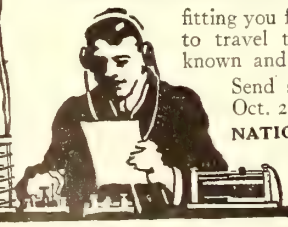
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THE U. S. SIGNAL CORPS WANTS YOU!

(*Continued from page* 179)

providing the men show ability and qualify."

The following information is publisht to answer, in general, inquiries regarding the Signal Enlisted Reserve Corps. The Enlisted Reserve Corps is authorized by section 55 of the National Defense Act, approved June 3, 1916, the purpose or object being to secure an additional reserve of enlisted men that could be brought to the aid of the Government in time of national crisis. Applicants must be citizens of the United States or have declared their intention to become such, and must be between the ages of 18 and 45 years.

The responsibilities assumed by men enlisted in the Reserve Corps are as follows:—They are subject, in time of peace, to duty in instruction camps or elsewhere, for fifteen days each year. They are subject to order to duty by the President whenever war is actual or imminent.

The benefits conferred are:—Opportunity to render their most effective service to their country in time of war; opportunity to prepare for that work beforehand by study and instruction; rank in the Army of the United States and corresponding pay while on duty; the right to wear a distinctive "rosette" or "knot" with *civilian* clothing.

Enlisted men of the Reserve Corps will be assembled in summer camps for fifteen days' instruction each year, so far as appropriations granted by Congress will permit. Transportation to and from these camps is furnished by the Government, also commutation of subsistence at the rate of 50 cents per meal during the journeys. While at the camps subsistence is furnished by the Government. Uniforms and equipment are also provided by the Government for use while attending the camps of instruction. Reservists are entitled to pay at the rate of their respective grades in the Regular Army during active service, including the time required for actual travel from their homes to the places to which ordered and return to their homes.

The grades and monthly pay of enlisted men of the Signal Reserve Corps, according to the new schedule, are as follows:—

Master signal electrician	$81.00
Sergeant, first class	51.00
Sergeant	44.00
Corporal	36.00
Horseshoer	38.00
Cook	38.00
Private, first class	33.00
Private	30.00

The following are the general qualifications requisite for enlistment in the Signal Enlisted Reserve Corps:

A. MASTER SIGNAL ELECTRICIAN. The applicant must be—

(a) An expert telegrapher and have knowledge of the construction, operation, and maintenance of telegraph systems, primary and secondary batteries, and motor generators, or—

(b) An expert radio operator and have knowledge of radio apparatus.

(c) Have knowledge of the construction, operation and maintenance of telephone systems, switchboards, location of troubles, repairs, primary and secondary batteries, motor generators, or—

(d) Possess such qualities as would fit him to act as senior non-commissioned officer of a company of Signal troops, to act as a leader.

B. SERGEANT, 1ST CLASS. The applicant must be—

(a) **An expert telegrapher and have knowledge of the operation and maintenance of telegraph systems and batteries, or—**

(b) **An expert radio operator and have knowledge of radio apparatus, or—**

(c) **Have knowledge of telephone systems, switchboards, batteries, locating and correcting faults, etc., or—**

(d) **Possess such qualities as would fit him to act as leader of a platoon of a company of Signal troops.**

C. SERGEANTS AND CORPORALS. The applicant must have general knowledge of the subjects given under B, or possess such qualities as would fit him to act as a leader of a platoon or section of a company of Signal troops.

D. PRIVATE, 1ST CLASS AND PRIVATE. The applicant must show an interest in the subjects mentioned, be competent, keen, and possess such qualities as will insure that he will develop along the proper lines in training.

Applicants for enlistment as Master Signal Electricians and Sergeants, First Class, will be given an oral examination. Applicants for enlistment in the other grades will demonstrate to the officer designated to obtain recruits that they have the necessary qualifications. Applicants for enlistment in the Eastern Department should present themselves at 39 Whitehall St. (near the Battery), New York City.

LOCATING AND DESTROYING SUBMARINES WITH A RED LIGHT RAY.

(*Continued from page* 165)

right angles to our course and she is thus in a position, broadside, to an observer from our vessel; that is, the submarine is presenting the greatest surface of her hull to us and is in the most favorable position for the visibility from our vessel, if she can be rendered so by any means.

A searchlight operated from aloft on our ship has two defects which prevent it from being sucessfully used for this purpose as a submarine detector.

A submarine ready to fire a torpedo is submerged to a depth of some fifteen or twenty feet. A searchlight played over the water from aloft must not only find the horizontal angle of the submarine but the vertical angle as well, the area being too great to admit accomplishment of this object.

Moreover, the ray of light when striking the water, passing from a light medium (air) to the denser medium of water causes a glare, due to the refraction which forms an opaque cloud to the observer, obscuring everything beyond it.

There is too much daylight for the searchlight to be practical during the day, the time when attacks are made by submarines.

However, if we submerge our searchlight or, rather, its ray of light to a depth of fifteen feet by installing the searchlight in the vessel at this depth below the waterline, and flash a powerful beam of light, *red in color* thru a thick lens of glass in the ship's side and out into the water, we obtain several distinct advantages over the searchlight operated from aloft.

It is only necessary to revolve this light thru an approximate angle of 90 degrees on either side of the vessel to bring a lurking submarine into its path, for the ray is already in the proper horizontal plane beneath the surface of the water.

It is operating only in one medium, water, and the opaque glow is not formed. Its color in contrast to the green sea enables it to be seen in bright daylight as a slender reddish path extending some *two miles* out into the ocean just beneath the surface of the water.

An observer with a powerful telescope is stationed aloft, whose duty it is to observe vigilantly this tract of crimson as it sweeps slowly back and forth abreast of the ship.

Suddenly he presses a button, instantly arresting the revolution of the beam of light, for he has noted that the ray of light does not extend to its ordinary limit, while there is a glare of blurred light forming what may be termed a "bulge" in its path and he realizes instantly that the beam of light has encountered a non-transparent body which is refracting the ray.

The alarm is sounded and the gun battery trained on the spot indicated. One or two shots will destroy the menace and the vessel may divert her course to clear it.

All that is necessary to insure the success of this method is the perfection of a searchlight of sufficient power and an experienced observer.

The public may confidently anticipate the rapid development of this system of defence, which will prove not only a mortal blow to the submarine but a benefaction to all humanity. The device here described is easily adaptable to either naval or commercial ships and a vessel may conveniently carry four search-lights of this type—two forward and two aft; one on either side of the hull in both positions.

DOES RADIANT LIGHT POSSESS WEIGHT?

(*Continued from page* 168)

mysteries. Briefly, he allowed a beam of light to fall on a suspended disc in a vacuum bulb, exhausted to the highest degree. In such a vacuum the disc was repelled on the impact of a light beam, and its repulsion was measured by its torsional effect on the suspending wire. This light-pressure at the distance of the earth from the sun is small, not quite a milligram per square metre of the earth's surface, or roughly, 70,000 *tons on the whole earth.* The light-pressure is applied only on the surface, and is proportional to the surface, while weight, or the pull of gravitation, affects the whole body. The adherents to the electro-magnetic wave theory of light have some difficulty in explaining this pressure, as it seems impossible to conceive of a mere wave-form in the ether exerting a material force or pressure on the earth. If light were considered a material substance, however, the above phenomenon could be more plausibly explained, as due to the effect of gravitation on a tangible substance.

There are many interesting facts to be obtained on the chemical and physical effects of light, and in respect to this side of the problem there are many opportunities for research work, which might result in the solution of the mystery as to the nature of light. Below are given a very few of the instances in which the elements are acted upon by the strange force of light: (1) Nitric acid is readily decomposed by light. (2) Silver chlorid, silver iodid and silver bromid are all chemically changed on exposure to light. (3) Silver nitrat in the presence of organic matter, looses its oxygen and is reduced to the metallic state by the action of light. (4) Mercuric oxid is decomposed by light. (5) The chlorids



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..Constipation	..Stoop Shoulders	..Great Strength
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and iodids of mercury and thallium are decomposed by light. (6) Upon heating nitrogen chlorid and nitrogen bromid in sunlight, the mixture explodes with violence. (7) A balloon containing hydrogen and chlorin will burst when exposed to the sun's rays. (8) Selenium lowers its electrical resistance when exposed to light. (9) In the Crooke's Radiometer the pressure of light causes a multi-blade vane or wheel to rotate in a vacuum.

It will be noticed in the cases cited above that the group of elements known as the *Halogens,* particularly the *silver salts,* are affected by the action of light, which acts in most instances like a reducing agent. Why the silver salts are singled out from all the other compounds and made an object of attack by the force of light is difficult to explain by the ether-wave theory. But if light were taken to be a gas, the above phenomenon would be more easily understood by the simple fact that light is then a reducing agent. The *light-gas* theory must thus assume that light possesses properties similar to other gases, such as chemical affinity, a definite valency, or possessing the power of a catalytic agent. Such properties appear to be consistent within the chemical effects of light as shown above.

As is well known, the element Selenium possesses the peculiar property of changing (lowering) its electrical resistance according to the intensity of the light cast upon it, and this strange phenomenon has been a strong argument against the wave theory, as it is almost impossible to conceive of the so-called ether waves producing such a tangible, material effect. Several theories have been advanced to explain this behavior of light. One is the formation of conducting selenids under the action of light. Another, the formation of conducting crystals. Still another, that it is due to electrolytic action and finally the electronic theory which assumes the releasing of negative electrons, due to vibratary resonance in the atoms.

Again, it has been demonstrated that light has a strong effect on bacteria, such as ferments. At the Paris Exhibition in 1900, the powerful results of light were forcefully illustrated by the culture of pathogenic bacteria in gelatin in glass bottles. Portions of the bottles were covered with dark paper, the bottles incubated at suitable temperatures in bright sun-light and the contents afterwards completely sterilized. Wherever the dark paper had prevented light action, dense colonies of bacteria could be seen, while in exposed parts the nutrient gelatin remained perfectly clear. Here again, light acts as a gas, for it can be easily shown that several gases such as oxygen, exert an influence on the growth of bacteria. Only a strong imagination could attribute these results to wave forms in the ether, it would seem.

In concluding, it may be well to take up the question of the speed of light and its relation to any of the accepted theories. The speed of light has been definitely accepted and proven as 186,000 miles per second, and this tremendous velocity has been for years a strong objection to the *corpuscular* or *material* theory, as it was unbelievable that any material form of matter could attain such terrific velocity. Of late years, however, there has been much progress made in the study and behavior of X-rays and radium emanations; and it has been conclusively proven by means of mathematics that the speed of the corpuscles emitted by metals under the impact of ultra-violet light, may be taken as anywhere from 10,000 *to* 90,000 *miles per second;* and it may also be stated that these corpuscles are *material* atoms of matter for their individual *weights* have been actually determined by mathematics.

In regards to the Alpha, Beta and Gamma-rays emitted by radium, it has been conclusively proven that the Alpha rays are streams of little bodies (matter) with a mass about twice the mass of the hydrogen atoms, flying off from radium with a velocity of 20,000 miles per second, while the Beta-rays given off by this innocent-looking little pinch of salt, are actual *material* corpuscles, with a known weight, and a speed of over 100,000 *miles per second.* This is now regarded as an established fact, and such being the truth, it is much easier to believe that a gas, such as light may be, could attain a velocity of 186,000 miles per second, and still be within the bounds of material matter.

As will be noticed, it was the author's object to present a few arguments in favor of the material theory, and altho this theory has not come into general acceptance by scientists, it is gradually gaining ground, and from the researches being made on radium emanations and all forms of radio-activity, it appears that the electro-magnetic-wave theory of light may have to be confined to more reasonable realms; it may well serve to explain wireless-telegraphy and such wave-activities, but the strange, material force known as "Light" certainly demands a more consistent explanation in view of its chemical effects.

U. S. BATTLESHIPS TO RUN ON LAND.

(*Continued from page* 170)

ner. The steering is equally simple and efficient. By running one motor at a slightly higher or lower speed, the ship must either turn to the right or to the left, as desired by its commander.

I have pointed out in previous articles, that the monster wheel is *the* prime requisite of all large war machines. A huge wheel, such as the ones here described, will easily ride over the widest trenches. Ordinary shell holes will be negotiated as easily as a cart wheel runs over a hole in the street due to a missing cobblestone. Rivers will be forded easily, if there is a fair approach. Even steep banks will be negotiated by running the craft diagonally thru the stream. Low hills will prove no obstacle at all, while steeper ones can be climbed by running the ship in a zig-zag line.

There will be less wear and tear, and less shocks too when running over land than when fording a tempestuous sea. The reason is that these huge wheels, just on account of their size, are rather elastic. They "give" a good deal. Then too, the earth as a rule is more or less soft. Thus we get a double spring action. Also due to the enormous width of the wheels—distributing the weight over a wide area—they will not sink into the softest earth much more than a few inches. This may seem surprising, but a simple calculation which any engineer may make in a few seconds, will prove the statement correct.

It goes without saying that in order to carry the enormous strain, the ship must be strengthened by a good deal of cross-truss steel work, as indicated in our illustration. Otherwise the shaft would rip clear thru the decks. This truss work, however, should not prove over difficult, nor a very long-winded operation. The reader has already guest that no new power plant is required. The old one is of course utilized, the ship burning coal the same as if it were on the ocean.

From a military standpoint, this monster engine of destruction proves rather interesting. But let us see what happens when the "Oregon," one fine summer morning steams thru the French fields, "Old Glory" flying from both masts, and plowing toward the German trenches. No more thrilling or awesome picture could be imagined. Of course long ere our battleship has reached the first trenches, the enemy aeroplanes have reported it, and the "Oregon" receives a warm welcome from the heavy enemy guns. But this is just what we want. After finding the range of the enemy guns, our battleship's 10-inch guns can either silence the enemy or otherwise run towards the German battery *and crush it by simply running over it.* There is no escape for them, for we have the advantage of quick mobility (the ship runs from 15 to 18 miles per hour) against the slow mobility of the enemy guns, which cannot be moved quickly. After annihilating these, the land monster runs amuck, destroying ammunition dumps, and raising general havoc behind the lines. Small guns and machine guns prove of little use against our armored battleships, and even if, as is to be expected, enemy shells find their mark, they cannot "sink" us or stop us. For the engines as well as all other vital parts are protected by heavy armor. The wheels themselves will not be put out of running order easily, because they are not solid. The shells, even if they do hit, will hardly destroy the entire wheel. Beyond ripping out a few steel beams, no great damage will be done.

The "Oregon" now runs over and parallel the trenches, the battleship's well protected machine guns emplaced low down in the holds, firing away continuously. The result is that the enemy must give way. If several battleships are used simultaneously in a grand attack, there is no question that the enemy must fall back over a wide area.

And it will be impossible for the enemy to board the swiftly moving vessel. Even if forced to stand still, its machine guns and other guns would ward off all close attacks.

There remains the aeroplanes dropping bombs into the ship. The answer here would be—anti-aeroplane guns, installed already on every modern war-ship. Besides our own aeroplanes would protect the ship by beating off the enemy flyers.

"HAM" JONES—SCIENTIST.

(*Continued from page* 181)

As we approached the curtain he spied a pair of pliers, and said, "By the way, you see how the cutting edges of these pliers are fused? Well, several days ago I cut a lamp cord with them. The current

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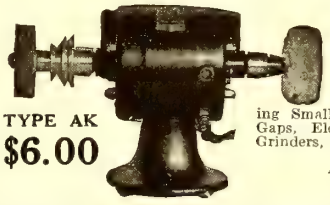
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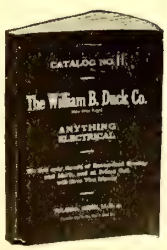
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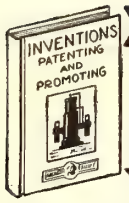
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EDWARD J. RYAN, Martin Bldg., Utica, N.Y.

was on, and I cut both wires at once. There was some great fireworks, but those new fuses of mine held first rate." Then he laid them reverently upon the top of the helix.

"Hen" told me all about the mechanism of the curtain and then towed me back to the bed to show how he "turned in" and "hit the hay." It seems he did not use the curtain arrangement very often, for it had a habit of rising before the desired time; however, all was ready for the demonstration. "Hen" was supposed to have said his prayers and be snugly tucked under the covers.

"Watch out," he warned, "while I press button number one." So he prest it and with a click the latch gave away and the door swung open.

"Now for number two," cried "Hen." "Watch the curtain. This is the best of the whole bunch!" *Twang* went the spring of the curtain and up went the latter with a *bang*, but on its upward journey it struck the end of the pliers which "Hen" had left sticking over the edge of the helix; the pliers sailed over toward the 110-volt switchboard and thereupon there occurred a series of twangs and bangs intermingled with shooting stars and meteors—then something gave away and the Jones' house was plunged in total darkness!

"What the deuce!" cried "Hen", in alarm, and very undignified. "Wouldn't that make yer mad?"

From below, on the second floor, there came in a stentorian voice, a series of interrogations, ejaculations and commentations which only served to add terror to an already fluttering heart—so while "Ham" Jones hunted around in the dark for a ten-penny nail with which to form a 1918 model *Jones' Unblowable Fuse* (Patents Pending) I slunk down two flights of stairs and ran home as fast as I could.

AMATEUR AND EXPERIMENTAL RADIO RESEARCH.

(*Continued from page* 201)

Apparatus Necessary for Research Work.

While a well-equipt radio experimental laboratory is a great asset in research work, it is by no means an absolute necessity. By means of the ordinary amateur equipment, together with a few easily made accessories, one can do much experimental work of a very useful and penetrating nature. There are certain research problems, of course, that would demand elaborate apparatus to work with, but this is not generally true.

The amateur who wishes to do experimental work should equip his station with a certain amount of auxiliary apparatus. He should first wind several loading coils and inductances of various sizes. These coils should be labeled as to the number of turns they contain and the wave-length they should respond to (or better still, calculate or measure the inductance in centimeters of each coil as explained in the series by Secor and Cohen published in the March and April issues of this journal), as it is always best to know just what one is working with. Aside from these, several variometers of different sizes should be constructed, as they are almost indispensable in work of this nature. It is not necessary to build an elaborate cabinet for the variometers, as they can be placed inside a square framework, which is just as good. On each variometer there should be a single-pole switch, connected across the terminals so the instrument can be quickly eliminated from the circuit if desired. At least three receiving transformers should also be included in the equipment and these should be of various dimensions capable of responding to a wide range of wave lengths. It is also desirable to build several fixt receiving condensers of various capacities and each one equipt with a shorting switch. Detectors of various types should also be on hand, as it must be remembered that certain crystals are better adapted for some work than others. The Audion is not an absolute necessity unless it is desired to experiment with this particular instrument for regenerative work, etc. It might be said here that the Audion and its circuits offer a very fruitful line of research. At least three variable condensers should be included in an experimental outfit, as they are very necessary additions, absolutely essential for real serious work.

Probably the most important consideration in wireless research work, especially in regard to receiving, is the rapid change of connections. Experimental apparatus should be as flexible as possible. The simplest way to accomplish this is to build a small switch-board and this should contain a number of single point switches, D. P. S.T., D. P. D. T., and multipoint switches. The points and blades of the switches should be connected directly to binding posts on the back of the board. There should also be a row of binding posts fixt along the top of the board, as it is oftentimes found convenient as well as necessary to use such an arrangement.

The transmitting outfit should be equipt with several inductances, both loose and close coupled, of various dimensions and known values. A rotary, quenched and series spark gap, together with a large condenser with removable plates or other means of capacity variation should also be included. If experiments in radiation are to be conducted, it is of course necessary to either construct or purchase a reliable hot-wire ammeter. The problem of providing means for the rapid changing of connections in the transmitting apparatus is not as necessary as in the case of the receiving equipment. Furthermore, the connections are not so complicated. A few heavy switches may be added to the sending equipment, as they are found to be useful in many cases. Valuable research work can be carried on in the laboratory by means of a buzzer transmitter, together with a wave meter and a dummy or *loading antenna*. This is formed of a compact coil of resistance wire, designed to have the proper radiation resistance, inductance and capacity, and corresponding to a fair size antenna. These are available in the market and those interested will receive information concerning them by writing to the Editor, Radio Department, enclosing a stamped and addrest envelope. Most commercial radio transmitters are tested out today on a phantom aerial or load, as they are sometimes termed. See article elsewhere in this issue on the "load" or dummy antenna used by the Federal Telegraph Company. (See page 186.)

The suggestions offered above only deal with a general equipment for research work, and there will, of course, be many instances where the experimenter will have to use his own judgment in building instruments of special design to carry out his ideas. The only suggestion of worth that can be offered in this way is to work carefully and neatly, as results cannot be expected from a piece of apparatus that is "thrown" together. Altho it is not necessary to build elaborate experimental instruments, they should be neatly and substantially made, as it may be that a poorly constructed instrument may defeat an important and valuable experiment that would otherwise prove successful. Part II will take up "Suggestions for Research Work."

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Edited by H. GERNSBACK

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries address to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

THAT BELL SOFTENER.

(160) The Editor sometime ago in an Editorial entitled *"Inventions Wanted,"* mentioned that there existed a large market for an appliance which would take the disagreeable jar out of the telephone bell. This editorial was consequently publisht broadcast by dozens of newspapers and periodicals. Since then hundreds upon hundreds of letters reached the Editor's desk, nearly all the writers wishing to know who would buy such an invention.

Frankly, we do not know of any, offhand. Altho we are certain that if a really good appliance, which fills the bill, is invented, there are a number of electrical manufacturers and telephone manufacturers who certainly would want to buy the patent. But, like all good things, nothing sells itself. There was a positive demand for the telephone, long before it was invented, but everybody knows of the long, bitter fight that Bell had, trying to introduce his telephone. It is the same with almost any invention. After you make it, the fight to realize on it, begins. If you have something really good, you will make more money in the long run by marketing it yourself.

Another thing: When the Editor suggested the "Bell softener" he did not have some sort of a muffler in mind at all, as most correspondents seem to think. Muffling the gongs does not solve the problem. Take the gongs off and substitute *something* that is *not* a gong. Wooden or similar gongs won't do. Substitute rather something giving a *musical pleasing note,* soft and mellow, which however should not be harsh or abrupt. It is the abruptness of the telephone bell which gets on one's nerves.

MAGAZINE PENCIL.

(161) Morton Gross of Chicago has submitted to us an idea of a pencil which requires no sharpening. It is made of paper, but embodies a totally different construction than the present paper pencils on the market. Our advice is asked.

A. An extraordinary good idea, as good as it is novel. It also seems to us that it could be manufactured cheaper than the present patent ones. We feel certain that a good patent can be obtained.

OSCILLATING DEVICE.

(162) William Woodward, Wilmette, Ill., submits sketch, an illustration of a novel device for making a damped hookup oscillate. Is the device practical and can it be patented?

A. The scheme looks eminently promising on paper, but without necessary research work, we would not be willing to give a final opinion. We advise our correspondent to try it out by building a model. If it works, as described, a valuable patent will result. We have never seen anything just like it.

COVER LIFTING DEVICE.

(163) A. J. Walrath, Detroit, Mich., has sent us a description and illustration of a clever automatic cover lifting device attachable to garbage cans or ash cans. Is it patentable and practical?

A. A capital idea. Something that should appeal to every housekeeper and to every janitor. Moreover, the device can be manufactured very cheaply, and sold at a low price. We think it extremely practical and we believe a patent can be obtained upon the device.

INSULATOR.

(164) Harry J. Wright, Jr., North Vancouver, B. C., Canada, submits an insulator for outdoor wiring. This insulator uses two nails which are placed in such a manner that the insulator is not easily pulled away from its support during storms, or when sleet settles upon the wire.

A. A very good and a very cheap insulator. There is only one objection and that is that the insulator will crack when the nails are driven home, due to the fact that only one point of the nails touch the top of the insulator. If the top is made at an angle, so that the nails will meet the surface at right angles, a much better insulator will be the result. We think a patent can be obtained on the device.

NOVELTY FAN.

(165) Sidney Brown, Lake Charles, La., has submitted a design of a certain fan in which are incorporated novelty lights. Our advice is asked.

A. While the idea seems original and while a patent can probably be obtained, we think that the resulting flickering of the lights will be a serious objection unless the device is to be used only for advertising purposes, such as window display, etc.

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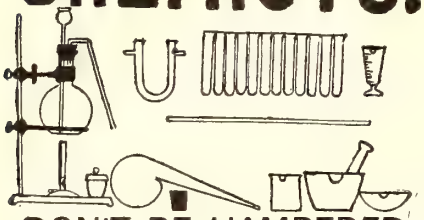
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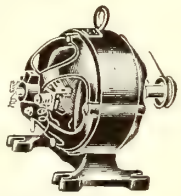
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EXPERIMENTAL CHEMISTRY.

(*Continued from page 203*)

Sodium Sulfate [$NaHSO_4$], is formed.

If two molecules of the salt are taken and one of Sulfuric acid, a less soluble salt, Normal Sodium Sulfate [Na_2SO_4] is formed, during which process a much higher temperature is required.

Hydrochloric acid can also be formed by the union of its constituent elements, namely, Hydrogen and Chlorin. When the gases, Hydrogen and Chlorin, are brought together in the dark, no action takes place. If the mixture is put in the sunlight, gradual combination takes place, and if the direct sunlight is allowed to fall for an instant, an explosion occurs, indicating the combination of the two gases. This sudden combination is also effected by the application of a flame, by a spark or by any intense light, as magnesium light, etc.

When water is formed by the combination of its constituent elements, hydrogen and oxygen, the introduction of an electric spark is necessary. This combination [Hydrogen and Oxygen] would not take place upon exposure to light. Thus we can see that Hydrogen and Oxygen can only combine to form water by introducing a spark, and not by exposure to light, while Hydrogen and Chlorin unite with explosive violence when any intense light is permitted to fall directly upon the mixture.

PROPERTIES:

Physical: 1. It is a colorless gas, possessing a sharp irritating and penetrating smell and taste, and produces suffocation when inhaled, and is poisonous.

2. It can easily be liquefied at 0° and 28 atmospheres, and solidifies at —111.1°. In the liquefied state it boils at —83.7°.

3. It is very easily soluble in water.

4. It is a little heavier than air.

5. When the fumes of the acid come in contact with moist air, dense white fumes are formed, and due to the great attraction of the gas for water, thus condenses the moisture. The fumes when the acid is brought into contact with Ammonia gas, are Ammonium Chlorid [NH_4Cl].

Commercial Hydrochloric acid [Also called Muriatic acid] generally consists of one-third acid to two-thirds water. This liquid if pure, should be without color. Sometimes it is of a yellow color, caused either by the presence of dissolved salts of iron or organic substances. The chemically pure [C. P.] should be without color. This may be distilled at 110°, when it gives a liquid containing 20% Hydrochloric acid, and corresponds to the formula, $HCl + 8H_2O$. If more Hydrochloric acid is contained in the liquid, heat will liberate the gas; if less, water will be liberated upon the application of heat.

CHEMICAL:

1. Hydrochloric acid possesses a very strong acid reaction.

2. It is not inflammable [a non-combustible gas], and does not support combustion, and is not decomposed by light or on heating; but its hydrogen may be replaced by metals as Zinc or Sodium, and its Chlorin by Manganese dioxid [MnO_2].

3. Sodium or Potassium burns vigorously in it on heating, forming chlorids.

4. It dissociates into its elements at 1800°.

5. It dissolves most metals, forming chlorids.

If there are two chlorids of a given

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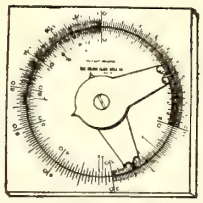
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metal, the lower is usually formed by Hydrochloric acid. Silver [Ag], Lead [Pb], Mercury [Hg], Copper [Cu], Platinum [Pt], Gold [Au], are not dissolved, or are very slightly acted on by this acid. Chlorids of the first three are insoluble; chlorids of the other three are formed by using Aqua Regia [Hydrochloric and Nitric acids].

USES:

1. It is used for preparing the chlorids of various metals.

As stated before, Sodium chlorid is the most important of the chlorids. Common Salt [Sodium Chlorid] besides its use as a preservative, is a necessary article of food with all animals living on vegetable diet. It is used in medicine, internally, in small doses as a gastric stimulant, in large doses as an emetic; externally in baths for the relief of rheumatism, and injected in solution, to replace loss of blood.

2. It is used for extracting phosphats from bones.

3. It is used in dyeing and tissue printing.

4. It is used in the manufacture of coal-tar colors.

5. It is used in preparing other compounds of chlorin than chlorids, and in preparing the element Chlorin itself.

6. In the laboratory it is used for generating hydrogen, also in analysis and in making Aqua Regia.

7. It furnishes chlorin, from which bleaching powder is made.

8. The silver chlorid [AgCl] in photography is deposited upon the photographic paper from solutions of Silver Nitrat [$AgNO_3$] and Sodium Chlorid [NaCl].

EXPERIMENT NO. 73:

Arrange a flask [about 250 cc.] with a two-hole rubber stopper and two bottles, each having a capacity of about 125 cc., make connections as shown in Fig. 69. The first bottle contains a three-hole rubber stopper thru which passes the delivery tube from the generator [the flask containing the Sodium Chlorid and Sulfuric acid], this tube should extend only a little below the stopper in both the flask and bottle, and should not touch the solution. A long glass tube is then inserted in the center hole of bottle No. 1 above the cork and below the surface of the water. This is called a *Safety tube*. A third tube just passes thru the stopper in bottle No. 1, and leads to the second bottle [which does not contain a cork] and in which the delivery tube is permitted to be under the water.

A *Wolff Bottle* (see Fig. 70) may be used in place of No. 1, and if this form is used, one containing three necks is to be preferred.

It will be noticed in the illustration of the apparatus that rubber connectors (cut diagonally—see Fig. 73) are used to connect the delivery tubes of the flask and second bottle. If it is desired, the tubing may be bent in one piece as shown, but it is more convenient to use separators, as the pieces may then be used in other experiments.

Fill the two bottles, 1 and 2, about one-quarter full of water. Set the flask on a ring stand support, on a piece of asbestos or wire gauze. Pour about 5 cc. of water into the flask and add 10 or 15 grams of sodium chlorid [common salt, NaCl], by pouring into the flask from a creased paper.

Have handy a splint, also an evaporating dish containing three or four drops of Ammonium Hydroxid [NH_4OH], and a stirring rod or piece of paper.

Make sure that all connections are air-tight, then pour about 20 cc. of Sulfuric acid [H_2SO_4] in small quantities, say three or four drops at a time, into the flask, by means of a *thistle* tube. Do not add too much acid at one time.

Action will probably take place upon the introduction of the acid, which is made apparent by the bubbling and frothing in the flask, but to aid it, a Bunsen flame should be placed under the flask. Do not apply too much heat, and if the liquid tends to pass over the delivery tube into the first bottle, remove the flame, and if it does not abate, add a little water thru the delivery tube.

The reactions which may take place, are:

1. $NaCl + H_2SO_4 = HCl + NaHSO_4$
   Sodium Chlorid — Sulfuric Acid — Hydrochloric Acid — Hydrogen Sodium Sulfate

2. $NaCl + 2H_2SO_4 = 2HCl + Na_2SO_4$
   Sodium Chlorid — Sulfuric Acid — Hydrochloric Acid — Sodium Sulfate

The equations are more fully explained in the preceding methods of preparation.

EXPERIMENT NO. 74:

Loosen the stopper of the flask and very cautiously try the odor of the fumes. Do not inhale too much, but just enough to give you the characteristic smell. [NOTE:—In case you have inhaled an overdose of the gas, an antidote should be taken, by inhaling the Ammonia from a bottle containing Ammonium Hydroxid].

Apply a lighted splint to the open mouth of the flask. The splint should go out, due to the fact that Hydrochloric acid gas is a non-supporter of combustion, and non-combustible.

Either bring the dish, glass rod or piece of paper dipt in the Ammonium Hydroxid to the mouth of the flask. Dense white fumes should be evolved upon the introduction of the Ammonia gas [obtained from the Ammonium Hydroxid] coming in contact with the Hydrochloric acid gas. This test is characteristic of the gas.

Look very closely at the liquid in the bottles 1 and 2 while the action is taking place in the flask. If you look thru the bottle at a strong light, it will be noticed that an oily liquid is being precipitated in these bottles. This is the Hydrochloric acid gas which is forming a solution with the water.

After about 10 or 15 minutes generating, remove the flame from under the flask. Allow to cool for a few minutes, then uncork the flask, insert a funnel, and cautiously pour in two or three test tubes full of water. The flask may then be filled from the jet and the contents poured out. If the substance in the flask has caked, be careful not to break the glass, but let it stand till cool before adding the water.

Save the liquid in the bottle No. 1 for the next experiment.

EXPERIMENT NO. 75:

Pour into a test tube about 5 cc. of the liquid obtained from bottle No. 1 in the preceding experiment, and into a second tube pour 5 cc. from the open bottle; then test each with litmus paper or solution. Determine if the solution is an acid by its action on litmus, as done in some of the experiments already performed.

To prove what is present we must apply tests for both the *positive* and the *negative* constituents of the compound.

EXPERIMENT NO. 76:

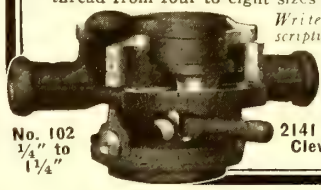
Pour about 5 cc. from bottle No. 1 into a small test tube and add two or three pieces of Zinc. After action has progrest for a short time, apply a lighted splint to the mouth of the tube to determine if a gas escapes. If we have Hydrochloric acid in bottle No. 1 it is reasonable to suppose that Hydrogen gas will be liberated when Zinc is treated with the liquid.

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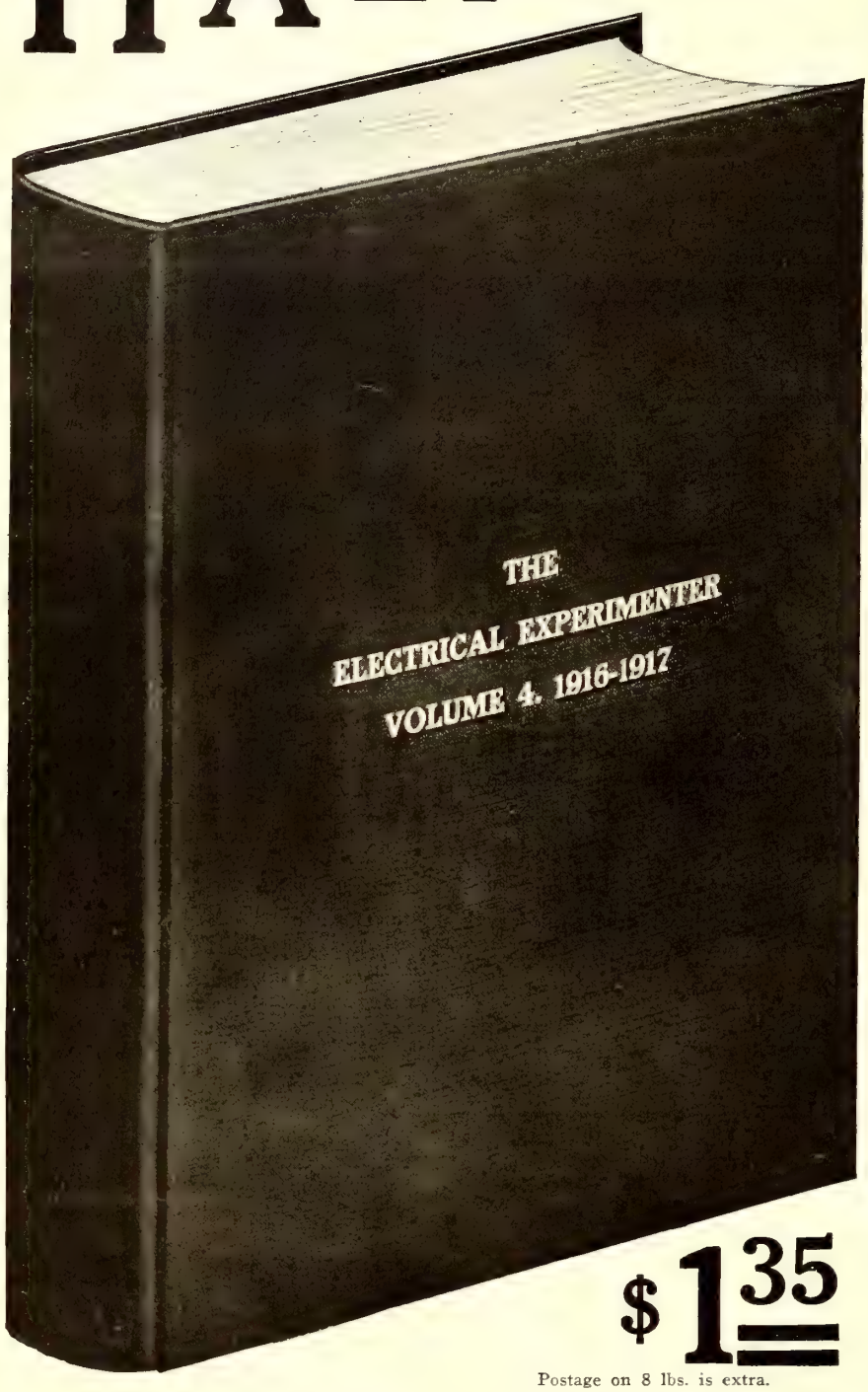
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EXPERIMENT NO. 77:

Pour small portions from bottle No. 1 into three tubes. To one add a few drops of Lead Nitrat solution, $[Pb[NO_3]_2]$, to another a few drops of Silver Nitrat solution, $[AgNO_3]$, to the third a few of Mercurous Nitrat solution $[HgNO_3]$.

White precipitates, the chlorids of the metals, Lead, Silver and Mercury, should form upon the mixture of the respective nitrats with Hydrochloric acid.

SOLUBLE CHLORIDS:

Soluble chlorids are made by dissolving in Hydrochloric acid, either a metal or some of its salts which are transposed by it.

INSOLUBLE CHLORIDS:

Insoluble chlorids may be made by adding Hydrochloric acid to solutions of the soluble salts of these metals, for example, Lead Nitrat $[Pb[NO_3]_2]$, Silver Nitrat $[AgNO_3]$, Mercurous Nitrat $[HgNO_3]$. There are only three chlorids, Lead Chlorid $[PbCl_2]$, Silver Chlorid [AgCl], Mercurous Chlorid [HgCl] insoluble in acidulated water.

SEPARATIONS:

Suppose we were to mix solutions of Lead Nitrat $[Pb[NO_3]_2]$, and Copper Nitrat $[Cu[NO_3]_2]$, the lead could be separated from the copper by Hydrochloric acid, for the former would precipitate and the latter remain in solution. On filtering, the lead would remain on the filter as a residue Lead Chlorid $[PbCl_2]$, and the copper would pass into the filtrat unchanged as Copper Nitrat $[Cu[NO_3]_2]$, or Copper Chlorid $[CuCl_2]$, and could be precipitated by Hydrogen Sulfide $[H_2S]$, as Copper Sulfide [CuS]. A mixture of Lead, Silver and Mercury salts could, by the same reagent, be separated from other salts in solution. This is exactly what is done in *Analysis*.

EXPERIMENT NO. 78:

Mix in a test tube about 5 cc. of Lead Nitrat solution, and an equal amount of Copper Nitrat solution. From the above explanation, see if you can devise a method of separating the lead from the copper in the solution.

EXPERIMENT NO. 79:

Pour about 20 cc. of Sulfuric acid [2 to 1] into a flask supported on an asbestos mat on a ring-stand, and add about 10 grams of Sodium chlorid [Common salt]. Gently rotate the flask so as to mix the acid with the chlorid. Close the flask with a two-hole stopper carrying a thistle tube and delivery tube arranged as shown, for the collection of gas by downward displacement in a *dry test tube*. If necessary heat the flask with a small flame. The contents of the flask will bubble and froth, indicating the process of liberating the gas (Fig. 74).

EXPERIMENT NO. 80:

Fill a dish with water and set it on the table. Take a test tube of gas collected [which is made apparent when the fumes are liberated in the air], close its mouth tightly with the thumb, invert the test tube, and hold its mouth below the surface of the water. Remove the thumb. Notice how the water acts with the gas.

EXPERIMENT NO. 81:

Close the mouth of the test tube with the thumb and remove it from the water. Moisten a piece of litmus paper with the liquid contained in the test tube. The result of change of the litmus would show that this effect is typical of the water solution of acids.

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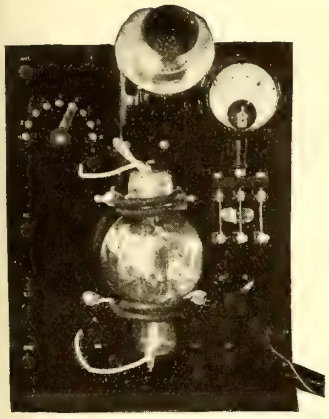
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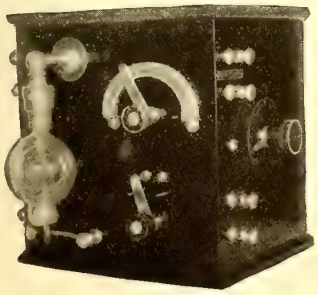
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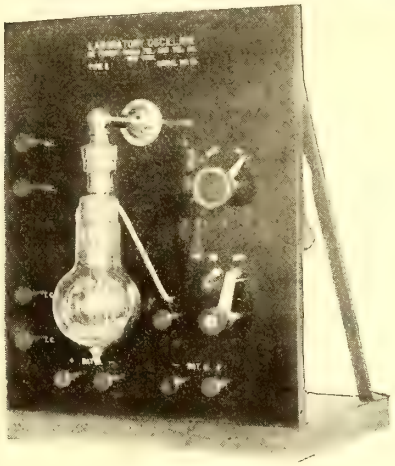


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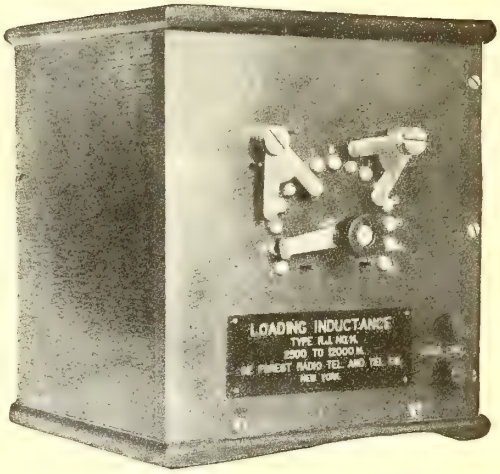
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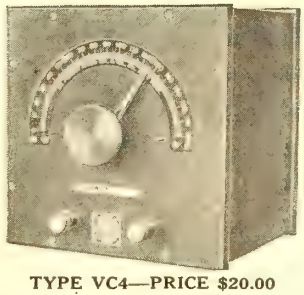
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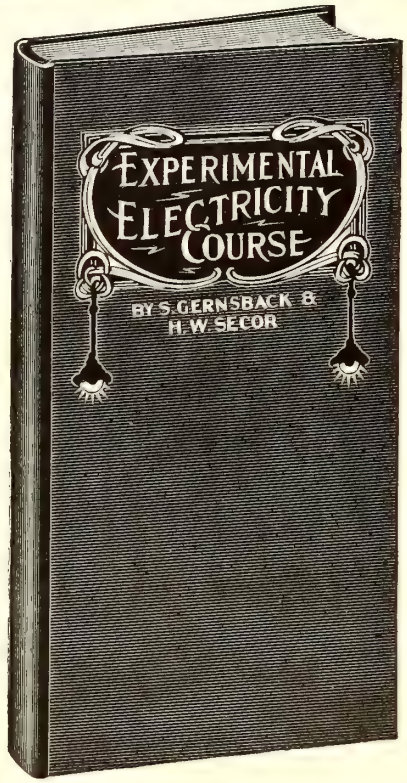
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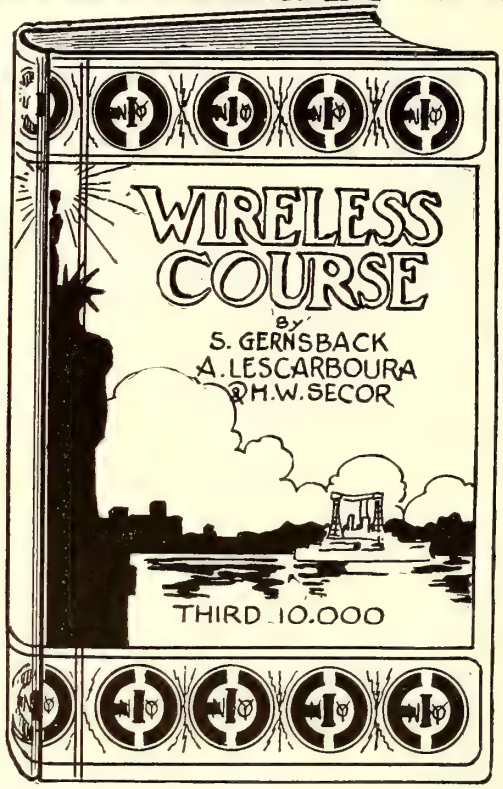


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The Electrical Experimenter

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AUG 31 1917
U. S. PATENT OFFICE

The Submarine War

THERE is hardly a problem today of greater importance and of a greater complexity than the submarine warfare. It affects not only this nation, but every nation, big and little, over the entire globe.

So complex and so entirely new is this problem that it paralyzes clear thinking of expert and layman alike. Logic runs rampant, even great thinkers and scientists continuously clashing in their widely divergent opinions. There is a chaos of plans, suggestions, inventions and schemes that seem to stupefy everyone concerned in solving the problem. And there seems to be no ray of light in all the darkness so far.

A visitor from Mars, not affected by the war fever bacillus, which now infects the whole world, would surely look in amazement upon the strange spectacle now being enacted upon this planet.

He would marvel first, that during the three years of submarine warfare, no general *plan* to combat the danger had been evolved by the several Allies. Everyone seems to be trying something different from somebody else, but there is no cohesion, no general coöperation that he could perceive.

Our Martian friend, after having looked on a while would probably say: "With the scientific knowledge now at your command, there are only a few ways to successfully combat the submarine evil. Either one will do perfectly, choose the one which is best adapted to your present day technique. Broadly speaking, there are only three practical means of effectively dealing with the submarine. They are:

"1st. Destroy the submarine.

"2nd. Prevent the torpedo from reaching the attacked ship.

"3rd. Blind the submarine so it can not take the ship's bearings."

There are, of course, more means than these three, but they can be left out on account of being impractical. Also each one of the above classes can be subdivided into numerous other classes; thus the suggestion to find a means of preventing the submarine from leaving its harbor comes really under class 2 because the primary purpose of a submarine is to sink ships with a torpedo. Gunfire from the U-boat is a secondary consideration, for with ships becoming armed more and more, the submarine is forced to rely upon its torpedoes.

At the present time our inventors are wasting valuable time trying to invent submarine "detectors." Of what earthly use are these? Suppose we *do* know that a submarine is near our ships? Suppose that we even know its exact position? What will it help us? Our knowledge will certainly not prevent a torpedo from reaching our ship. You can't destroy a submerged U-boat as yet. Even running in a zig-zag line does not always help, for the crafty U-boat commander, if he can but take a few observations, running in a straight line behind the fleeing ship, will average the zig-zag course and if he wants to use two torpedoes, one of these almost certainly will find its mark.

While in some high quarters the opinion prevails that there will never be found a real cure against the submarine evil, we refuse to share such a view. There has never been a weapon in all history which in time did not find its equal or its master. The submarine and its torpedo will prove no exception to this rule. Science in the end will conquer as it always does.

It is more than probable that it will not be a startling new invention that will solve the problem. Rather, we venture the opinion that a combination of well known and tried out methods will do the trick. All indications point that way. Also, we believe that either means 2 or 3 as above enumerated will prove the simpler of the three.

If we would only make up our minds which course to pursue, the solution of the problem would be reached much sooner.

It is foolish and humiliating trying to build ships faster than the U-boats can sink them. If we pursue this course the U-boat will win in the end. If the sun melts your ice too fast you don't go and put out more ice in the sun. You devise means to keep the sun away from the ice, by protecting the latter.

The submarine war is no different. And we will need a lot of ships. Let our inventors devise means to protect them adequately.

H. GERNSBACK.

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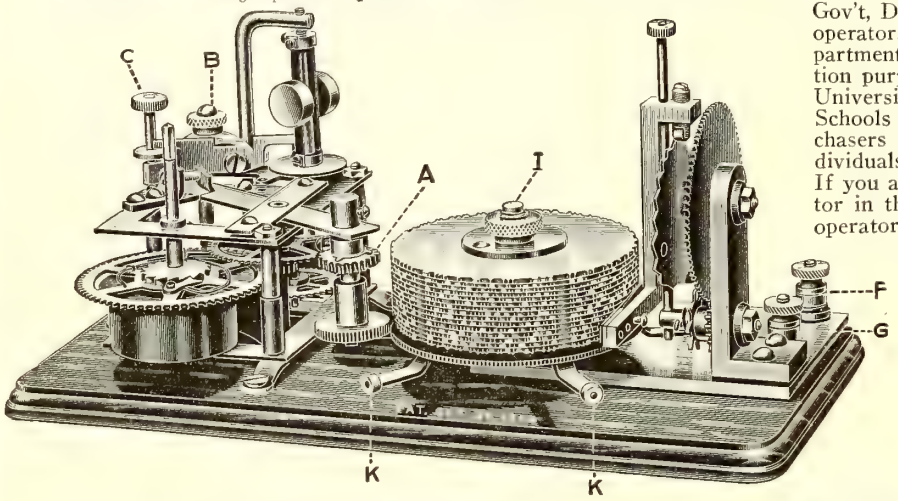
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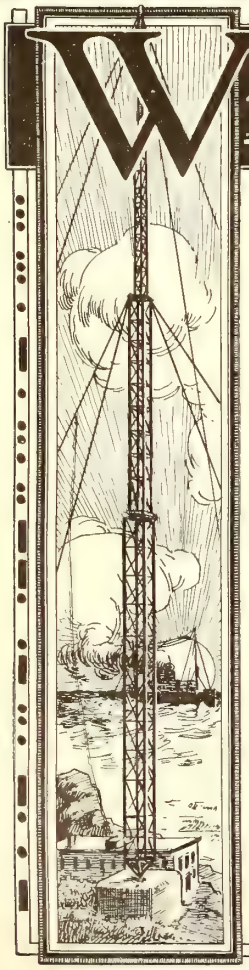
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THE ELECTRICAL EXPERIMENTER

H. GERNSBACK EDITOR
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Vol. V. Whole No. 52 August, 1917 Number 4

Tesla's Views on Electricity and the War

By H. WINFIELD SECOR

Exclusive Interview to THE ELECTRICAL EXPERIMENTER

NIKOLA TESLA, one of the greatest of living electrical engineers and recipient of the seventh "Edison" medal, has evolved several unique and far-reaching ideas which if developed and practically applied should help to partially, if not totally, solve the much discust submarine menace and to provide a means whereby the enemy's powder and shell magazines may be exploded at a distance of several miles.

There have been numerous stories bruited about by more or less irresponsible self-styled experts that certain American inventors, including Dr. Tesla, had invented among other things an *electric ray* to destroy or detect a submarine under water at a considerable distance. Mr. Tesla very courteously granted the writer an interview and some of his ideas on electricity's possible rôle in helping to end the great world-war are herein given:

The all-absorbing topic of daily conversation at the present time is of course the "U-boat." Therefore, I made that subject my opening shot.



Nikola Tesla, the Famous Electric Inventor, Has Proposed Three Different Electrical Schemes for Locating Submerged Submarines. The Reflected Electric Ray Method Is Illustrated Above; the High-Frequency Invisible Electric Ray, When Reflected by a Submarine Hull, Causes Phosphorescent Screens on Another or Even the Same Ship to Glow, Giving Warning That the U-boats Are Near.

"Well," said Dr. Tesla, "I have several distinct ideas regarding the subjugation of the submarine. But lest we forget, let us not underestimate the efficiency of the means available for carrying on submarine warfare. We may use microphones to detect the submarine, but on the other hand the submarine commander may employ microphones to locate a ship and even torpedo it by the range thus found, without ever showing his periscope above water.

"Many years ago while serving in the capacity of chief electrician for an electric plant situated on the river Seine, in France, I had occasion to require for certain testing purposes an extremely sensitive galvanometer. In those days the quartz fiber was an unknown quantity—and I, by becoming specially adept, managed to produce an extremely fine cocoon fiber for the galvanometer suspension. Further, the galvanometer proved very sensitive for the location in which it was to be used; so a special cement base was sunk in the ground and by using a lead sub-base suspended on springs all mechanical shock and vibration effects were finally gotten rid of.

"As a matter of actual personal experience," said Dr. Tesla, "it became a fact that the small iron-hull steam mail-packets (ships) plying up and down the river Seine

BRITISH WOUNDED HEAR LONDON'S FAVORITES VIA TELEPHONE.

The free Electrophone Service, contributed by public-spirited people of London to the hospitals in that city, includes an installation by which a hundred patients can listen, whilst lying in bed, to the performances transmitted from the stages of the leading musical comedy theaters and music halls in London. The accompanying illustration shows some patients, with their mascot enjoying a performance. It is probable that some similar arrangement will be made in this country when the regular and auxiliary hospitals become filled with wounded soldiers and sailors. The telephone has made unprecedented strides in America where there are more telephones per capita than in any other country in the world. There are more telephones in New York City than in all Europe.

Hence, with such extension telephone facilities available, the American convalescents will surely fare as well as their allies. Connection with band and orchestra concerts would seem very suitable.



Photo by Central News Photo Service

The Hospitals of London, England, Are Fitted with Special Telephone Instruments So That the Wounded Soldiers Can, As They Lie in Bed, Listen to the Latest Music Direct from the Theaters and Music Halls. Even the "Mascot" Enjoys It.

ELECTRICITY AND MILK PRODUCTION.

The shortage of milk, due largely to difficulties of transport, suggests another field of agricultural work where electricity can do good service. The transport of milk and agricultural produce is largely a matter of providing light electric railways. In the pastoral districts in parts of Wales and Ireland, for example, facilities for carrying such produce are almost non-existent, and this has always been a check on agricultural production, as well as potential industrial resources. In the dairy electrical appliances have fully justified their value, and it only requires electric power to be available for them to be much more used. The prejudice against the milking machine has now been largely overcome, and experts believe that its action is more reliable than milking by hand, especially as skilled milkmaids are now difficult to obtain in England and Ireland. Refrigerating machinery, again plays a great part in preserving milk and enabling it to be transported for long distances, and electrically driven centrifugal separators for removing the cream are great time savers. The use of mechanical methods is also of assistance in maintaining cleanliness and in sterilization.

The electrical dairymaid is growing to be more of a reality every day, especially in the United States.

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at a distance of *3 miles* would distinctly affect the galvanometer!"

"How could this be applied to the submarine problem?" I asked.

"Well, for one thing," the scientist replied, "I believe this *magnetic* method of locating or indicating the presence of an iron or steel mass might prove very practical in locating a hidden submarine. And it is of course of paramount importance that we do find a means of accurately locating the sub-sea fighters when they are submerged, so that we can, with this information, be ready to close in on them when they attempt to come to the surface. Especially is this important when several vessels are traveling in fleet formation; the location and presence of the enemy submarine can be radiographed to the other vessels by the one doing the *magnetic surveying* and, by means of nets in some cases, or gun-fire and the use of hydro-aeroplanes sent aloft from the ships, the enemy under water stands a mighty good chance of being either 'bombed,' shelled or netted.

"However, a means would soon be found of nullifying this *magnetic detector* of the submerged undersea war-craft. They might make the 'U-boat' hulls of some non-magnetic metal, such as copper, brass, or aluminum. It is a good rule to always keep in mind that for practically every good invention of such a kind as this, there has always been invented an opposite, and equally efficient counteracting invention."

"How about this new *electric ray* method of locating submarines?" I ventured to ask.

"Yes, yes, I am coming to that," the master electrician parried. "Now suppose that we erect on a vessel, a large rectangular helice or inductance coil of insulated wire. Actual experiments in my laboratory at Houston Street (New York City), have proven that the presence of a local iron mass, such as the ship's hull, would not interfere with the action of this device. To this coil of wire, measuring perhaps 400 feet in length by 70 feet in width (the length and breadth of the ship) we connect a source of extremely high frequency and very powerful oscillating current. By this means there are radiated powerful oscillating electro-static currents, which as I have found by actual experiment in my Colorado tests some years ago, will first affect a metallic body (such as a submarine hull, even tho made of brass or any other metal), and in turn cause that mass to react inductively on the exciting coil on the ship. To locate an *iron* mass it is not necessary to excite the coil with a high frequency current; the critical balance of the coil will be affected simply by the presence of the magnetic body. To be able to accurately determine the direction and range of the enemy submarine four exciting inductances should be used. With a single inductance, however, it would be possible to determine the location of a submarine by running the ship first in one direction and then in another, and noting whether the reactive effect caused by the presence of the submarine hull increased or decreased. The radiating inductance must be very sharply attuned to the measuring apparatus installed on the ship, when no trouble will be found in detecting the presence of such a large metallic mass as a submarine, even at a distance of 5 to 6 miles; of this I feel confident from my past experiments in the realm of ultra-high frequency currents and potentials."

"What particular experiments do you have in mind, Dr. Tesla?" I asked.

"The Colorado tests of 1898-1900. Wonderful were the results there obtained, both those anticipated as well as those unexpected. As an example of what has been done with several hundred kilowatts of high frequency energy liberated, it was found that the dynamos in a power house six miles away were repeatedly burned out, due to the powerful high frequency currents set up in them, and which caused heavy sparks to jump thru the windings and destroy the insulation! The lightning arresters in the power house showed a stream of blue-white sparks passing between the metal plates to the earth connection. I could walk on the sand (ordinarily considered a very good insulator) several hundred feet from my large high frequency oscillator, and sparks jumped from my shoes! At such distances all incandescent lamps glowed by wireless power, and banks of lamp, connected to a few turns of wire arranged in a coil on the ground, were lighted to full brilliancy. The effect on metallic objects at considerable distances was really remarkable."

I asked him about the "Ulivi ray," which was accorded considerable newspaper publicity some time ago.

"The 'Ulivi ray' really was transplated from this country to Italy," asserted Dr. Tesla. "It was simply an adaptation of my ultra-powerful high-frequency phenomena as carried out in Colorado and cited previously. With a powerful oscillator developing thousands of horsepower it would become readily possible to detonate powder and munition magazines by means of the high frequency currents induced in every bit of metal, even when located five to six miles away and more. Even a powder can would have a potential of 6,000 to 7,000 volts induced in it at that distance.

(*Continued on page 270*)

Electric Submarine Forts to Destroy Submarines

A NOVEL method of destroying the stealthy submarine is here illustrated and described. It is the invention of Mr. H. Hartman, a consulting engineer of New York City, whose Submarine Camera, Electric Speaking Clock, Automatic Electric Light Buoy, Automobile Direction Signal, *et cetera,* have been described and illustrated in previous numbers of THE ELECTRICAL EXPERIMENTER.

The present invention relates to a Submarine Exploration Device which originally has been intended only for the purpose of conducting submarine exploration and salvage operations at such depths of the sea which are beyond the reach of a diver, but this device can also be adapted successfully for warfare against enemy submarines and especially for the protection of entrances to harbors, rivers, bays and more or less narrow water-ways as well as for the defense of vital parts of the coast.

This device, on which the U. S. Patent Office has granted letters patent to Mr. H. Hartman, consists mainly of a vertically arranged strong steel cylinder of 25″ to 30″ inner diameter which can be closed water-tight at the top, providing sufficient room for an operator and also containing within special compartments a powerful electric search-light, a storage battery, a photographic camera, the appliances necessary for the absorption of the carbon dioxid exhaled by the operator as well as for supplying the oxygen required to revitalize the air within the operator's chamber, and a number of instruments like water-pressure gage, volt and ammeters, switches, telephone, etc.

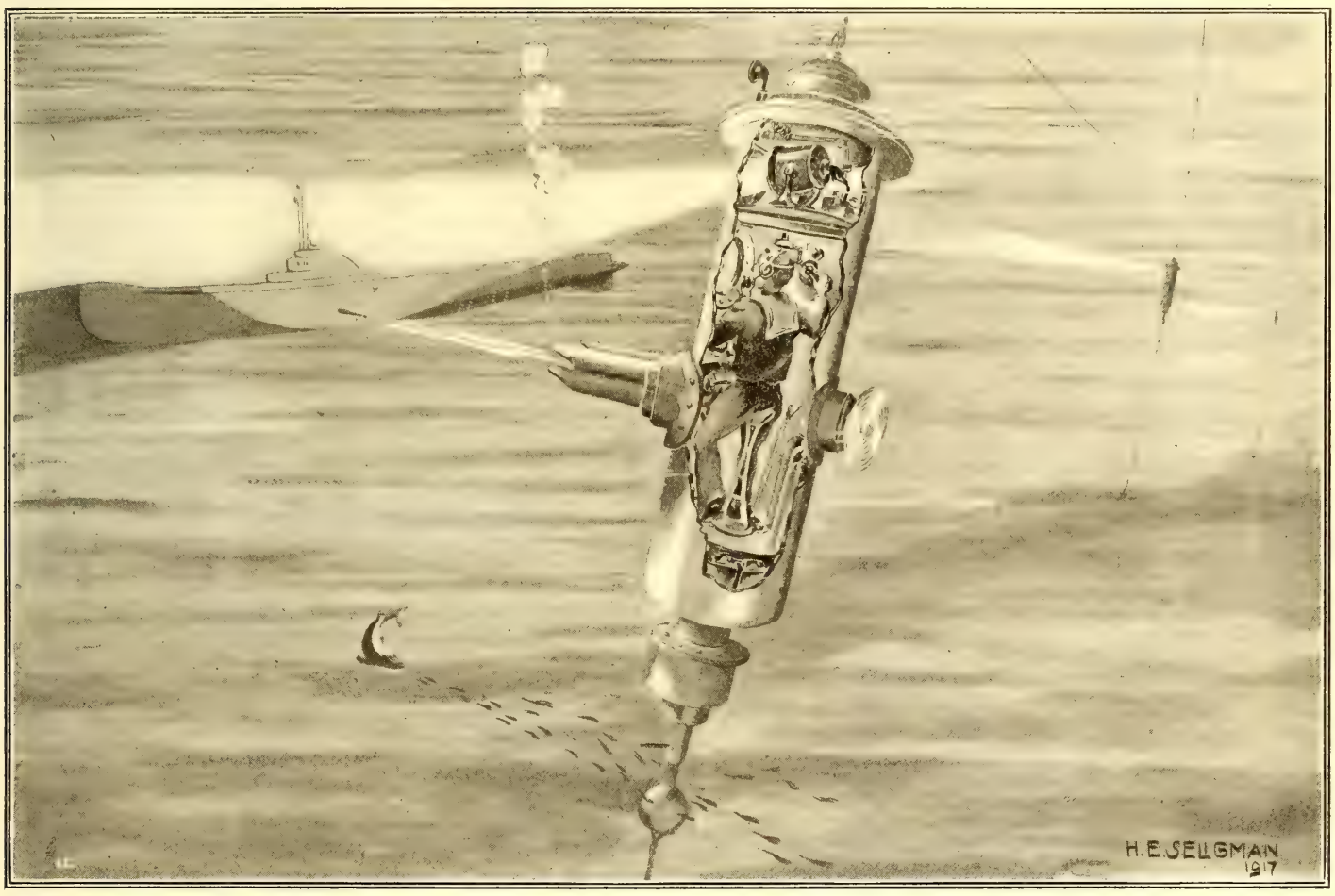
Attached below the main cylinder is an auxiliary casing, closed watertight and containing a second storage battery for the purpose of overcoming the buoyancy of the main body. This auxiliary casing can be dropt at will by the operator in case of emergency; for instance, if the wire rope from which the whole device is lowered into the water should break, in which case the main body would rise by buoyancy to the surface of the water.

Furthermore, there is provided at the rear of the main cylinder an electrically operated screw propeller which will rotate the whole suspended (or anchored) unit round its vertical axis if desired by the operator. The main cylinder is divided into three separate compartments as is shown in the picture. The lowermost compartment contains a storage battery of high capacity and sufficient evacuated space to take up any gas which the battery may develop during its discharge action.

Hermetically sealed from this compartment follows the operator's chamber in which a man may comfortably ride on an elastic saddle and observe the surrounding waters thru a system of heavy lenses which are set carefully and watertight into the steel cylinder. To illuminate the water a very powerful electric searchlight is arranged within the next or top compartment, which in its turn is also divided from the operator's chamber by a water-tight partition, so that no water can enter the same in case that the large lens thru which the light is projected into the water should break under the high pressure prevailing at great depths. The water-tight cover of the main cylinder contains a special cooling arrangement which is required, as otherwise the heat emanating from the light projector would rise to a dangerous degree, which could cause the bursting of the large lens; nevertheless the same is protected by an inner circle of transparent mica with small openings thru which the heated nitrogen gas, filling this compartment, may only gradually and slowly circulate before striking the large lens which is cooled from outside by the icy waters of the depth.

The operator can not only swing the light projector under different angles by means of electro-magnets but also rotate the whole device slowly round its vertical axis and incline the same to a certain degree and observe the surrounding water in every direction. A telephone connection, whose insulated conductors are embedded into the core of the wire rope from which the device is suspended into the water, permits the operator to remain in constant communication with his mother ship and to report at once everything he sees and also to direct salvage operations, when so used. The submarine fort can also be anchored as shown, the top cable running to a submerged buoy. A string of these forts could be placed across the entrance of a harbor or bay.

(*Continued on page* 270)



"Why Not Mine Harbor Approaches and Other Shallow Waters with a Series of Submarine Forts Like Those Here Shown?" Asks a New York Inventor. They Would Carry Powerful Sub-sea Searchlights, Microphones, Telephone (Connecting with Shore Station), and Special Torpedo Tubes for Torpedoing the Enemy Submarines, Should They Come Within Range.

Putting the Ocean Waves to Work

By CHARLES W. GEIGER

IF there is any one invention that has been well-nigh worked to death, it is that which tends in some way or other to make practical use of the boundless energy in the ocean waves. But, regardless of all the study and work that has been expended on this engrossing and worthy problem, all attempts up to the present time have signally failed to produce any satisfactory results in putting these ever-rolling walls of water to work. It must have exasperated many an engineer to see this tremendous power continually going to waste. But indomitable courage and resourcefulness will overcome almost any obstacle as long as it comes within the pale of practicability.

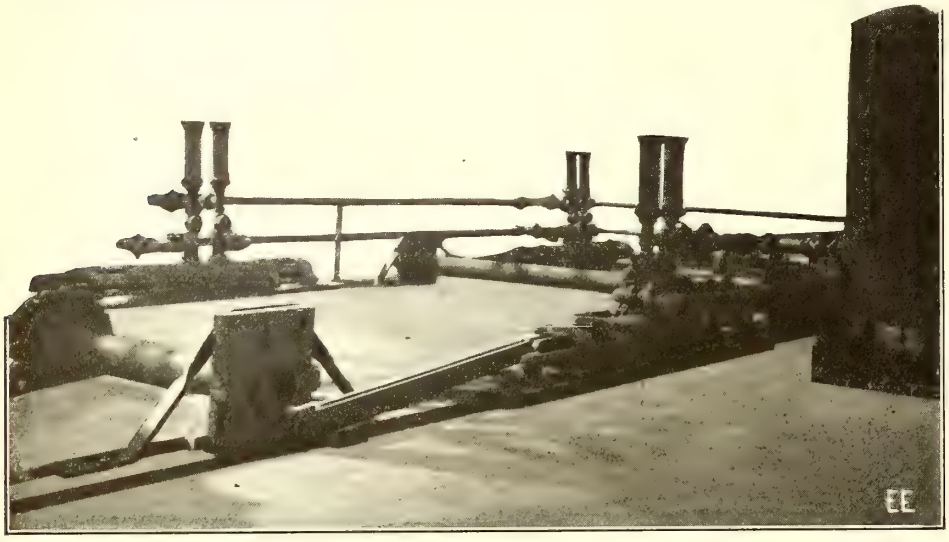


Fig. 2—Another View of the Hydraulic (Compound Pump and Turbine) Type of Wave Motor Shown Below. Depending Paddles Are Actuated by the Waves and Every Bit of Motion Is Put to Useful Work.

Just to show that there is a way to harness the industrious waves and breakers, two California inventors have worked out what seems to be a start in the right direction, as the accompanying photographs bear testimony, illustrating as they do, two distinct types of wave motors installed at Long Beach, California. They are intended to develop considerable power and to show that it is possible to develop electrical energy more cheaply than by burning coal or by other means. The view, Fig. 1, shows the extensive wave power plant now being installed in commercial capacity at Long Beach, California. The wave motor here presented displays a wide divergence from the wave motors of past experimentation.

The unique feature of this new machine is a compound uni-directional or free-draw and release clutch. This clutch is an achievement in rotating a power shaft in such a manner as to free the same from all dead center action, as well as creating rolling energy with the condition of no given stroke. So perfect is the action of the clutch employed, it is said, that any vibrational action is immediately transformed into a continuous rotary impulse. The machinery employed utilizes for its driving energy the reciprocating action of the ground swell occurring in ocean water. This action being caused by volumetric displacement as the wave moves forward setting up compound actions in opposite, a feature that no other motor possesses.

Substantially the machine consists of a multiple number of large *bull-wheels* each actuated by an *impulse paddle*, well covered by water at low tide. These wheels, by the merit of the novel clutch used, have an absolute freedom and independence one from the other, even tho they play on a *common* power shaft. In this manner any vibrating tendency of the swell is immediately disposed of as driving energy on power generating units. The machine now being installed will, when fully completed, present an ultimate capacity of some three to four thousand horse-power.

This machine, aside from presenting the required feature of being a continuous power producer operating irrespective of surface action, also possesses the merit of being a storm resistant machine, being the only one of its kind having no resistance to start, and at no time experiencing back pressure effects. The device was thoroly tested and proven by the operation of a demonstrating plant which experienced the action of two of the heaviest storms that has occurred on the Pacific coast for a period of twenty-five years, without the slightest damage.

With its wave power equipment the company anticipates the production of electric energy on a wholesale basis, at about 90% of the cost of production by steam, and 75% of the cost of production by present-day hydro-electric methods. According to the best of authority it will be possible even under the present strest condition of the steel market to install these plants at the surprising figure of $30.00 per horse-power.

In actuating the power shaft, oscillating *bull-wheels* are connected by heavy ¾-inch plow-steel cables, which engage the impulse wheels actuating the clutch units by multiple series of turns on the same. By direct connection on side and reverse connection on the opposite side, the continual rotation of the power shaft is readily maintained. The bull-wheels employed in driving the power shaft are of a six-sector bridged arc type, 24 feet in diameter, built to resist fractious stress on two one-inch steel cables. These wheels are so disposed as six units to incorporate within the machine the action of two ground swells at any one time, taking varied action so as to afford a steadied maintenance of power at all times.

Mr. Alva L. Reynolds, the inventor of the second type of wave motor being installed at Long Beach, shown at Figs. 2 and 3, possesses several promising features.

This wave-motor is of the *hydraulic transmission* and *regulation* type. The paddles are actuated with any kind of a wave, and either forward or backward movements of the paddle are transmitted into energy. The paddle is connected to a pendulum shaft with a sprocket as shown. This sprocket actuates a chain that is connected with a sprocket on the shaft that drives the pumps. On the drive shaft is a crank connected with the pumps by means of a connecting rod. These pumps were designed for this special work in this special position. The chain and cog-wheel that drives the crank-shaft is seen near the left edge of the picture. Each movement of the paddle moves this crank-shaft and by means of the connecting rod works the pumps. There are two pumps to each pendulum. There is another crank-shaft on the end of the drive-shaft that

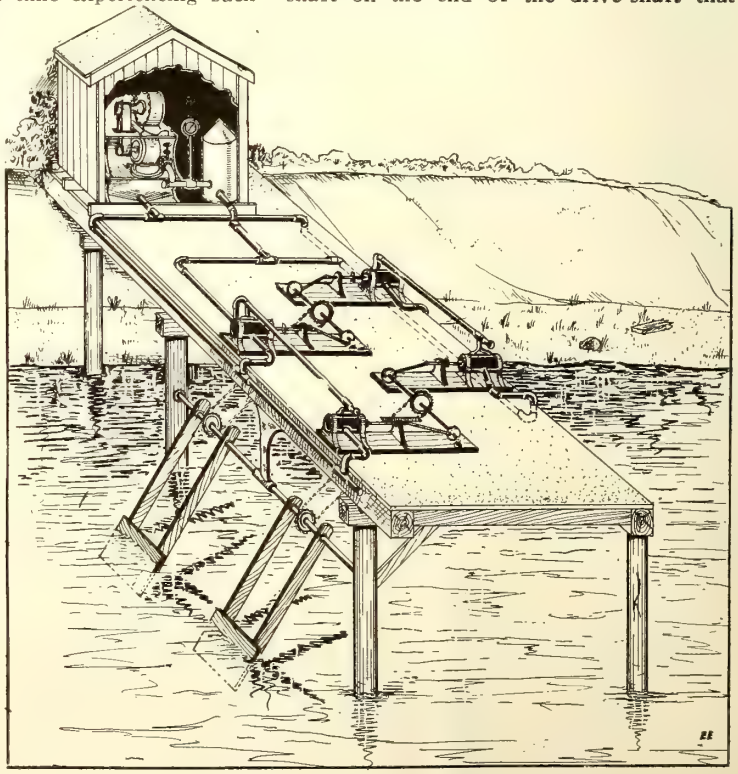


Fig. 3—Perspective View of New Hydraulic Transmission and Regulation Type of Wave Motor Installed At Long Beach, California.

actuates the pump seen to the left of the picture. There are four pumps altogether in this unit and two pendulums.

As the water is comprest by the pumps, it passes thru a large pressure tank (seen to the right in the large picture). This takes the pulsating effect of the pumps out of the water and leaves a perfectly steady stream for the water wheels. This water, under 120 pounds pressure, runs a water turbine which in turn is connected to the electric generator.

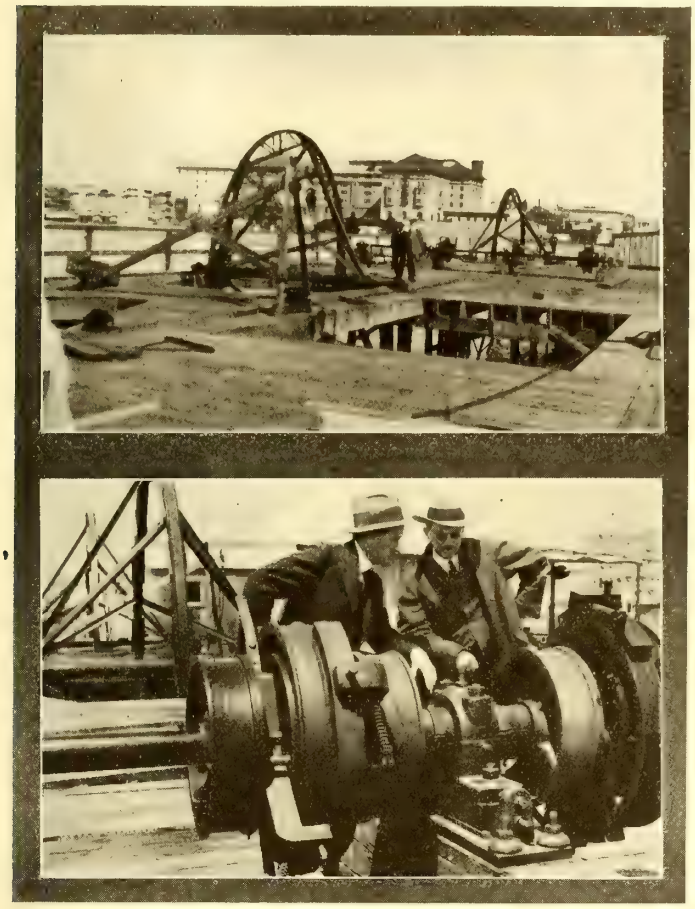


Fig. 1—A Second Type of Wave Motor Being Installed At Long Beach, Calif. The Waves Actuate Dependent Paddles Attached to the Large Bull-Wheels (Top Photo). Continuous Rotary Motion Is Obtained by the Remarkably Sensitive Free-Draw and Release Clutches Used (Lower View).

The power thus generated is at present used for lighting purposes and for a large search-light. The generator is also connected to storage-batteries, which are charged when there is plenty of water power in preparation for the time when the ocean may be comparatively calm.

SELENIUM SPEEDS UP THE OCEAN CABLE.

A new invention, devised by Mr. J. B. Dixon, has been in practical operation on certain of the Atlantic cables, and is reported to have given remarkable results, the speed of operation in the commercial handling of cable messages has been increased upwards of 125 per cent, while in tests far greater speeds have been attained. The gain in speed is due to the use of selenium cells to amplify the signals received, and to the use of means for obtaining, from one or more sources of illumination, a very large number of light beams, concentrated coincidently upon selenium cells, and deflected by a line galvanometer across the surface of the cells, the effect being that a very intense illumination of the cells is obtained.

It is found that the practicable speed of operation increases as the intensity of illumination increases. The selenium cells operate a siphon recorder or a relay. There being no physical connection between the recorder or relay and the line galvanometer, the inertia and frictional losses present in the older magnifying and recording apparatus are largely eliminated, the more so as in the new system the amplitude of vibration of the galvanometer coil is, in general, much less than in the case of the older apparatus. It is stated that Mr. Dixon employed 45 separate light beams, all derived from one 400 candle-power tungsten lamp, and all concentrated on a thin galvanometer mirror 5 inches long and 3/8 inch wide. These light beams were reflected from the galvanometer mirror, in one case, a distance of 7 feet 6 inches, and were then reflected a further distance of 7 feet 6 inches to the selenium cells, the light beams being concentrated coincidently upon the cells.

With this apparatus, working over one of the transatlantic cables the normal rate of operation of which is less than two hundred letters per minute, a speed of 450 letters per minute and higher was obtained in the regular commercial handling of business, and still higher speeds have been obtained on tests, with signals fully readable as to size and character.

GROWTH OF ELECTRIC STEEL FURNACE INDUSTRY.

In 1908 there was one electric steel furnace in the United States with an annual production of 55 tons. January 1st of this year there were 136 furnaces reported, as compared with 73 in use in 1916. The electric furnace can no longer be said to be in the experimental stage, with 20-ton furnaces in regular operation.

ELECTRIC TRAPSHOOTERS WHO "NEVER MISS" ARE NO MORE.

For the past 16 months, from sunset to sunrise, the electrically operated trapshooters on the world's largest, most attractive, realistic and spectacular electric sign—located on the Million Dollar Pier, Atlantic City, N. J.—have fired at 10 targets a minute and recorded a "hit" every time.

Human trapshooters are not equal to the task of breaking every target thrown. Mechanisms, of course, can be made almost infallible, but mark you, from now on, the electrical trapshooters are to be more realistic and more human than ever. They will miss at irregular intervals. *Irregular* is the proper word.

Thousands of persons seat themselves on the spacious hotel verandas and many more mass on the boardwalk every night trying to figure out when the shooter will *miss*. Sometimes the misses are as many as two or three in thirty seconds—while at other times the misses are not more than two in the same number of minutes. Therefore it is difficult to work out a system and play it.

Figuring out "when the shooter misses" has become quite a game in Atlantic City, and every one is playing. You cannot help but enthuse and get into the game after watching the electrical display. It is only human to try and solve the puzzle—and ascertaining just when the shooter misses is a puzzle. Thousands check up the misses each night, keeping tabs by the hour, but on no two nights thus far has the rotation of misses been the same.

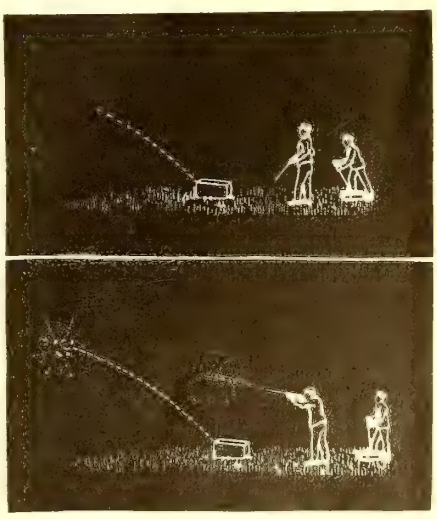
It took five months of incessant scheming and testing to perfect the scheme of having the shooters miss, and the changes had to be made so as not to affect the operation of the sign. The iron work was extended 10 feet and several hundred additional lights are now in operation.

This is the second change that has been made in the working of the great sign since it was first shown to public view—January 4, 1916. The original shooter was a man. Then the idea was suggested to have a woman alternate with the man in firing at the targets. This wonderful accomplishment was perfected and the fair Diana began alternating with the male shooter several months after the first operation of the sign.

There are 4,000 lights in the entire sign, which is 50 by 100 feet. The figures of the shooters are 21 feet high. The trap puller is 18 feet 6 inches tall. The target is 15 inches in diameter. The sign cost upwards of $100,000.

There are six operations to the sign, each one taking about one second. First the green lights come on, producing a lawn effect, and then in order appears the trapshooter, who places his gun to his shoulder and aims as the trap puller rises behind him. The puller throws the lever, which releases the target. You soon learn whether the target is hit or mist. When hit, the target bursts into hundreds of small lights, looking for all the world like the fragments of a target. When the target is mist it travels the length of the sign and disappears into the fourth dimension—inky blackness.

It is a most interesting display, and has proved the only means so far of grafically depicting the actual sport of trapshooting by mechanical effects.—*Photos courtesy of R. C. Maxwell Co.*



Atlantic City Crowds Are Now Kept Busy Figuring When the Electrical Trapshooter Is Going to "Miss."

Blinding The Submarine

By H. GERNSBACK

THERE is one dead sure way of making a ship torpedo-proof and that is by making it invisible. No one will deny this. For if the submarine commander can't see his quarry he can't torpedo it. Now, this is not intended as a joke, nor do I refer to Grimm's Fairy Tales, where the young prince by the turn of his magic cap becomes invisible to all. Rather I wish to stay within the realms of common physics, and present day physics at that.

After all, what is visibility? It is that which is perceptible to the eye. A ship visible in broad daylight is invisible in a dead black night. But visibility depends upon sight, so that a ship visible to you in broad daylight is invisible to the blind man. All this is obvious.

Our problem as applied to submarine warfare then resolves itself in blinding the submarine commander, so that he cannot see the ship he wishes to attack. Can this be done? I am certain of it. And what is more, the plan which I advance herewith is so idiotically simple, that probably just on account of its very simplicity it has not been tried before. It is the old story of Columbus and the egg—it is simple if you know.

In order to understand what I mean let us try a few simple experiments.

EXPERIMENT 1. Light up a powerful auto searchlight tonight, *only one tho.* The auto must be in the dark. Now station yourself 50 yards away. Do not look directly into the shaft of light. Can you tell *where* the driver sits? You cannot. You simply see the light shaft, that is all. But you can't see *where* the car is, and whether it is the right or the left searchlight that is lighted.

EXPERIMENT 2. Have an assistant throw the full glare directly into your eyes. You will be blinded for several seconds.

EXPERIMENT 3. Try experiment 2 in broad daylight, but with the searchlight detached from the auto. Ask your assistant to move to one side of the car. Have him train the full glare into your face. It will be impossible for you to see the car, but you cannot see the objects to either side of your assistant—even in full daylight—because the darkened glass does not pass thru enough light.

You readily understand these experiments, and they are correct as stated, having been actually tried out in New York City by us. "But, what is the good of them," you will ask. Here is the answer:

Consider that the submarine commander, in order to look thru his periscope, must of necessity be in the dark, or at least his quarters immediately surrounding him must be more or less subdued and shielded from light. You know you cannot look thru a telescope at a distant object without

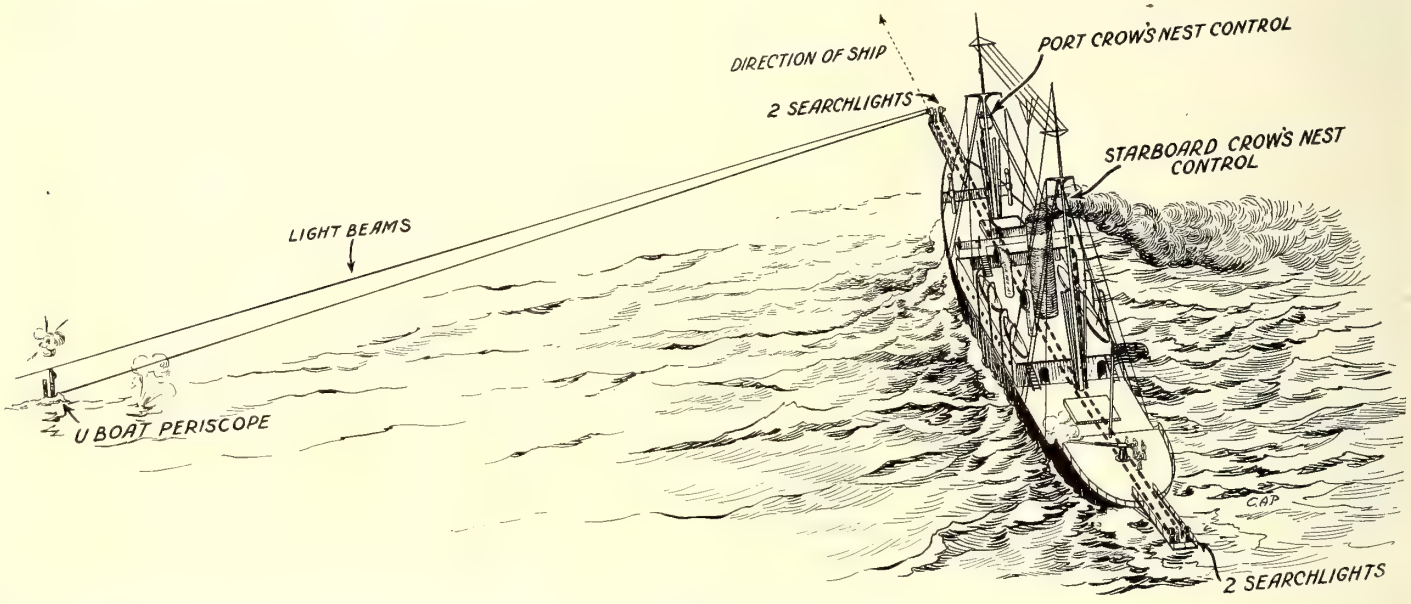


Fig 1. Keeping Very Powerful Searchlights Trained On the U-Boat Periscope, Makes It Impossible for Its Commander to Take the Attacked Ship's Bearings. The Searchlights Are Used In Broad Daylight. Now See Fig. 2.

EXPERIMENT 4. Repeat experiment 3, but protect your eyes by black glasses (smoked glasses). You will find that it won't help you at all. Instead of a ball of white fire you now get a ball of orange fire into your eyes. Less blinding, true—even with the sun shining on it. You are blinded in broad daylight. This, of course, providing that the searchlight is sufficiently powerful. If you don't own a searchlight try a mirror, and have your assistant reflect the sunlight into your eyes. *Try as you may, you will never as much as glimpse an object within* 500 *feet of either side of him.*

When a U-boat Commander wishes to torpedo your ship he must know three things:

1st He must know the speed of your vessel.

2nd He must know in which direction you move.

3rd He must know the distance measured in a straight line from the U-boat to your ship.

If you devise a means whereby he cannot make his observations correctly, the commander will be unable to torpedo you. The idea outlined in this article aims to blind the U-boat commander in broad daylight by means of powerful searchlights, thereby making it impossible for him to correctly take a ship's bearing.

An interesting as well as plausible article, that will set you thinking.

Consider that the submarine commander, in order to look thru his periscope, must of necessity be in the dark, or at least his quarters immediately surrounding him must be more or less subdued and shielded from light. You know you cannot look thru a telescope at a distant object without placing your eye close to the eye-piece, in order to shield your eye from the light. Now then imagine for a minute that you are the submarine commander, with your eye glued to the as yet submerged periscope. Slowly and cautiously you raise the periscope tube till it is a foot or more above the water. Rapidly you turn it in a circle to scan every point of the horizon. Nothing but the blue sky and the ocean. You keep on turning. Suddenly like a bolt of lightning your eyes are filled with a ball of white fire that makes your eyes water.

"Donnerwetter!" you will say—presuming that you are a German U-boat commander. Down comes the periscope, while you wipe your eyes stupidly. After a few minutes you try again. Once more you are blinded for seconds at a time. You see the light but that's all.

Now to torpedo a ship you must know several things. First you must know its position, that is how far away it is from you. Second, you must know in what direction the ship is traveling. Third, you must know its speed. Without knowing these three things it is as a rule impossible to torpedo successfully.

And with a powerful searchlight trained full on your periscope you would of course

know where the ship was, but you could not possibly know how far away it was from you as measured in yards, nor would you know if the ship was traveling *towards* you or *away* from you. You could not know if the searchlight was on the bow or on the stern of the vessel. Neither would you know if the ship was traveling at right angles to you or whether it presented its bow or stern to you. Artifices such as sensitive microphones will not help you much. You must take the ship's bearings accurately or you cannot possibly torpedo it; any naval man versed in submarine matters will confirm this. As long as the glare persists you cannot take your bearings. And you don't dare come up to the surface to walk on deck of the U-boat, because the ship that has the searchlight, most likely will have guns too. So you curse a full round, haul down the periscope for the ninth time and drown yourself in a *stein* of *Würzburger*.

My idea then is this. Mount on the ship four powerful searchlights. Our illustration shows how it should be done. There should be one attendant to each searchlight. Ordinarily the searchlights are not lighted but remain dark. Each searchlight operator wears a telephone headgear, exactly as our naval gunners do now. Stationed high up in the crow's nest are two observers scanning the water at all times with their glasses. One observer scans the ocean on the starboard side, the other overlooks the water on the port side of the ship. Strapt to their breasts is a transmitter, the same as "Central" wears. The instant the top of a periscope is observed, let us say on the port side, the crow's nest immediately gives the position to the two port searchlight attendants. By means of a foot operated switch, the current is turned into the searchlight instantly and the latter is trained onto the periscope. The searchlight being placed on ball or roller bearings, obeys the touch of the finger. Thru a sighting tube the attendant will positively throw the glare full onto the periscope *in less than five seconds* after he received the position from above. Very great accuracy is not necessary for these simple reasons:

Let us assume the U-boat is two miles off. At this distance the beams of the searchlight cover a fan-shaped expanse of about 50 yards. In other words, if the attendant makes a mistake of 25 yards on either side of the periscope, it does not matter; the U-boat commander will be blinded just as efficiently. Besides, the man behind the searchlight will correct his aim in less than three seconds, once his rays have hit the periscope.

Observe the simplicity of the operation. A hundred percent hit should be recorded every time. It is inconceivable how either of the two attendants could fail to make a "hit" with their rays. Note, too, that the operation is unlike firing a gun. First, considerable time is lost in sighting the latter; second, to hit an object one foot high and six inches in diameter (the enemy periscope) with a two or three inch projectile is almost an impossibility. It has never been done, except by pure chance. One hit in a thousand would be considered good. Consider, on the other hand, a shaft of light 50 yards wide, which can be moved *instantly* over an expanse of several miles, and it becomes plain why there cannot be possibly any escape for the periscope.

The beauty of the scheme is the great speed at which the entire operation is performed. Five to six seconds—and with a trained crew it should be less—is ample time once the periscope is located. No submarine commander can possibly make his necessary observations in such a short time; it requires a minimum of *one minute* to take a ship's bearings.

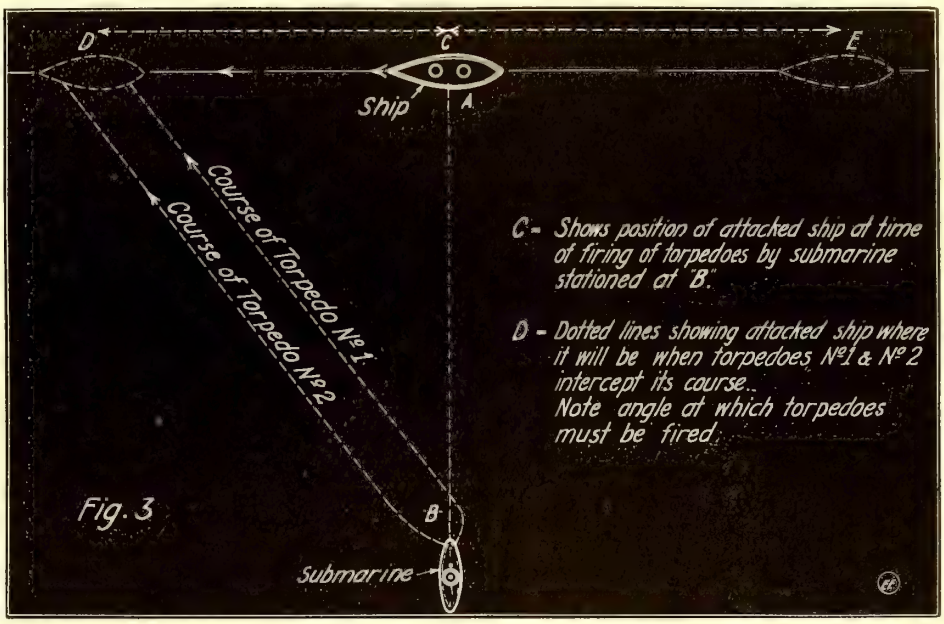
Of course it is evident that the success of the scheme lies in the ability of the lookout, who must spot the periscope at once. This, however, should not be so difficult for a trained seafaring man.

I mentioned above that two searchlights could and can be used simultaneously. For practical purposes and for tactical advantages a single searchlight, however, is preferable for the following reasons:

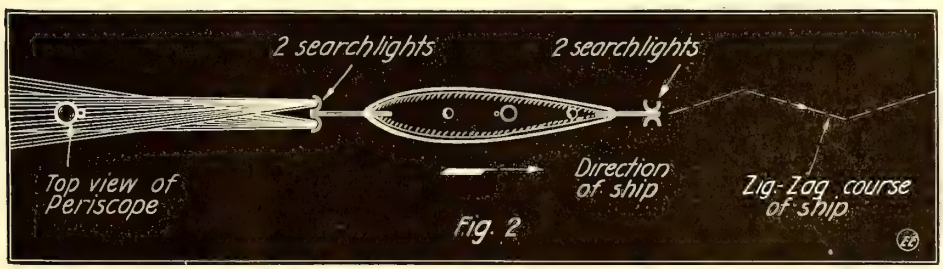
Our front cover shows how the searchlights are mounted on a long steel extension projecting some 25 feet from the bow and stern of the ship. This is done for two reasons. First, it gives the operator a better sweep, second and most important, if the submarine commander should fire a torpedo in the direction of the light rays, even if he has the general position of the searchlight, he probably would miss the ship by a great many feet, due principally to the extended location of the searchlights. This is not apparent at once but bear in mind that the commander *does not see the ship itself,* and that *he does not know if the beam of light originates from the bow or from the stern of the vessel* to be torpedoed. Neither does he know in which direction the ship moves. Then, too, as soon as the enemy periscope is sighted and has been covered by the light beam, the ship can turn about at once, the searchlight's rays however being kept on the periscope all the while during this maneuver. If the periscope is hauled down, the operators have but to watch for its reappearance, when the game starts anew. In the meantime the commander of the ship can either "zig-zag" his ship or else present the stern of the ship towards the U-boat. In either case torpedoing is extremely doubtful, and the attacked ship should make good its escape.

The scheme as outlined is for use in broad daylight, or rather during the daytime, but I doubt if it is feasible or practical at night. Nor is it necessary, for only comparatively few boats are sunk between sunset and sunrise. Of course in clear moonlight or in extraordinarily clear nights where the visibility is not too low, the searchlights can be used to advantage. In a very dark night, however, it is obvious that the U-boat possesses a great advantage over the ship. It is then almost impossible to sight the small periscope, and the U-boat would surely see the searchlight much quicker than the ship's observer could see the U-boat. Still the fact remains that the submarine commander would be baffled, because he could not tell if the searchlight was in the center, in the bow or in the stern of the ship. It is therefore doubtful if he could make a hit, except perhaps by using two torpedoes simultaneously directed fifty yards to either side of the searchlight. But even then a hit is not at all certain, because the ship might present its bow or its stern to the U-boat, thereby offering a very small target. In that case the torpedoes would of course pass the ship on either side of it. The main requirements of the plan as outlined are VERY powerful electric searchlights. Hundreds of thousands of candlepower MUST be used, otherwise the scheme is

(*Continued on page 270*)



To Torpedo a Ship the Submarine Commander Must Know These 3 Things: 1st, Distance from A to B in Yards; 2nd, Speed of Ship, i.e., How Long It will Take to Travel from C to D; 3rd, Direction in Which Ship Is Moving, i.e., Does It Travel from C to D or from C to E?



From the Ship's Position As Shown in Fig. 1 It Now Swings About—Still Keeping the Searchlights On the Enemy's Periscope—Thereby Presenting Its Narrowest Part to a Possible Torpedo. Then By Zig-Zagging, the Attacked Steamer Can Escape.

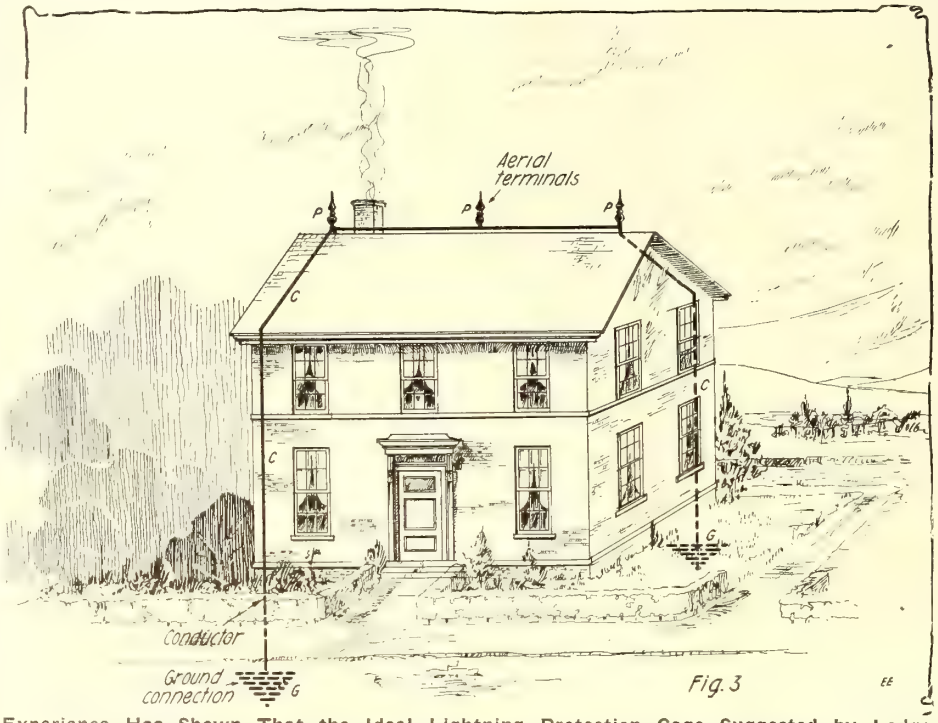
Thunder-Storms and Lightning Rods

By TERRELL CROFT

THIS matter of thunder-storms and lightning rods is one about which many inaccurate impressions exist. Altho the lightning rod is the oldest useful electrical invention (it was first proposed by Benjamin Franklin in 1752) it has been the writer's experience that, today, a majority of otherwise well-informed folks do not know whether or not lightning rods afford protection to the buildings on which they are installed. The subject is one of such universal interest that everyone should be familiar with the general facts relating to it. Therefore in this article the essential and underlying principles as they are explained by the modern theories will be discust.

There are no experiments which the reader can readily perform to verify the facts disclosed in this article because the electrical qualities involved in lightning phenomena are of such great magnitude that they cannot be accurately reproduced in the laboratory. In this instance he must, without verification, take the author's word for it that the statements which will be made are correct.

First of all, lightning rods *do*, when they are properly installed, afford practically perfect protection against lightning damage to structures. The United States Government Bureau of Standards finds that even as they are ordinarily installed—and they are not always in practise arranged as effectively as should be—lightning rods "reduce the fire hazard from lightning by 80 to 90 per cent in the case of houses, and by as much as 99 per cent in the case of barns." Inasmuch as something more than $8,000,000 worth of property is destroyed annually by lightning in our United States (practically all of this loss could be prevented by the suitable lightning-rod installations), the importance of the subject is apparent.



Experience Has Shown That the Ideal Lightning Protection Cage Suggested by Lodge Is Approximated Amply if a House Is Rodded in the Manner Illustrated.

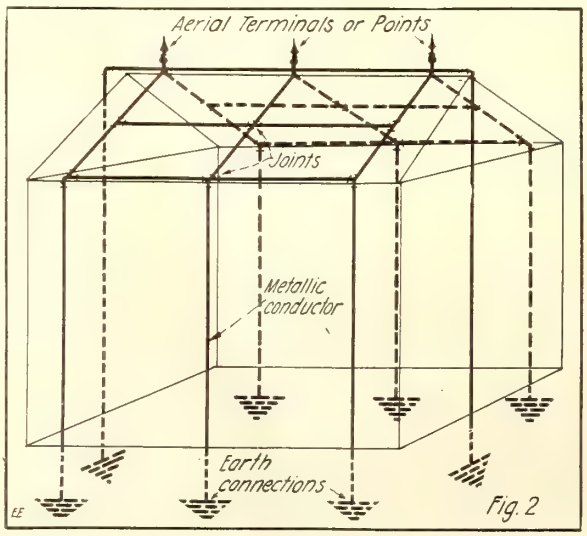
Now that we understand the fundamental dollars-and-cents feature affecting this situation, let us examine the causes of thunder-storms and lightning and find out how and why lightning rods afford protection.

What is it that causes lightning and thunder-storms? That is, how do the unusual electrical conditions, which we all know must precede a lightning flash between a cloud and the earth, originate? It is almost apparent that the cloud must be highly electrified—must contain an excess or a deficit of electrons as compared with the earth to cause the lightning flash. But how does the cloud thus become electrified?

No one can now answer this question with absolute definiteness. But we can, thanks to the researches of Dr. George C. Simpson of the India Meteorological Department, Simla, give a logical explanation which is well supported by experimental facts. It is, probable, as will be shown, that the electrification of thunder clouds is due to an excess of electrons in the cloud which electrons have been knocked off, in the base of the cloud, from drops of water by an ascending air current.

It appears that there is always a current of moisture-laden warm air ascending from near the earth to the cloud just prior to a thunder storm.

When this humid warm air current reaches the cold region at the cloud, the moisture in the air current is condensed by the low temperature there and then forms into drops of water. The data collected by Dr. Simpson tends to indicate that the ascending air current then breaks into smaller water particles or minute water globules the drops of water which have been condensed from it.



It Would Be Expensive and Unsightly to Install a Complete Inclosing Metallic Cage on Every Building, Altho This Would Afford the Ideal Protection from Lightning.

Now it can be shown experimentally that when "drops of distilled water which are falling downward thru an upward air blast of sufficient strength to cause some spray," the water particles and the surrounding air become *electrically charged*. The particles become positively electrified and the surrounding air becomes negatively electrified. In other words, such an air blast appears to knock off some of the electrons, which are, as has been explained, particles of negative electricity. These float about and finally penetrate to all portions of the cloud, charging the cloud negatively thruout its entire volume. The drops of water, from which the electrons were knocked, finally shift or are forced away from the area where they are supported by the ascending air current and ultimately fall to the earth as rain. Thus the entire cloud becomes negatively electrified.

The ascending air current from the earth to the cloud must, in order that the electrons may be torn off from the condensed-water drops, as above described, have a certain upward speed or velocity. And there are other conditions—which it is unnecessary to discuss here—that must be satisfied. But, taken all together, observation of actual conditions leads Dr. Simpson and others, who are well qualified to judge, to believe that the above outlined theory explains in a general way, how thunder-storm clouds become so highly electrified.

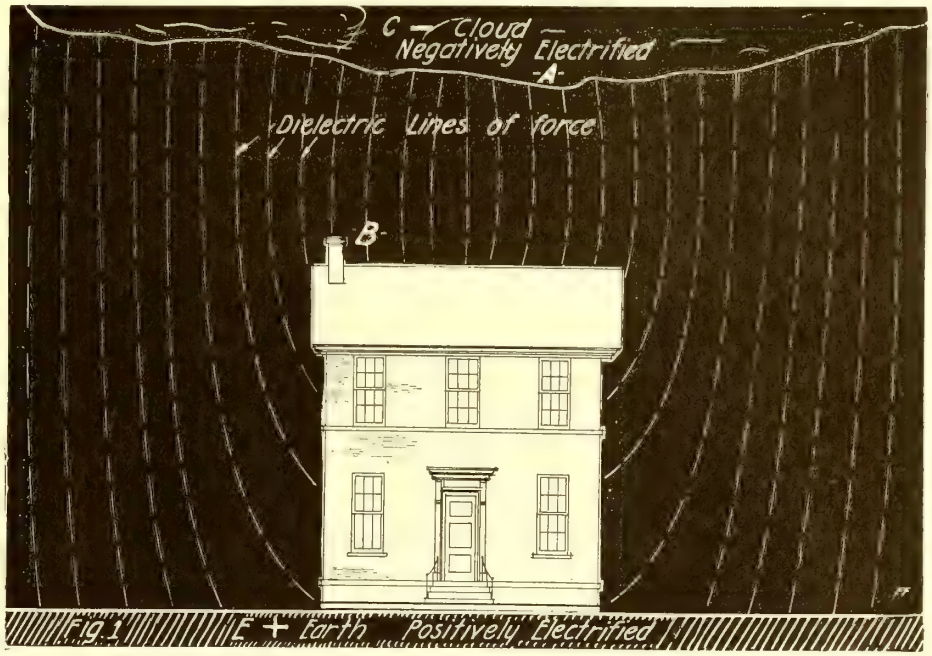
Thus when a cloud has become negatively electrified, thru the process above outlined, the situation may then be diagrammed somewhat as shown in Fig. 1. The cloud, *C*, contains many or an excess of free electrons—is highly electrified negatively. The area of the earth, *E*, under the thunder cloud, is in an almost neutral state, that is, practically speaking, it contains neither an excess or a deficit of electrons. Hence, there is a tendency (which is sometimes called an electric pressure or electromotive force) tending to establish an electrical balance between the cloud and the earth. There is a tendency for the excess electrons in the cloud to pass thru the atmosphere between the cloud and the earth to equalize the unbalanced electrical condition due to all of those excess electrons in the cloud.

However, the atmosphere is a non-conductor of electricity or electrons. Hence, the excess free electrons on the cloud cannot pass freely thru the air to equalize the electrical unbalance. (If the air were a good electrical conductor there could be no lightning.) But the tendency of the electrons to pass to the earth does create a stress—an electrostatic field—in the air

between the earth and the cloud. This field is represented in Fig. 1 by the dotted lines.

Now, as more and more electrons are knocked off of the water drops by the air current ascending from the earth to the cloud, the electrification of (the number of free electrons in) the cloud increases. The electrostatic stress in the air increases correspondingly. Ultimately, if the separation of the electrons from the water drops continues, the layer of air insulation between the cloud and the earth breaks down—it is ruptured—and then the free electrons in the cloud do flow to the earth and the flow is an *electric current.* Such an electric current thru the air produces what we call *lightning,* or a lightning flash.

The "break down" thru the air between the cloud and the earth will occur at the path of least opposition. Usually the path of least opposition—the shortest path electrically—is between a portion or knob of the cloud protruding from the lower face of the cloud and the upper end of some semi-conducting object extending up from the surface of the earth. Thus, with conditions as shown in Fig. 1, the lightning flash would probably occur between *A* and *B,* this being the shortest path. However, for reasons which it is unnecessary to discuss here, the shortest path in feet between the cloud and the earth is not necessarily the one of the least opposition.



Elementary Representation of the Electrostatic Stress Existing Between the Earth and a Charged Cloud. When This Stress Reaches a Certain Limit, the Air Insulator Is Broken Down, an Electric Current in the Form of a Powerful Spark (or Sparks) Passes, and We Have a "Lightning" Discharge. Thunder Is the Sound Caused by Lightning.

Thus we now understand what, probably, causes lightning and why lightning usually "strikes" high objects extending from the earth's surface, such as buildings, trees, towers, steeples and the like.

If there is no lightning-rod installation on a building or object and lightning "strikes" it, the lightning-flash current will flow thru some part of the building to the earth. The current, which is always of enormous intensity, may develop sufficient heat to ignite combustible objects in its path. Thus, buildings are set on fire by lightning. When the current flows in a non-combustible material, it may heat the part of the material in its path to very high temperature. Then, almost instantaneously, that moisture which has been absorbed by the material and which lies in the path of the current is turned into steam. An explosion results. It is due to these explosions that bricks, stones and boards are knocked from buildings and trees are splintered and split. Chemical action due to the great current may also play a part in these "explosions."

However, if a building be surrounded by a metallic cage, as suggested in Fig. 2, and it is "struck" by lightning, the metallic conductors will offer a path of such low resistance (as compared with the path thru some poorly-conducting part of the building) that all of the lightning flash current will flow thru the conductors to earth. Then no damage will occur, assuming, of course, that the conductors are large enough so that they will not be melted by the lightning-flash current. We may now understand how lightning rods protect buildings.

It will be very expensive to install a complete inclosing metallic cage like that of Fig. 2 on every building, altho such a cage would afford the ideal protection. Experience has shown that ample protection is provided if only part of the cage is installed on the ordinary building, as shown in Fig. 3. The conductor is so routed over the building as to afford maximum enclosure with minimum material. Aerial terminals or points (*P, P* and *P*) are connected to the top part of the conductor system and extend upwardly into the air. The lower ends of the down conductors are grounded as shown at *G* and *G.*

There is not sufficient space available here to give complete directions for the installation of lightning-rods, because if an installation is to be made most effectively there are many things must be considered. In fact the routing and arrangement of the conductor system are the most important features of an installation. Good materials can be arranged and connected so as to provide ineffective protection. A few pointers will be given.

The lightning conductor should not be insulated from the building and its contents. First of all, it is foolish to endeavor to insulate against the enormous voltages to which lightning flashes are due. An insulator that would actually *insulate* against such voltages would be almost as big as a small-sized house. Furthermore, even if it were feasible to insulate the lightning rod system from the building and its contents, it would be undesirable and, in some instances, positively dangerous to do so. The ground connections should be good. The ground conductors should extend down into permanently-moist soil.

As to the best metal for the lightning conductors: Any reasonably good conductor will do, provided the rod is large enough so as to be mechanically strong and so that the lightning-flash current will not melt it. Either iron or copper is ordinarily used. While iron—if big enough—is altogether satisfactory as long as it lasts, copper is much more preferable because it will have a long life under conditions where iron would rust away in a short time. All iron conductors should be protected with a zinc coating to minimize corrosion. A good substantial iron conductor is, doubtless, in most cases, preferable to a flimsy, weak copper one.

The day of the lightning rod agent of ill repute is past. Once, these agents used to ramble over the countryside, selling the unsuspecting farmers anything from a fake lightning rod to a neat parcel containing a "million volts." But the farmer of to-day is educated in electrical matters.

JOINING GLASS AT MODERATE TEMPERATURES.

In a paper recently presented to the Faraday Society, Messrs. Barker and Dalladay described some interesting experiments on the direct joining of glass at relatively low temperatures which they have carried out in the research laboratories of Messrs. Adam Hilger, Ltd., England. The results described are not only of very considerable direct scientific interest, but afford great practical advantages in the construction of glass apparatus out of what is actually a single solid piece instead of using more or less unsatisfactory cements. The advantage of such solid construction is particularly evident in polarimeter tubes and absorption cells—the latter can now be constructed with truly parallel faces and with inside faces optically worked.

The process of joining which the authors have worked out consists in placing the surfaces of glass to be united in good optical contact under pressure, and then raising the temperature to a carefully determined degree. The glass surfaces thus treated become perfectly united, so that the two pieces of glass will not separate along their former interface, and the composite piece acts as if it were a single solid mass, even a crack or a diamond-cut will pass thru the junction without hindrance or deflection. The temperature employed is chosen as high as possible in order to lessen the time required for union of the surfaces, but if distortion of the optically worked surfaces is to be avoided, then the temperature must not be taken too near the limit, which the authors describe as the "annealing point." This point they determine by observing the strains set up in a piece of glass while being heated at a definite rate in an electric-tube furnace; for each kind of glass they find that these internal stresses—which are readily observed by means of polarized light—disappear quite suddenly. At this point, also, the glass becomes appreciably soft, and can be indented by a sharp tool. When similar kinds of glass are used, having similar "annealing points," then the welding of surfaces in optical contact takes place well below this annealing point. Very dissimilar glasses, however, cannot well be joined, since the softer becomes distorted before the harder is hot enough to weld freely.

Women Radio Operators To Aid Uncle Sam

AMERICAN women have never yet been found wanting when it comes to real dyed-in-the-wool service, no matter what that service might be—even to helping in executing the duties of war. The exigencies of war have now claimed several hundreds of the fair daughters of Cleveland, Ohio, where a new radio service school has been inaugurated by Arthur S. Newman, of that city. It has received the unqualified recommendation of Secretary of War Newton D. Baker, who says of it:

"This effort to teach a number of competent young women the art of wireless telegraphy in order that their services may be available to the Government if needed, seems to me a very practical thing to do, and it shows, too, the patriotic impulse of the service and the practical wisdom of choosing a way in which services may really be demanded."

The classes, which meet every Monday evening at 8 in the Cleveland Advertising Club's rooms, represent a real, sincere and highly practical preparedness measure conceived by Mr. Newman, indorsed by Secretary of War Newton D. Baker, and entered into with a zest that assures success both to instructors and students.

The idea back of the instruction is the training of women to take places of men in telegraph and railroad service and in the wireless service on lake vessels, so that the men now holding those jobs may be relieved for the service the country needs. Railroad men, telegraph and wireless operators have been in great demand since the very inception of strife.

The classes are well organized and happily ensconced in rooms where work is conducted in a quiet, systematic manner. The Cleveland Advertising Club has bent every effort to make the pupils comfortable, and supplies every need for efficient work, like tables and blackboards.

There have been over one thousand applicants for instruction and 238 of these have been accepted. Among these are lawyers, teachers, physicians, professional and business women. A very small per cent. has tackled the intricacies of wireless telegraphy—only about forty, in fact. Of course the wireless operation presents more complications which many girls fear to undertake, and, too, there is a great deal more opportunity for real service in telegraphy than in the wireless.

"Except in case of exhaustive war," Mr. Newman stated, "there will be but little employment for women as wireless operators, while railroad work and telegraphy offer an unlimited field. In case of a long-drawn out war, women would doubtless be employed in the wireless service on freighters and passenger lake boats, but the railroads and telegraph companies can make use of efficient women right now."

Various railroads have evinced interest in the classes, but the Baltimore & Ohio has assumed a very live and active concern since the very inception of the measure, even sending Charles Seldon of Baltimore, chief telegrapher and head of the maintenance department of the road, to Cleveland to investigate the plan and offer the assistance and co-operation of the road. The company has supplied the classes with books on railroad rules, and has practically guaranteed to place in positions every girl who is turned out from the classes. The railroad has further announced that it is not looking for girls to take the positions in order to cut the pay roll, but will place them on the same salary schedule it uses for its men employees.

Telegraphy, wireless operating, railroad traffic and signaling will be taught during the course. The classes meet in separate rooms. A part of the two-hour period is given to talks, and the rest to practise work.

The directors of the school endeavor to bring speakers each Monday evening, who will fire the patriotism of the students as well as give them practical talks on the subject matter. Scientific demonstrations are also given, and as the work progresses, more complicated and technical programs will be planned.

The girls work at three tables in the telegraph room. Tables are equipt with instruments, and each table has its own instructor. Miss Agness Galagher, who has

(*Continued on page* 270)



Indorsed By the Secretary of War and Engineered By a Progressive Cleveland, Ohio, Man, Mr. Arthur S. Newman, These Sturdy American Girls Are Rapidly Learning the Arts of Radio and Wire Telegraphy, So As To Be Ready When Uncle Sam Needs Them.

DATE OF ISSUE.—*As many of our readers have recently become unduly agitated as to when they could obtain* THE ELECTRICAL EXPERIMENTER, *we wish to state that the newsstands have the journal on sale between the fifteenth and the eighteenth of the month in the eastern part of the United States and about the twentieth of the month west of the Mississippi River. Our subscribers should be in possession of their copies at these dates. Kindly bear in mind, however, that publications are not handled with the same dispatch by the Post Office as a letter. For this reason delays are frequent, therefore kindly be patient and do not send us complaints as to non-arrival of your copy before the twenty-fifth of the month.*

ONE CENT'S WORTH OF ELECTRICITY.

At ten cents per kilowatt hour electricity will operate the following for one cent:

A 16-candlepower Mazda lamp for five hours.
A six-pound flatiron 15 minutes.
A radiant toaster long enough to produce ten slices of toast.
A sewing machine for two hours.
A fan 12 inches in diameter for two hours.
An electric percolator long enough to make three cups of coffee.
A heating pad from two to four hours.
A domestic buffer for one and one-quarter hours.
A chafing dish 12 minutes.
An electric broiler 6 minutes.
An electric griddle 8 minutes.
A radiant grill for 10 minutes.
An electric curling iron once a day for two weeks.
It will operate a luminous 500-watt radiator 12 minutes.
A portable vacuum cleaner 45 minutes.
A sewing machine motor two and one-half hours.
A vibrator (for massage) four hours.
A washing machine for half an hour.

"BUY A LIBERTY BOND" ELECTRIC SIGN BLAZED.

One of the leading New York electric sign producers erected this sign for the Government, free of all cost. They also maintained the sign free of cost to Uncle Sam and paid the "juice" bill. That's what we call real patriotism! Let's have more of 'em. The space is a $20,000 one. The original plan was to erect an exceptionally artistic sign, but the time was too short, so Mr. Woolley, the Director of Publicity at the Treasury Department, suggested the design as used. The phrase, "The Fate of Mankind Lies in Your Hands" is his thought.

There are 3,800 lamps in the sign, and the structure is 50 feet high and 125 feet long.—*Photo courtesy O. J. Gude Co.*

WIRELESS PATROL OF TRANSMISSION LINES.

The Chattanooga Wireless Club, an amateur organization having wireless stations at Chattanooga and Cleveland, Tenn., rendered excellent service to the Tennessee Power Company on three occasions by discovering breaks in the transmission line. The company has used an aluminum line, and when this parts, the arc has made itself heard at the wireless stations.

ELECTRIC VIBRATORS HELP HEAL CANADIAN WOUNDED.

Surgeons in most of the hospitals caring for soldiers have found the electric vibrator extremely helpful in assisting the cure of returned soldiers, suffering from any form of muscular paralysis. The devices hasten by days the cure of bayonet, shrapnel and gun shot wounds, as well as sprains, strains and bruises. Nerves shattered by long hours under fire in the trenches, sudden shell-shock, and the resulting nervous disorders, are all benefited by electric vibratory treatment.

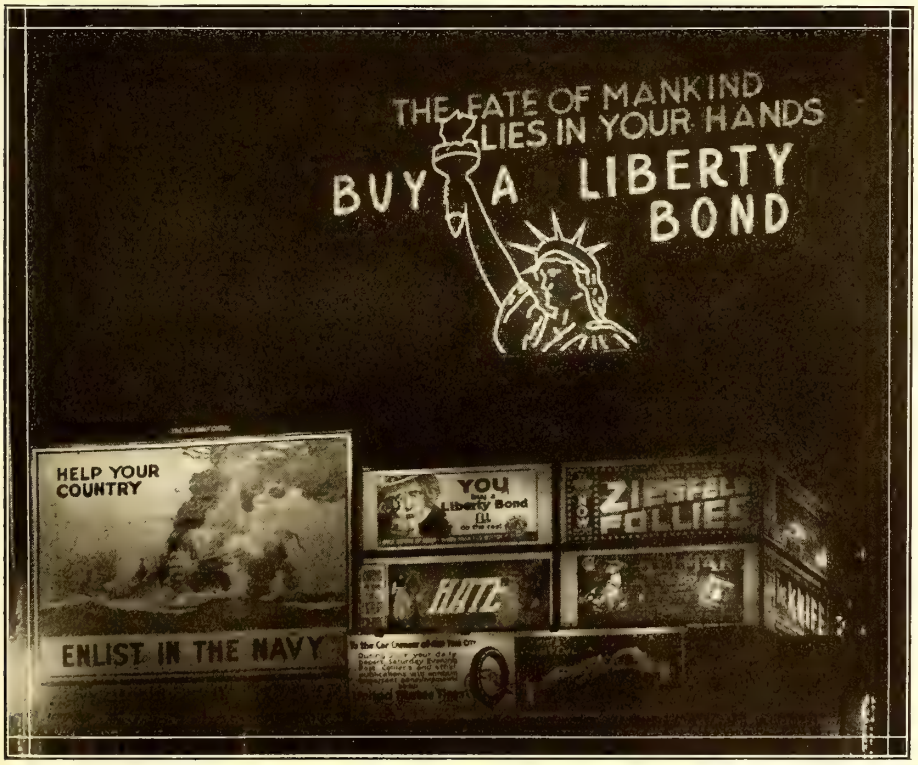


The Electric Vibrator as Well as the Treatment Lamp Have Come Into Their Own for Relieving the Stiffened Muscles and Wounds of Hundreds of Canadian Wounded, the Illustration Showing These Devices in Use.

Under a doctor's instruction the nursing sister can use the vibrator on the patient with equally good results, and as the patient improves he himself can assist his cure. This treatment is said to energize and vitalize, besides purging the blood of toxic poisons—soothing the nerves and giving complete relaxation more restful than sleep.

The illustration shows a special vibrator, as well as a thermolite treatment lamp in actual use in one of the Canadian convalescent homes.

The thermolite, whose healing properties are produced by a combination of light and heat, is highly recommended for nervous complaints.



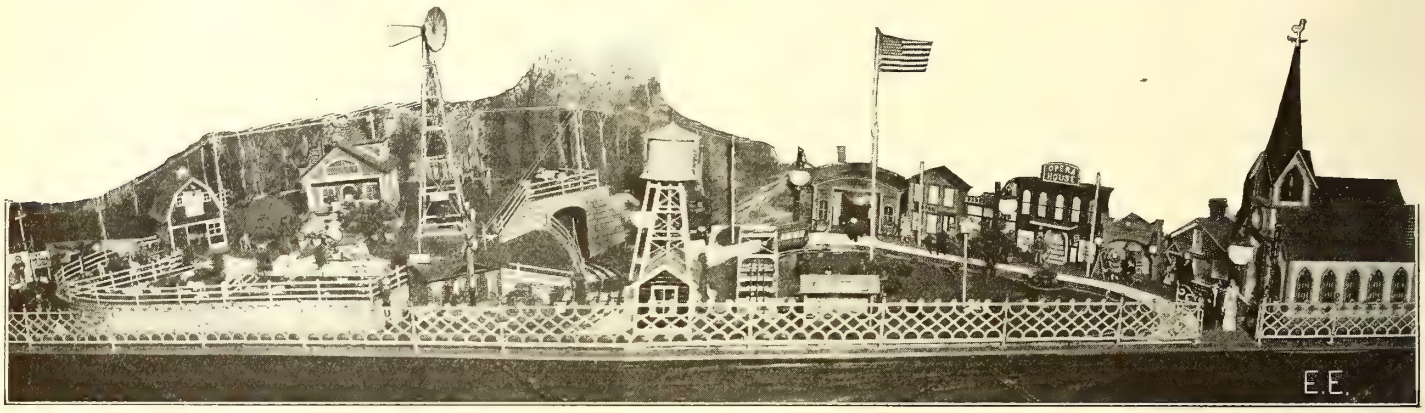
These Electric Signs "Buy a Liberty Bond" and "Enlist in the Navy" Were Erected and Maintained in New York City Free of All Cost to Uncle Sam by a Patriotic Concern in That City.

CITY SELLS LIGHTING POSTS FOR MUNITION USE.

The Street Department, Bronx, N. Y., has arranged for the sale of about 6,000 old lamp-posts used for gas service, and now superseded by an electric street-lighting system, to R. D. Wood & Company, Philadelphia, Pa., at a cost of $1.06 each, with removal by the purchaser. Prior to the country's entrance into the war the borough had been paying about $11 each to have the posts removed by private contractors, bringing a considerable asset where a financial burden was anticipated. It is said that the posts will be utilized in shrapnel manufacture.

An Electrical Miniature Village de Luxe

WE were all kids once, to be sure, but it is doubtful if any of us ever had such a wonderful play-thing as two little Chicago boys, George and Robert, the twin sons of Mr. and Mrs. Robert Hutchison, who have an electric village that might very well typify in miniature the great electrical city of Chicago in which they live. The photograph cannot, of course, show the movement of the miniature railroad train, operated by electricity; nor the speeding third-rail interurban electric car; the whirling windmill pump; the twinkling of the electric stars in the little blue firmament provided; the tolling of the church bell and the music of the organ; the man cranking the automobile at the entrance to the garage, and the flashing of the sign on the opera house. These things the camera must show as tho they moved not; but when the village is in operation they all do move and, in addition, the pretty little electric fountain throws its spray nearly a foot into the air, the electric street lamps glow, the store, residence and church windows shed a pretty light, and the safety gate at the railroad crossing, just where the big engine is standing in the photograph, falls and rises with precision on the approach of the train and when it has past.



How Would You Like to Be the Boy Who Owns This Wonderful Electric Village—Where the Trains Whiz by the Crossings, the Windmill Turns, the Church Chimes Ring, and Even the Opera-house Electric Sign Flashes On and Off? Two Chicago Boys Are the Happy Owners and We'll Bet Dollars to Doughnuts They Will Grow Up to Be Future Edisons. Such a Display Is Nothing If Not Highly Educating and Inspiring.

All of these things are arranged with beautiful mechanical perfection of finish and detail. The base is fifteen feet long and six feet wide. The motive power for everything is electrical, there being nine separate small electric motors in different parts of the foundation of the electric village. There are no less than 42 miniature electric lamps, counting headlights on the trains and other small lights.

With the aid of an able assistant whose artistic work with the brush appears in the decorative part of the work, Mr. Hutchison, who made nearly every detail himself, has worked out these things and many more, with a careful regard for relative sizes; thus, the farmer standing in the barnyard, and the horse and other live stock nearby, are relatively of about correct proportions; so are the other people on the street and on the porch of the house, and so are the buildings and the implements and accessories which go to make up the completeness of social and commercial activity in this model village.

The village main street begins just to the right of the residence, and along it will be seen the house, the garage, the opera house, the stores and the church. The residence is on a grassy knoll with lawn and path neatly laid out, and the railroad line finds it necessary to pass thru a long tunnel underneath this part of the scene. The street railway, on the other hand, makes a loop over a pretty rustic bridge and around the park with the little pond and the ducks at the right-hand end in the foreground, passing back to another loop at the left hand and returning. An interesting feature of this street railroad is the automatic switches connecting the main track with the loop at each end and operated by the flange of the rear wheels of the car as it passes over them, so that the next time the car approaches the loop it will pass round it in the opposite direction, varying the effect.

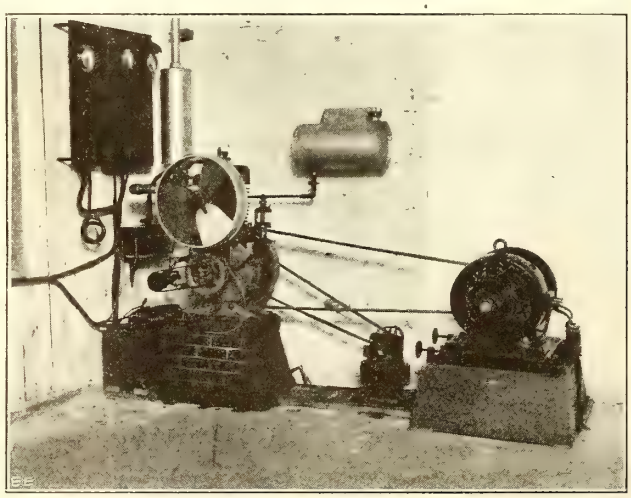
The electric fountain used to be supplied from the water tower, the pump feeding the latter; but this has been superseded by a direct feed from the pump to the fountain, a metal diafram and air chamber equalizing the pressure.

So particular has Mr. Hutchison been about the construction of his electrical features, that there are certain lamps in this installation which were made especially for him. These little incandescent bulbs have flat sides like very short bung-hole lamps of miniature type, and were made to accommodate themselves to the little electric lanterns which were originally purchased as oil lamps and have been made over by Mr. Hutchison. All motors have been rewound to accommodate themselves to the voltages derivable by the use of a 150-watt step-down toy transformer and the alternating current lighting circuit. The smaller illustration herewith shows the neat 400-watt electric plant, comprising a dynamo driven by a gasoline engine. A suitable switchboard is installed so that service may be taken from the electric light company's mains or from the isolated plant here pictured.

A very neat asbestos board switchboard on the wall near by has switches for all the principal divisions of the exhibit, including the street lighting, the street car, the railroad train, fountain, windmill, graphophone, church chimes, sign flasher, star flasher, store lights, automobile, crossing gates, etc.

It is quite interesting to see the two little boys manipulate these switches with the utmost quickness and precision to exhibit the various effects of which they are so fond.

Mr. Hutchison sets up this electric village in the basement of his residence each Christmas time, and for the last five years it has been growing to its present proportions.



The Complete Independent 400-Watt Electric Generating Plant Which Is Available for Supplying the Miniature City Shown Above with the Necessary Current.

LIABILITY TO TRESPASSERS ON POLES.

An employee of a telephone company went on the pole of a power company in the absence of any contract or agreement giving the employee or the telephone company the right to do so. He was injured by an electric shock received thru a defect in a transformer. In an action against the power company it was held that both the telephone company and its employee were trespassers on the power company's pole, and the power company was not liable for the injury. The establisht principle in the law of negligence, that there is no liability to trespassers except for injuries wilfully or wantonly inflicted, is applicable to electric companies and electric appliances.

A wireless plant fully equipt and capable of sending messages 5,000 miles, was discovered by government Secret Service officials near the base of Mount Hood in the Cascade Mountains of Oregon recently. Evidently the proposed raid had become known, the plant being abandoned.

BEAUTIFUL ILLUMINATION OF CAPITOL AT WASHINGTON.

Against the sombre shadows of night, at this critical moment in our history, the inspiring white dome of our Capitol at Washington, high above the Federal City, stands resplendent in rays of shining light, a radiant monument to freedom and democracy. The plans for illuminating the Capitol dome were perfected for the recent inauguration of President Wilson, and the spectacular results were so satisfactory that the system was made permanent.

Flood lighting was the method used to illuminate the great dome, which is 135 feet in diameter at the base, 218 feet high above the roof, and is surmounted by a bronze statue of Freedom. Eighty-four flood projectors, each equipt with a 400-watt flood lighting lamp, were used. These projectors were placed in four banks, about 200 feet from the dome, on the corners of the House and Senate wings. By placing the projectors in these positions, it was found possible to throw light from different directions on the 36 columns at the base (representing the 36 states in the Union at the time it was designed), and thus eliminate objectionable shadows. Some shadows are desirable to bring out the architectural beauty, but if the shadows are too pronounced they become objectionable.

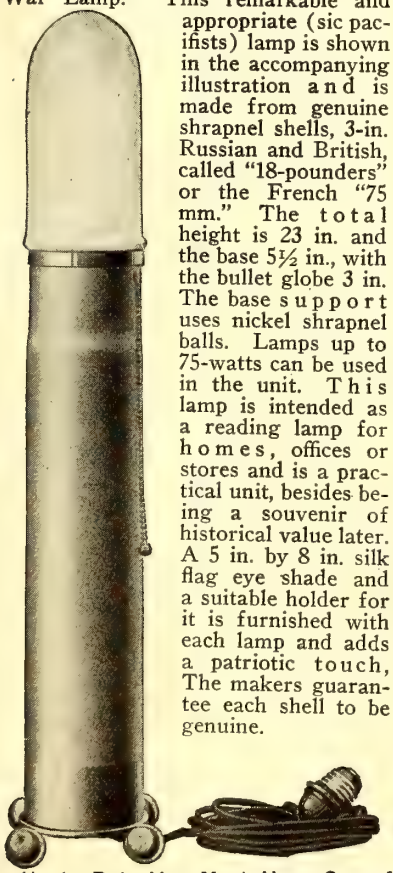


The Capitol at Washington, D. C., at Night with Its New Electric Flood Lighting—a Triumph in Illumination Engineering.

The building proper was also lighted to a low intensity, to form a setting for the dome and to relieve the contrast between a very light dome and a dark building. The building is about 750 feet long and 250 feet wide. The central portion, or main building, is of sandstone painted white, and the House and Senate wings at the ends are of white marble. Surrounding the building on three sides is a wide concourse bounded by a parapet. Thirty-four flood lighting projectors, each equipt with a 400-watt flood lighting lamp, were mounted on ornamental posts and placed on this parapet. The poles were originally designed to take large opal globes. These globes were removed and blocks of wood were placed in the fittings, to which the projectors were bolted. Thus the projectors were inconspicuous and did not detract from the natural architectural features around the building. *Photo. G. E. Co.*

A REAL "WAR" LAMP MADE FROM SHELLS.

An Ohio concern is now offering a special lighting unit which is known as the "War Lamp." This remarkable and appropriate (sic pacifists) lamp is shown in the accompanying illustration and is made from genuine shrapnel shells, 3-in. Russian and British, called "18-pounders" or the French "75 mm." The total height is 23 in. and the base 5½ in., with the bullet globe 3 in. The base support uses nickel shrapnel balls. Lamps up to 75-watts can be used in the unit. This lamp is intended as a reading lamp for homes, offices or stores and is a practical unit, besides being a souvenir of historical value later. A 5 in. by 8 in. silk flag eye shade and a suitable holder for it is furnished with each lamp and adds a patriotic touch, The makers guarantee each shell to be genuine.



To Be Up to Date You Must Have One of These Electric Table Lamps Made from Genuine 75 mm. Shells.

ELECTRIC PROGRESS IN JAPAN.

Japan is taking to electricity like a duck to water. The Lake Inawashiro plant now includes six 10,000 h.p. turbines, and transmits power at a pressure of 115,000 volts over 140 miles of transmission lines in Tokio. This is one of the big hydro-electric schemes which Japan has now put in service. At the end of 1914 there was a total of 1,940 stations supplying electricity, 390 of these being central stations, 24 railway plant, 47 combined railway and central station plant, 1,366 isolated plants, and the remainder official installations. The water-power stations number 695, steam 788 and gas-driven stations 547. The total capacity of these stations is 608,544 kw., of which 341,809 kw. are central stations, 140,000 isolated plants. The water-power equipment totalled 366,243 kw., steam 217,967 kw., and gas stations 24,-344 kw. There were 21,909 miles of aerial and 751 miles of underground transmission lines.

METAL HEATING PAD.

A western manufacturer has placed on the market, after thoro testing, a metal heating pad. This hot-pad consists of a heating element encased in a nickeled steel jacket made up of hinged units permitting the bending of the inner heating element. The flexibility is sufficient for the requirements demanded of a hot-pad as the illustration shows; it may even be wrapt around a limb.

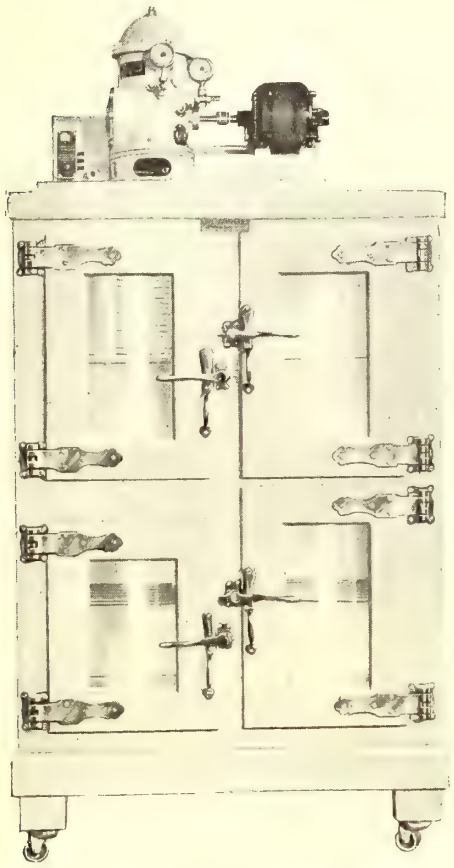
It operates from any lamp-socket, consumes 40 watts and its heat is easily regulated, even in the dark or under the bed-cover, by a small lever. Any temperature from 100 to 200 degrees Fahrenheit is easily attained and automatically maintained by thermostat; it cannot become overheated, as current is shut off automatically when certain temperature is reached. Under average conditions, it may be operated at least five hours for less than one cent's worth of current. It is provided with soft, washable and removable eider-down cover and encased in "parchmyn" envelop. It comes complete with cord and connection plug, ready for use.



The Electric Metal Heating Pad Here Illustrated Is Excellent for That Stiff Neck, Ear-ache, or Neuralgia. It Connects with Any Lamp Socket.

LET THE ELECTRIC REFRIGERATOR KEEP YOUR FOOD.

The electric refrigerator illustrated comprises a motor-driven ice-machine adopted to any standard refrigerator, the ice machine itself occupying what would ordinarily be the ice-box. Here we have the cooling coils, partly immersed in a brine tank containing receptacles in which small blocks of pure ice are formed for table use. This electric refrigerator is claimed to be entirely safe. Explosions in large refrigerating plants are due to the use of ammonia gas under pressure. To avoid possible danger from this source in the household refrigerator, ethyl chlorid at low pressure has been substituted for ammonia.



Using Ethyl-Chlorid as the Refrigerant, This Electrically Operated Refrigerator Automatically Keeps the Food Compartments at Frigid Temperature. Besides, it Freezes Ice Cubes for Table and Kitchen Use.

This type of electric refrigerator is automatic. It is regulated to maintain a constant temperature, the machine starting and stopping automatically, by means of an ingenious thermostatic control. All valves are locked; the consumer is not called upon to make any adjustment, and the machine will run from one to three years without adjustment.

Artificial refrigeration by such a machine is said to be much cheaper than ice. About two and one-half kilowatt hours of current are required for one hundred pounds of ice-effect in the course of one day. At the eight-cent rate for current, this makes the cost of refrigeration twenty cents for the ice-effect of one hundred pounds, as contrasted with real ice at forty cents a hundred. In suburban and country districts the contrast is still more marked for the price of ice there more frequently runs up to sixty and seventy cents a hundred, and in addition the ordinary ice supply is usually irregular and inadequate.

Automatic control cuts down the amount of electricity used, for when the set temperature is reached the motor is automatically cut off. Thus the machine consumes current only when actually in operation, and this is but a small proportion of the twenty-four hours. The entire machine can be operated from an ordinary lamp-socket, this being another indication of the small amount of power required.

With an electric ice machine, the purity of the table-ice can be absolutely guaranteed, each family using whichever distilled water it prefers for this purpose. Table ice is frozen in about two hours' time. Furthermore, with artificial cooling substituted for melting ice, the refrigerator can be kept strictly clean with little effort, thus preventing contamination of food.

The household refrigerator comes in three sizes; the smallest is rated to give the cooling effect of one hundred and fifty pounds of ice; the second size, three hundred pounds; and the largest, six hundred pounds.

The machine is regulated to preserve certain temperatures thruout the refrigerator. In the upper left-hand compartment, where table-ice is made, the temperature is twenty-four degrees Fahrenheit. The section below it is kept at thirty-eight degrees, the lower right-hand compartment at forty-two degrees, and the upper right hand at forty-six degrees. These variations provide for proper circulation of air within the refrigerator, thus keeping it dry and sweet. They are also desirable, as foods require different temperatures for best results in their preservation. Thus, milk, butter and eggs would be placed in the lower left-hand compartment; cooked foods and meats in the lower right-hand chamber; and fruits and vegetables, requiring a less degree of cold, in the upper right-hand chamber.

The refrigerant, ethyl-chlorid, is a neutral gas which in the manner employed does not change or deteriorate with use, neither does it act on the metals of which the machine is constructed. The process employed is known as the compression system; the gas is expanded from a liquid state at a relatively high pressure to a gaseous state at a lower pressure, corresponding to the temperature required. This gas is withdrawn from the cooling coils and discharged into the condensing chamber by means of a specially designed rotary compressor, where, by the combined action of pressure and cooling by water passing thru the condenser coil, the latent heat of vaporization is removed, and the gas condensed to liquid again, ready once more for the refrigerating cycle. Water consumption is at the rate of about fifteen gallons per hour while the machine is running, the flow being shut off when the machine is stopt.

Mine gas is detected with a portable electric outfit which miners carry.

FLASHLIGHTS AS CHEAP AS MATCHES.

It costs no more to operate an electric flashlight than to use matches for the same purpose, according to figures compiled recently. Each modern tungsten battery (for flashlight use) is guaranteed to burn for a certain number of hours, and, using this guarantee as a basis, it is found that the average cost of operating such a flashlight is one cent for 600 flashes, of a second each, or for 60 flashes of 10 seconds each.

Now, the average one-cent box of matches contains just 60 matches. Each of these will burn for 15 seconds, but when allowance is made for some blowing out and others being used for a second or two only, it is estimated that the average match does not burn longer than 10 seconds. At this figure the cost would be the same as that of using a flashlight.

Some of the most popular styles of flashlights, however, cost a good deal less than this to operate. Take for instance, the tubular pocket flashlight, in which the battery gives 1,200 flashes of a second each for one cent. This size battery costs one-half as much to use as would safety matches.

AN ELECTRIC TABLE LAMP THAT SPEAKS.

The combination phonograph and electric lamp shown in the accompanying illustration has been developed by a New York inventor. The phonograph is concealed in the base of the lamp, which is so designed that it will accommodate any size records up to the 12-in. disk. When the phonograph is to be played the hood is raised, the disk inserted and the power turned on.

The disk is revolved by a small motor in the same circuit as the electric light, but controlled by a separate switch. This arrangement makes it possible to play the instrument when the lamp is not in use. Instead of using a horn as with some "talking" machines, the sound is diffused thru the stem of the lamp, which, it is claimed, considerably softens the tone. The "phonolite," as this combination set is called, is especially applicable where there is a limited amount of room as in small apartments.



Behold! the Electric Table Lamp That Speaks and Sings—Thanks to a Phonograph Cleverly Concealed in the Base and Driven by a Miniature Electric Motor.

ELECTRICAL CITY GUIDE TELLS WHERE YOU'RE AT.

By D. Wyman.

A novel device, the *Electric Directory*, has been installed by several prominent New York City Hotels and will soon be seen all over the United States.



How Do I Get to 125 Street and Seventh Avenue? That and Hundreds of Similar Ones Are Now Answered by the Electric Street Guide, Here Shown Installed in the Hotel Martha Washington, New York City.

The apparatus serves the dual purpose of an accurate street guide and attractive sign board. It is of pleasing appearance, about sixteen square feet in size and has an all-glass and mirror front. In its center is a large map of New York City with a number of interchangeable advertising spaces arranged alongside of it. Below the map are two boards, each mounted with thirty numbered push buttons. In a pocket between the push button boards is an *Index Book*, wherein every point shown on the map is alphabetically listed, with a number placed opposite each of them. All a person has to do to operate the guide is to press the button bearing the number of the place sought; railroad station, part of street or avenue, etc., whereupon a bright light appears on the map giving the desired location, while a red light indicates the hotel as the starting point. The pressure of any button automatically flashes up all the advertisements, which together with the map are, however, visible and readable even when not illuminated.

Fifty 4-volt lamps are evenly distributed behind the advertising spaces. The current is supplied by a special type of storage battery. The pressure of any button closes the circuit to one map light and to the starting point indicator, automatically operating a relay which closes the second circuit for the fifty advertising lights.

TEACHING WAR AT COLUMBIA.

Columbia University's enrolment in the special war courses which opened some time ago has exceeded all expectations. The work is in charge of Prof. James C. Egbert, director of the department of extension teaching. Prof. Egbert has decided to permit students to enter the classes for several more weeks.

The courses include training in trench construction, camp sanitation, army regulations, radio telegraphy and engineering training such as is needed by army engineers and for similar courses.

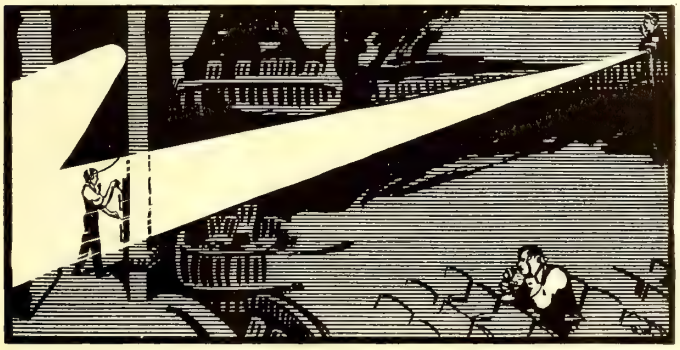
Other courses are offered for governmental training, and hosts of classes are open for special training for women who desire to be of service to the Government during the war.

HOW TELEPHONE AIDS STAGE LIGHTING DESIGN.

The great motion pictures of the day are practically all directed by means of the telephone, but the telephone is used not only for directing motion picture scenes, but also as a modern aid in securing desired lighting effects in connection with the staging of scenes in a theater catering to legitimate drama.

An expert in lighting effects equipt with an operator's set occupies a seat in the audience and transmits instructions to the stage electrician also equipt with an operator's set, who is stationed at the electric light switchboard, which is located on one side of the stage. By using the telephone, the most perfect lighting arrangements can be obtained and proper adjustments made at the instant under expert direction without the noise of bells, buzzers or other signals, as the telephone line is in constant use thruout the performance.

The stage electrician is so located that it is impossible for him to see the lighting effect as it is seen by the audience. The telephone has again solved a problem and has accomplisht the desired results with success.—T. R.



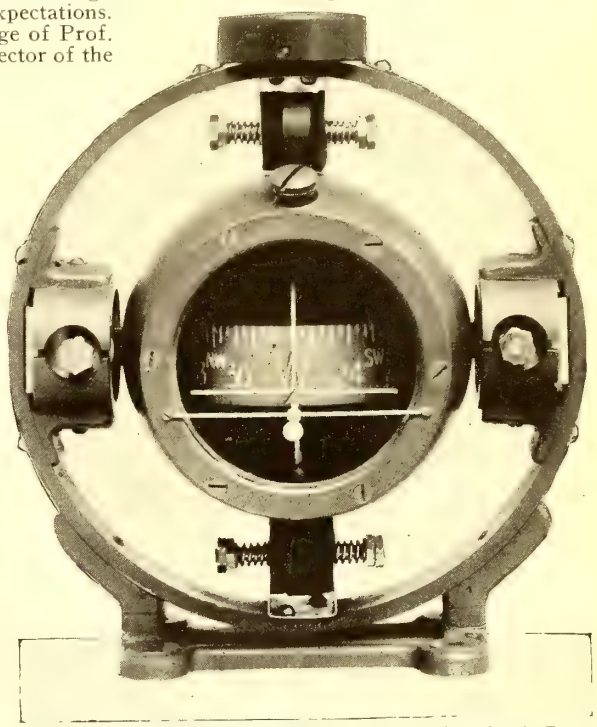
The Telephone Has Found Another Role in Helping the Experts to Design Theatrical Illumination Effects.

AT LAST A VERTICAL COMPASS.

Navigators on the Sea or in the Air can now ascertain their direction from a compass whose dial is *vertical*. This is especially convenient because it makes possible the reading of a compass set on a level with the eyes and does away with the necessity of bending forward and over the compass. At the same time the vertical compass on aeroplanes can be mounted a greater distance from the disturbing elements, such as control cables, etc.

This new compass was invented by Captain F. O. Creagh-Osborne, Superintendent of Compasses for the British Admiralty. It is now manufactured for the United States Air Service by Elmer A. Sperry, member of the Naval Consulting Board, and inventor of the gyro-compass now used in American and other first-class navies thruout the world.

This new instrument is a magnetic compass, having the card mounted in a liquid in order to minimize oscillation and to help support it. The *compass card* really is a narrow strip of metal mounted on the float. The points of the compass are indicated on the card with a *radium compound* so they will be visible at night. The bowl of the compass is like a metal sphere having a circular window on its surface.



Always, for Centuries, Mariners Have Had to Look Down on a Compass. Now They May Look Straight Ahead, Thanks to the "Sperry" Vertical Compass.

This bowl is mounted so that the vibrations are not transferred by the frame to the card. Gimbal rings are entirely dispensed with and, at the same time, a generous heeling angle is obtained. Neither reflecting nor refracting devices are necessary, the compass being read directly. Compensating magnets are provided in the small container attached separately to the frame.

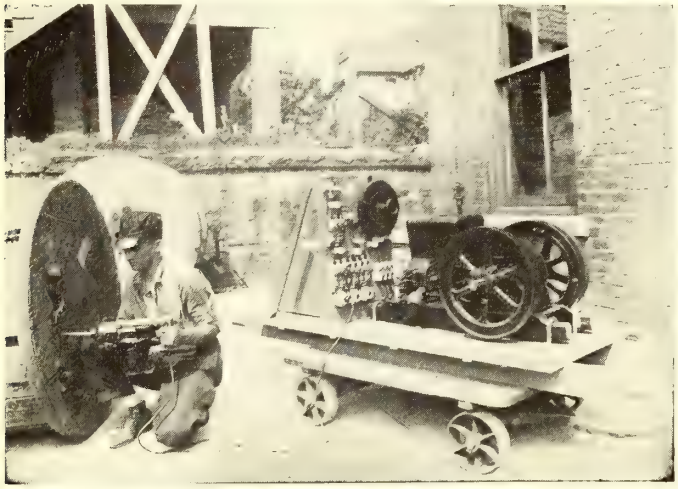
ELECTRIC AUTOS IN MADRID.

It is considered probable that there will shortly be a good opportunity for pushing the sale of electric vehicles in Madrid, as the cobble pavements of the city must be replaced by asphalt or other similar surface within two years.

The ordinary animal-drawn carts and heavy wagons are injurious to asphalt pavements, and it should not be difficult to get a footing for the smooth-running and reliable electrically-propelled vehicle.

UNIQUE PORTABLE ELECTRIC PLANT.

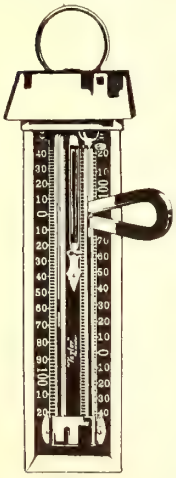
The accompanying photograph shows a portable electric generating outfit which has been manufactured especially for the use of the American Telephone and Telegraph Company, in building the Jacksonville-Key West toll line along the concrete causeways of the Florida East Coast Railway. The set consists of a 1½ h.p. gasoline engine, belted to a 120 volt 30 ampere generator. The wiring on the power board admits of attaching three leads which are used for the electric drills and electric hammers, one of the latter being shown in the position in which it will be used. The weight of the entire outfit is not great, four men being able to handle it easily. —*Photo courtesy Western Electric Co.*



Extremely Compact and Efficient Portable Engine and Dynamo Set for Supplying Current to Electric Hammers and Drills, One of Which Is Here Shown In Use.

MAGNET RESET FOR MAXIMUM AND MINIMUM REGISTERING THERMOMETER.

The thermometer shown in the illustration below is *set* by drawing the bottom of the index in each side of the tube down to the mercury column, with the magnet.



As the temperature fluctuates the mercury will rise in one side or the other, leaving the index in either case to show when the next reading is taken what has been the highest degree of heat or cold since the thermometer was last *set*.

WIRELESS FOR TRANSMISSION LINE SERVICE.

A new and important use has been developed for wireless telegraphy in connection with long-distance transmission lines of electric light and power companies. For communication between stations over large systems of this character, a private telephone service usually is installed along the route, with lines strung on the transmission poles or towers, making them liable to all the troubles to which the power leads are subjected.

The wireless has now stept in to eliminate the many inconveniences and interruptions of communication over metallic circuits with absolute and reliable service under all conditions of operation. The radio installation seems destined to be placed to this new use with increasing range of accomplishments and unquestioned possibilities, both in service and maintenance features, becoming a highly essential factor for extensive power transmission systems, where continuous and positive service always is necessary.

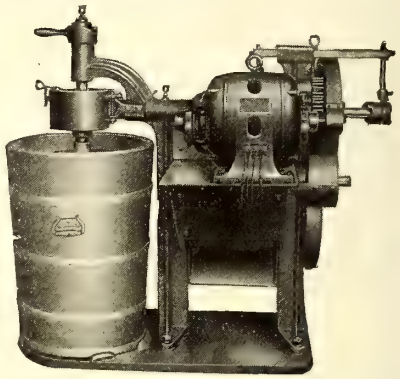
As a result of many practical experiments, the Southern Sierras Power Company of California is rapidly adopting wireless telegraphy transmission and reception between its important power plants and substations, readily appreciating the value and dependability of radio-communication at all times. The company's system extends from Bishop, Cal., to the Imperial Valley district, a distance of about 500 miles, consisting for the most part of a double three - phase high-voltage circuit on steel towers. The stations in the Bishop Creek section, on the north are situated on a rugged and mountainous country, a territory which is frequented by sudden and exceptionally severe storms and floods and extreme weather conditions.

Radio transmitting and receiving sets have been installed to provide communication over this district, as well as at other important plants on the main transmission system leading into San Bernardino. Plans are being perfected to provide all other primary stations with wireless equipment, effecting a complete chain for radio-communication thruout the company's territory. In this, the equipment installed at the different plants will be arranged for a particular type of service, in some instances allowing for a communicating radius of 500 miles or more, and in others for connection with the next sub-station along the route only; dependent upon the character and province of the station. The service, when entirely installed and perfected, will be used both for regular and emergency purposes.

It is interesting to note that the station operators have welcomed this change from the telephone and telegraph to wireless; and, adept in the use of the key thru the private telegraph system which the company has employed superimposed upon the telephone lines of the system, the new installation has not brought any particular departure in the general workings of the station organizations. Moreover, the company has been active in advancing the knowledge of its operators in wireless and the wireless code, furnishing equipment, data and instructions to make them fully proficient in this new phase of science.—L. R. W. Allison.

ICE CREAM BY ELECTRICITY.

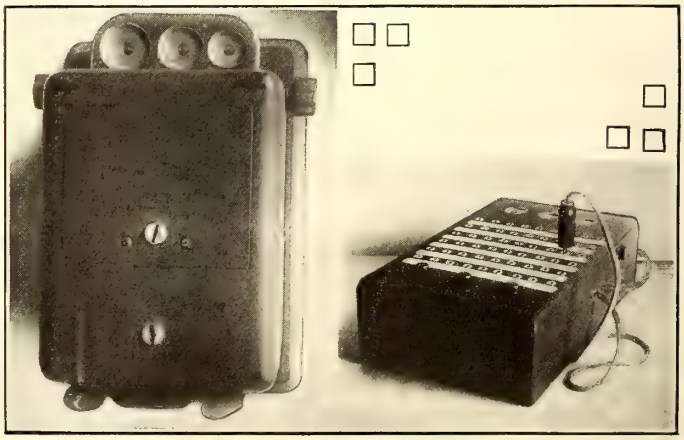
Did you ever grind an ice-cream freezer on a sultry July day, and—eventually lose about 4 pounds avoirdupois, along with your appetite for the great American delicacy. That's the usual case—but our friend, the electrical engineer, has perfected an electric motor drive for turning the ice-cream freezer which is warranted not to develop a "glass" arm when the cream is about half frozen. The cost of one hour's operation for this welcome servant is only a fraction of a cent for the family size outfit, and the initial cost is soon repaid. It is furnished in both large and small sizes.



Ice Cream at Any Time, When You Have the Motor-Driven Freezer at Hand. It Saves Its Cost in a Very Short Time.

COLLECTING TELEPHONE TOLLS BY MACHINE.

A device used as an accessory to telephone systems and which, it is claimed, simplifies the collection of telephone tolls among tenants in apartment houses, hotels or other buildings has been developed by a New York concern. The device may be placed on the switchboard ledge and connected with a coin collector in every apartment. The machine enables the operator to determine whether a coin is deposited in any particular machine. Such notification will correspond with the different denominations of the coins used. The operator can also cause any number of deposited coins to be delivered to a customer, either for the purpose of making change or for returning the equivalent of any deposited coin or coins. If a tenant does not have the necessary money with which to pay for a call, the operator can cause a check or checks to be issued to the tenant, who in turn deposits them in the machine. The value indicated on these checks is redeemed by the customer when the regular monthly or weekly collections are made.



A New Device Intended to Facilitate the Collection of Telephone Tolls in Apartment Houses and Hotels. It Enables the Operator to Check Coins Deposited and Also to "Make Change."

Even the Chinaman has found electricity a cheap and obedient servant. Thousands of electric irons and cooking utensils are used in China.

Unique Electrical Apparatus Reads the Mind

The accompanying illustrations show two extremely interesting electrical apparatus of French design, and which are of particular moment at this time, when we hear so much about industrial and various other kinds of psychological research. The larger illustration shows a precise electrical instrument, comprising an electro-magnetic solenoid which operates a shutter. When this shutter descends, as in the present illustration, it exposes for a short space of time, several words, or in some cases several sentences, the time of all such exposures being governed accordingly. The person taking the memory test with this apparatus sits in front of the table and the operator simply presses a button which causes the electric solenoid to drop the shutter of the apparatus quickly. By means of a stop-watch the time during which the shutter is dropt is accurately taken note of by the expert making the test, which time may be a few seconds or more, depending upon the length of the sentences or phrases, and by carefully grading the make-up of the words and sentences flashed before the eyes of the person undergoing the test and also by making a series of careful observations of the various time periods required for the person to more or less accurately memorize th se captions, an accurate criterion of the subject under test is obtainable.

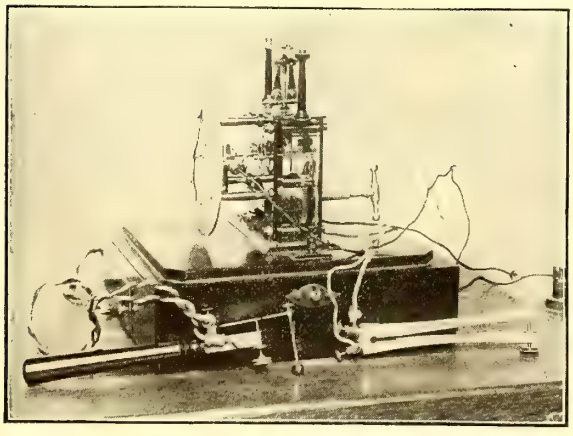


Photos from Jacques Boyer

How Many Words Out of 25 in a Group of Sentences Can You Remember If They Are Flashed Before You for a Fifth of a Minute? With This Electric Shutter Device and a Stop Watch the Expert Will Know Exactly What Kind of a Memory You Have.

The smaller photograph shows a D'Arsonval chronoscope or electrical time mechanism designed for certain applications in psychological research. This apparatus can be used by the average person with very little training. Its use in one particular instance is for measuring the exact time, in thousands of a second, required for auditory reaction, or in other words—the time required for the nerve waves to pass from the ears and to signal the brain that a sound has been received by them. The special, double contact electrode used by the expert making the test is provided ith a small tapper, so designed that when this is used to strike a bell, that its movement will cause the electrical circuit to be opened.

Connected with the clock-work of the electrical chronoscope is a second two-contact electrode shown at the right and which is held in the hand of the person under test. The procedure is as follows: The expert strikes the bell with his special electrode, and the instant the gong sounds, the electrical circuit thru the chronoscope is opened, permitting the clock-work to rotate the hand over the dial, which is spaced off in small fractions of a second. As soon as the subject hears the sound (which is not, it should be noted, at the exact instant when the sound strikes the membrane or drum of the ear, but an appreciable and measurable time afterward) he at once presses the contacts of the electrode in his hand, and this actuates an electro-magnet on the chronoscope, causing it to stop. It is thus a simple matter to at once read off the fraction of a second required for auditory reaction to take place.



A Gong Is Struck with the Electric Hammer at the Left; When You Hear the Sound You Compress the Hand Switch (at Right) and the Electric Chronograph Registers in 1-1000ths of a Second the Time Required for Auditory Response.

A NEW PORTABLE PYROMETER.

By Thomas W. Benson.

Possibly the first form of portable pyrometer or means for measuring radiant heat was the human eye. And stranger still to relate is the fact that some of the *Old-timers* can heat-treat steel more accurately by eye than some of the younger experts who use the various forms of pyrometers.

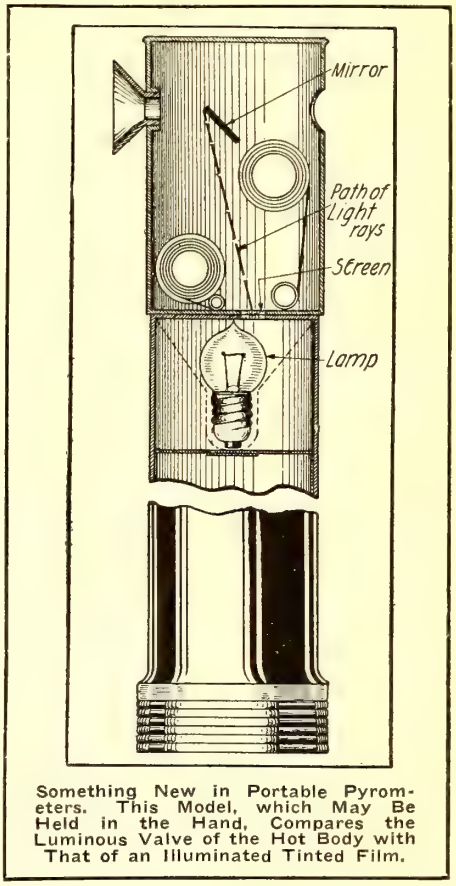
This is not difficult to understand when it is considered that pyrometers using a fixt thermo-couple do not measure the temperature of the piece under treatment but merely the temperature of the furnace itself. That a difference exists in the temperature of the two requires no proof.

The portable form of pyrometer solved this by measuring directly the temperature of the body itself by measuring the brilliancy or amount of light given off. This method takes advantage of the fact that the temperature of steel varies directly as its luminosity after it begins to glow.

The illustration shows the constructional details of a unique portable pyrometer recently brought out. This device is about the size of a large tubular flashlight, being but 8½ inches long. It can be easily carried in the pocket, is sturdy, accurate and not apt to get out of adjustment.

As will be observed the case contains at the lower end a flashlight battery that supplies current to the small incandescent lamp. Above the lamp is placed an opaque diafram in which is mounted a diffusing screen. By means of small rolls and knobs mounted on the outside of the instrument it is possible to cause a tinted film to pass before the diffusing screen. The film is tinted in the varying shades of color assumed by a heated body. The different shades are carefully calibrated with relation to the corresponding temperatures.

At the left is seen the conical eye-piece through which the operator views the hot body under observation. A small mirror is arranged to cover one-half of the field of vision as shown. This mirror reflects the light that passes thru the tinted film from the lamp.



Something New in Portable Pyrometers. This Model, which May Be Held in the Hand, Compares the Luminous Valve of the Hot Body with That of an Illuminated Tinted Film.

In use the rolls are turned until both halves of the field correspond exactly in shade, then by referring to the dial it is possible to determine accurately the temperature. It is possible to build the device in practically any range, but the more common ranges are 1000-1800 degrees Fahrenheit and 1800-2300 degrees Fahrenheit.

NEW YORK HERALD WIRELESS STATION AGAIN IN COMMISSION.

The wireless station of the New York *Herald* was formally returned to commission on February twenty-eighth in its new quarters atop the United States barge office in New York. Mr. John Bottomley, vice-president, secretary and treasurer of the Marconi Wireless Telegraph Company of America, New York, was present at the opening ceremonies. This station was placed under censorship last October.

The Radio Bomb

By C. M. ADAMS

"YOU'VE been wantin' proof. There it is!" With a gasp of astonishment the group about the big stove in Preston's store leaned forward with a jerk, necks craned, mouths and eyes wide, staring in wonder at the object old Tom Waldon had drawn from beneath his big sheepskin coat.

Cylindrical in shape, it was made of heavy steel, measuring about two feet in length by four inches in diameter, and painted a brilliant red, save at one end where the figure "6" was stenciled in black.

"What does that prove?" Dick Preston demanded, from his perch on a cracker barrel.

"Prove?" Waldon repeated, glaring up at the boy who questioned him. "Just what I've been tellin' you—that he's a 'spy' and he'll blow us all up if we don't stop him! Why, me and my hoss would've been blowed to pieces this mornin' if it hadn't been wet from layin' in the snow so long!"

"What is it?" Pete Bailey asked in an awed whisper.

"A bomb!"

With a clatter of upsetting chairs the terror-stricken group fled precipitately to the opposite end of the store.

"Don't get scared!" Dick laughed, slipping down from his barrel and taking the tube from the old man. "Look!"

With a twist of the threaded cap he removed one end of the tube and poured out in his free hand a dirty brown wet powder.

"It's gunpowder!" Waldon exulted.

"Powder, nothing; it's sand and ashes and dirt!" Dick scoffed. "Watch!"

He jerked open the door of the glowing stove and threw in a generous handful of the material. On the red-hot coals it lay in an inert mass, while one by one the group tiptoed cautiously back to see and regain courage.

"Course it won't burn when it's wet," old Tom defended. "That's why it wouldn't go off this mornin'. It was layin' right in the middle o' the road at the end o' my lane and my hoss almost stept on it. So I gets out and picks it up after I'd seed it was wet."

"Suppose it was gunpowder. What does that prove anyhow?" Dick demanded, resuming his seat on the cracker barrel.

"He put it there!" the old man declared.

"Did you see him?"



". . . Straight as an Arrow the Uncanny Thing Came, Showing Momentarily the Glimpse of a Humming Propeller. . . . A Huge Column of Spray and Ice Spouted Skyward From the Jam, and—Where Had Been the Towering Ice Barrier, the People of Pine Flat Saw the River—Yellow, Swift and Turbulent, Running Free and Clear Thru the Gap and Down Past the Hamlet."

"Who else would?" Waldon parried. "Who's been prowlin' around here all hours o' the day and night? Who's been livin' in a cabin on Pine Mountain by himself all winter and not sayin' what he's up there for? Couldn't he shoot up the whole valley with a cannon up there?"

"Them boxes and crates and barrels and things he had me haul up, was mighty heavy," Tom Sullivan affirmed.

"Yes, and what's that thing he's been carryin' around that pretends to be a surveyin' instrument?" Pete Bailey demanded.

"All that don't prove a thing!" Dick retorted angrily. "Just because he doesn't choose to tell you what he's here for, and everything about his business, you think he's a spy. Why don't you be reasonable?"

"I am reasonable," old Tom grinned maliciously. "I hain't takin' no chances. I sent down to Squire Jefferson's this mornin' for a search warrant and when it gets here, I as constable, will go to that cabin and see just what he's doing there and find out if he can't give some reason for actin' the way he does!"

"That's the stuff. Good for you, Tom!" a half dozen endorsed.

"Yes sir, I think it was time we was a doin' somethin' besides sittin' around here talkin' and wonderin' and lettin' him have a chance to blow us into next week!" the old man continued importantly, opening his coat so that the nickel-plated star showed plainly. "This here bomb," and he tapt the tube in his lap, "sort o' set me to thinkin' and I'm goin' up the first thing in the mornin' if that search warrant comes up on the mail this afternoon."

"You're doin' just right, Tom!" Pete Bailey declared. "I was just wonderin' if you was goin' to let him run loose around here, while you're constable."

"You bet I won't!" that official boasted.

But Dick Preston did not endorse old Tom Waldon's new decision. For a moment he sat on his cracker barrel, staring in surprise at the old constable and the group about the stove which was so loud in its support of his new plan of dealing with the mysterious and undesirable stranger.

And then without a word he slipt to the floor and past out into the house which adjoined the store and mounted the stairs to the room which he occupied under the eaves.

A worried frown puckered his brow as he seated himself at a table covered with a bright new set of wireless telegraph instruments, and his frown deepened as he adjusted the detector and inductances.

"Suspicious old fool!" he growled as he slipt on the head receivers. "I hope we can beat him!"

"H D, H D, H D, D P," the white spark in the gap crackled in clean-cut Continental as he tapt the key.

Again the call repeated before he threw over the aerial switch.

Then, "O K, D P, H D," sounded the clear reply in his receivers.

"News to report. Coming up," the spark snapt.

"O K," the reply buzzed.

Slipping receivers from his head Dick drew on mackinaw, mittens and cap, as he went rapidly down the stairs, and paused on the back porch to adjust a capable looking pair of snowshoes.

Then off up the slope which rose abruptly at the rear of the building he swung, laying a course eastward to where Pine Mountain reared its low broad bulk against the skyline. For a half hour he climbed, leaving behind the hamlet sprawled in the valley on the broad flat just below the narrow gorge where Pine River rushed swiftly between steep high banks. But not once did he turn to look back at the cluster of houses or to glance up at the dazzling glory of the late afternoon sun on the clean crisp whiteness of the deep snow which covered the whole country.

With the worried frown deepening between his brows he mounted steadily until he topt the last rise and came out on a broad flat summit, where, in the midst of a large clearing, stood a cabin.

It was different from the usual mountain cabin in that it was long, narrow and low and windowed at but one end. Otherwise, except that from one end a span of glittering wireless antennae rose in a long slant to a tree at the edge of the clearing, it was quite the usual rough log structure.

Dick drew off his snowshoes at the door and stept inside without knocking. He found himself in a small room, evidently partitioned off from the main windowless apartment. Stove, bunk, a table spread with a litter of papers, and the other usual furniture made it seem like the ordinary cabin room. But at one side stood a table on which was spread the elaborate wireless instruments connected to the antennae wires. It was similar to Dick's set except that above the table was a row of carefully dialed instruments marked "Distance—height—speed—direction—shot control."

Dick had barely entered and drawn off his mackinaw when the door leading into the other room opened and a tall man whose erect military poise contrasted strangely with his grease-smeared overalls, entered.

Dick saluted.

"Good afternoon Captain," he said.

"Hello, Dick," the tall man replied, returning the salute. "What's the matter? Didn't the tests work right?"

"Oh, they were fine!" Dick answered. "It's old Tom Waldon again."

"Oh, your worthy constable and defender of the peace and safety of the commonwealth," Captain Hardy laughed, as he drew up a chair beside the stove.

"Its nothing to be laughed at," Dick protested, while the concern deepened in his face. "He's sent for a search warrant and is coming up here to investigate you and what you've been doing."

"Whe—e—e—ew!" the tall man whistled. "What's the matter now?"

"Number '6' fell in front of his house last night. He's all worked up about it and now he's certain you're a spy. The search warrant will be here tomorrow morning if the mail's on time; then he'll ransack the whole place. If he'd only keep his fool notions to himself and not try to be buttin' around into other people's business!" and Dick kicked savagely at a block of cordwood beside him.

"Of course I don't want to stir up any trouble," Hardy began thoughtfully. "You know I could resist search by him."

"But he's got the whole bunch worked up to believing the same as he does," Dick put in despairingly.

"Yes, that's true," Hardy replied. "But to come back to something more important, how did the tests come out?"

"I have the locations here," Dick replied, drawing a notebook from his pocket. "Number '6' fell in front of his place, and the rest—"

For a half hour the two bent over a detailed map of the valley while they compared figures and locations.

"That's fine! The biggest variation is about four feet and that's corrected by the adjustments I've been making to-day," Hardy breathed in satisfaction, as he straightened up. "Now I think if we can run a test with a real charge instead of those dummies we can be prepared to announce results."

"I know a good target for it," Dick volunteered. "Its a big pile of drift and rubbish down by the bend just below town. Its doesn't belong to anyone. See—" and he pointed out the spot on the map.

"Good! Just the thing!" Captain Hardy endorsed. "What do you say we try it this evening? If your friend the eminent detective is to come up here to-morrow with his search party, we can tell him everything, if the test is successful."

"That suits me," Dick agreed.

"Very well," Hardy replied. "We'll set the time for nine o'clock then. Get your 'interference' going and we'll see how this tryout works."

"All right, sir. I'll be ready," Dick replied. "And I hope that warrant doesn't get here in time," he added as he smiled thru his anxious frown.

"Don't you worry about that," Hardy advised.

"Yes, but it makes me sick," Dick protested. "When a man's trying to do what you are and then for him to plot against you! It makes me want to hit him!"

"Oh, never mind," Hardy laughed. "Just you go to bed to-night and get plenty of sleep. We may have to run another test if this one doesn't work and I'll have to have you fresh and ready, because you're responsible for half the success of this thing."

"No—no!" Dick protested, while he blushed with pleasure.

"Yes, but you are," the tall man insisted. "I couldn't have done a thing without your 'interference' and the other ways you've helped. So just go along and forget that old spy-chaser."

But Dick could not shake off the thought of what the old man might do to wreck Captain Hardy's plans. All the way down the long white-covered slope he wondered and pondered, as he tried to find some way out of the complication into which his friend was drifting with the local officials.

"Has the mail come in yet?" he asked his father as he tramped into the kitchen and found the family at supper.

"No," Joe Preston replied. "The trail's getting too soft. That wind's melting the snow fast. Didn't you notice it?"

Then Dick remembered. While he had been in the big cabin on the top of Pine Mountain the wind had shifted to the south and with it had come balmy warm air which had rapidly softened the hard-crusted snow.

"I don't like this spell at all. There's too much ice and snow on," Joe Preston remarked.

But Dick rejoiced secretly. It might so impede the trails as to make it impossible for old Tom's search warrant to arrive in time from the Squire down the river.

His anxiety was gradually relieved as all that evening the warm south wind blew and the snow melted. It was dripping from the eaves in pattering cascades when he went upstairs into his room about eight thirty, after preparing his lessons for the 'morrow.

But he forgot it and even old Tom as he adjusted his wireless instruments carefully and cleaned all the contacts and tightened connections.

Then at a quarter before nine his call came in, "D P, D P, D P, H D."

"O K, H D, D P," he responded and the reply came back.

"Ready!"

Throwing over the aerial switch he set to work methodically. For the next fifteen minutes he sent anything and everything, stopping at intervals of several seconds to make swift changes in his transmitting wave length adjustment.

Then just as the hands of the watch which lay before him, pointed to nine, he heard faintly the muffled boom of an explosion from down the river, and with a satisfied sigh slipt off his receivers and crawled into bed.

Day had scarcely broken the next morning when he was awakened by an unusual sound. Sitting bolt upright in bed he listened for several moments before he recognized what it was.

(*Continued on page 279*)

WATCH FOR THE SEPT. "E.E."

"X-Ray Tubes for High-Frequency Coils."—A subject of extreme interest to all those owning radio transmitting apparatus or high frequency coils, by Dr. Frederick F. Strong.

New Electro-therapeutic apparatus, by H. Rosenthal.

The Marvels of Radio-activity. Part II (with some wonderful illustrations), by Jerome S. Marcus, B.Sc., (Ch.E.)

Invisible Radio Aerials that "Spies" might use.

The first electric apparatus—The first incandescent lamp; the first dynamo; the first motor, et cetera.

A New Popular Scientific Article, by Rogers D. Rusk, B.Sc.

Selenium Cell, Design and Construction by Thomas W. Benson.

An Automatic Storage Battery Charger, by Lewis Scriven.

Making an Electric Clock—Part I, by Thomas Reed.

Are There Currents About a Magnet? by F. F. Mace.

The Franklin Electric Club, as founded by William J. Hammer, and his message to the "Electrical" and "Radio-Bugs" of To-day.

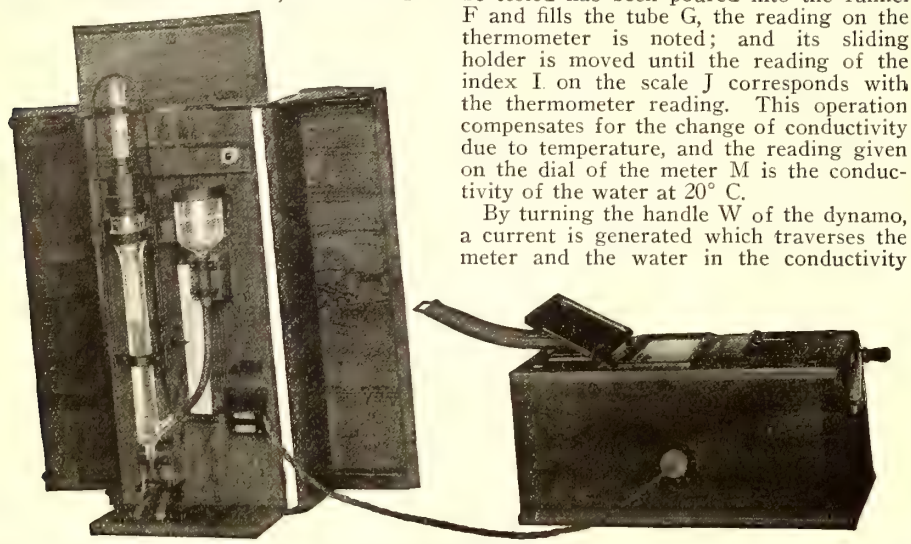
Unusual Entertainment Stunts with High Frequency Currents—With several startling photos of actual stunts.

Announcement of Prize Winners in the "What to do with your radio set during the war" contest.

Besides these leading articles the September number will fairly bristle with dozens of live, up-to-the-minute electrical, scientific and radio articles of interest to all of our readers.

Dionic Water Tester Operates by Electricity

WHAT is known as a dionic water tester has been recently perfected and appears to be an extremely practical apparatus for testing water, or any dilute solution. So simple and so direct is its operation that any unskilled person can make accurate tests, and even de-



General Appearance of New Dionic Electric Water Tester. Operates on the Principle that Relative Chemical Make-up of Water and Its Electrical Conductivity Correspond.

tect and measure traces of impurity so small as entirely to escape chemical analysis.

The detection and estimation of impurities dissolved in water and the measurement of the strength of weak solutions have hitherto been carried out by chemical tests of more or less complexity. The dionic water tester involves the substitution of an extremely simple electrical meas urement.

When the nature of any substance in solution is known, the conductivity of the solution is a measure of its amount; and the dionic tester is therefore able, by a simple measurement of conductivity, to determine to a high degree of accuracy the strength of the solution under test. The weaker the solution, the more sensitive becomes the method, so that the instrument is peculiarly well adapted for detecting the contamination of water. Not only is it possible by the use of the dionic instrument to measure amounts of salt in solution too small to be detected by chemical means, but it performs in a few seconds, and in the hands of totally unskilled persons, work which a skilled man would take some time to carry out by chemical methods.

It does not, of course, discriminate between one kind of substance and another; analysis alone can do that. But in most instances in which water testing is carried out for engineering and kindred purposes, the substance present in the water is well known. Such tests are not made for purposes of analysis, but to find out how much of a known substance is present in the water; and in all these cases the dionic meter gives the required answer with a rapidity and simplicity unapproached by any chemical test.

The complete apparatus is shown here, where G is a glass tube to contain the water under test, and A and B are the electrodes for passing the electric current thru the water. The electrodes are connected by wires to a direct-reading conductivity meter M, and a continuous-current hand-driven dynamo E.

The thermometer T, measures the temperature of the water under test, and is capable of being lowered or raised in the water, so altering the effective cross area of the liquid path. This thermometer is supported in a sliding holder L, which moves in guides H, H, and which carries an index I ranging over a scale J, calibrated in degrees centigrade. After the water to be tested has been poured into the funnel F and fills the tube G, the reading on the thermometer is noted; and its sliding holder is moved until the reading of the index I on the scale J corresponds with the thermometer reading. This operation compensates for the change of conductivity due to temperature, and the reading given on the dial of the meter M is the conductivity of the water at 20° C.

By turning the handle W of the dynamo, a current is generated which traverses the meter and the water in the conductivity tube G. The pointer of the meter is deflected, and comes to rest at some point upon the scale which directly indicates the conductivity of the water in the tube corrected to 20° C. The test is completed as soon as the pointer has come to rest, that is to say, in two or three seconds.

The conductivity meter is a novel instrument; it measures directly, and without calculation, the conductivity of any electrolytic solution in the tube to which it may be connected. The indication is given by an index which ranges over an engraved scale, graduated in units of conductivity. Conductivity (specific conductance) is the reciprocal of specific resistance, and the most convenient unit for the purpose of water-testing is the reciprocal of one megohm. No one has given a name to the reciprocal of one megohm, and we must be content to call it simply one unit. In the conductivity meter for dilute solutions the scale extends from zero up to 2,000 units.

The tube is mounted in a strong teak case designed to be as compact as possible and when opened to afford a firm support for the tube during test. It is so constructed that by pouring water into the funnel F. and allowing it to overflow through the outlet pipe O, every part of the tube is thoroly washed out. A drain pipe D, of pure rubber, is provided at the bottom for the purpose of drawing off the contents at the conclusion of a test. Normally, the drain is closed by a pinch-cock. Water may be left standing in the tube for days at a time without the slightest trace of contamination from the rubber being traceable. All the user has to do in order to connect the tube to the meter is to push the plug into the socket.

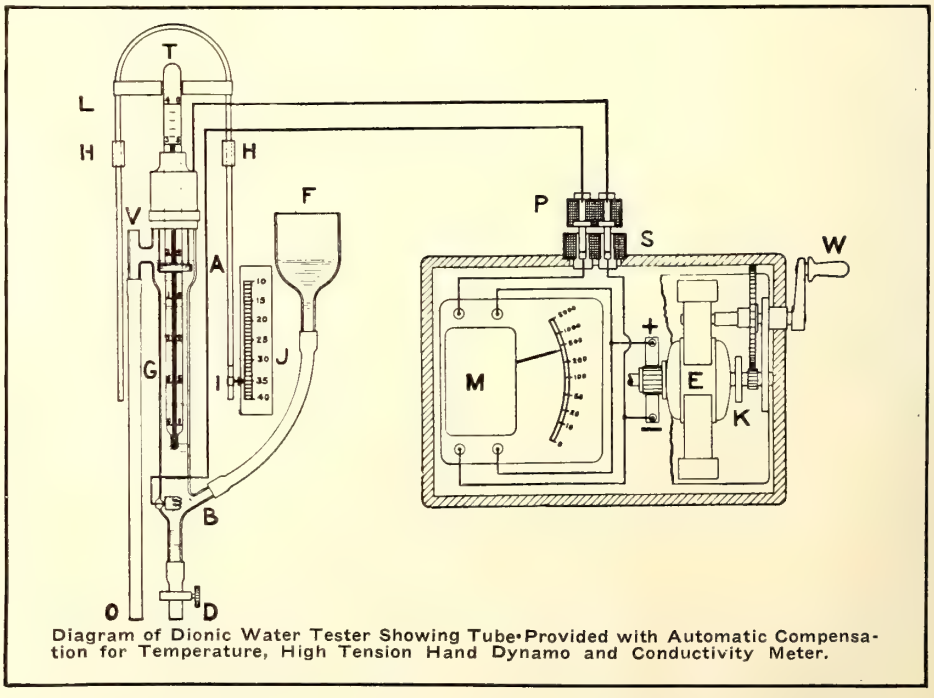


Diagram of Dionic Water Tester Showing Tube Provided with Automatic Compensation for Temperature, High Tension Hand Dynamo and Conductivity Meter.

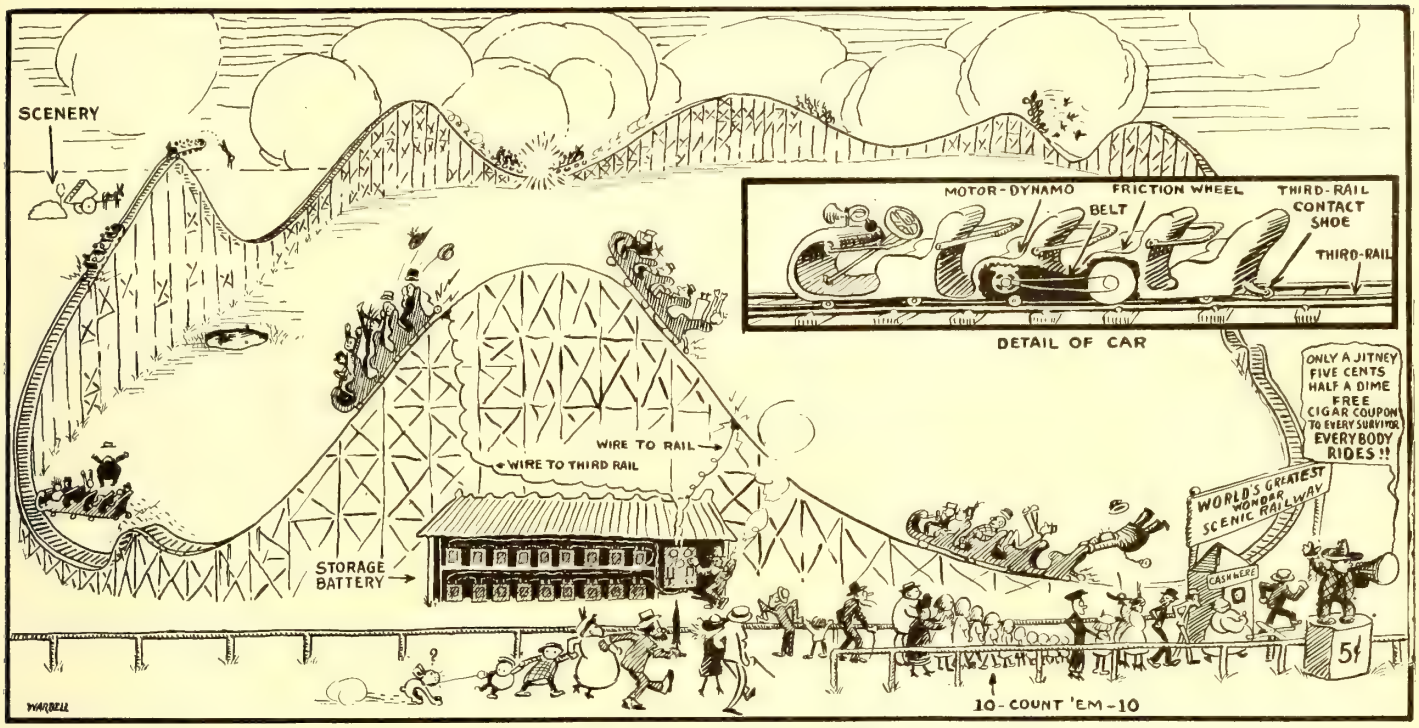
TWO NEW RADIO STATIONS FOR COLOMBIA.

It is reported that the two Marconi wireless outfits purchased by the Colombian Government some time ago will be delivered soon. It is intended to establish these two stations at Arauca and Orocue. The former is situated on the Arauca River where it forms the boundary between Colombia and Venezuela, and the latter is on the Meta River some 200 miles east of Bogota.

VALUABLE NEW DEPOSITS OF PLATINUM.

Platinum is becoming so scarce that Russia, where most of the mines are, is seeking new deposits. M. Chtein published in *Promichlennost i Torgorlia* last year a calculation showing that the Ural mines would be exhausted in from fifteen to twenty years. But the Russian paper *Gorno-Zadvodskoie Dielo* announces the recent discovery of a very rich deposit in the Vilyui River near where it flows into the Kundai, in the Yakutsk region. It is found mixed with gold in the sands of this river and its tributaries, from which the natives wash it and obtain an ore that is 50 per cent pure platinum and 50 per cent iridium, palladium and ruthenium.

"Perpetual Motion"



Here's Your Chance, "Electrical Bugs," to Become Internationally Famous. Design a Perpetual Motion Scenic Railway Like That Shown; the Descending Cars Pump Electrical Energy Back Into the Storage Battery; the Ascending Cars Are Helped Over the Peaks by Current from the Battery. For the Best 100 Words Explaining Why This Device Will or Will Not Keep Going For Years, Ignoring Wear and Tear, We Will Give a Year's Subscription to the "E. E."

WHEN your Editor was at the tender (?) age of eleven—yes, tough old birds like us were tender once, strange as it may seem—he had, just like the rest of us bugs, rather strange ideas about electricity and mechanics. Perpetual motion had a great and attractive fascination and appealed "mos' pow'fully" to his imagination. Yes, you said it—imagination is his middle name—altho, bless his dear ignorance, in those innocent days he was as yet not aware of the great axiom, to wit: "If you wish to lift yourself by your own boot-straps, do it in an elevator!"

Just like all budding electrical bugs, his first revolutionary invention consisted of the time-honored perpetual motion where you take a motor and a dynamo both of the same size, mind you, and connect them together by a belt. Then you connect the binding posts of the motor to those of the dynamo, and let 'er go! Of course you must give the belt a push, in order to start the rinktum going, that much is clear. In that case you generate a little current in the dynamo which feeds the motor. The latter in turn runs the dynamo by means of the belt. In a few seconds the system will run so fast that the dynamo—bless its soul—will have a generous amount of juice left over, which latter will feed all your various contraptions in your shop. Of course once started the system will run forever. Sounds fine.

Well, anyway, your Editor was one of those fool kids who did not believe in theory alone. Not him. He meant to try it out. He had a nice enough motor, but no dynamo. True, the patient old motor had been taken apart so often, and its field and armature had been rewound so frequently that it looked decidedly disreputable—but it ran, yes, on one Leclanché! Speak of a finely balanced armature! Well, after committing almost every imaginable crime on the bill of fare, with the possible exception of murder, enough cash was scraped together to send for that dynamo. In the catalog it said that it gave 4 volts and 4 amperes at 3,000 R.P.M. "Takes *remarkably* little power—can be driven nicely from a sewing machine, in order to charge storage cells, etc., etc."

Well, in those days, mail order firms were not so careful about their statements as they are today. At any rate your young hopeful for the benefit of all bugs in the Universe concerned, wishes to make public the fact that charging storage batteries with a dynamo from a sewing machine cannot be termed as a howling success. He tried it. Oh yes, frequently. Once for almost ten minutes at a time. For the first 19 seconds the dynamo ran at the prescribed 3000 R.P.M. It ran remarkably easy too. At the end of the first minute its speed had dropt to about 1100 R.P.M. At the end of the 10 minutes its speed had gone to *minus* 10 R.P.M. From this you will infer correctly that the storage battery now ran the dynamo as a motor, and the latter ran the sewing machine flywheel and the treadle! This was decidedly unpleasant. So he went at it again, first taking off coat and collar. This time he lasted eight minutes. But the storage battery got *some* juice in its carcass anyway, that afternoon. We should guess approximately 2¼ watts net. And next day, too, your Editor-to-be had such sore legs that he could not possibly walk. But it works. The catalog *was* right!

But we are running ahead of the story. At any rate, the dynamo soon arrived. It was a great day. Birds sang in the trees.

And the squirrel jumped hush, hush,
From the tree into the bush!

From this you have correctly deducted that it was a spring day. Ah, noble spring . . . and if we had been a trifle older we might have completed the "pome" with:

Maiden aunts grow sentimental
While the landlord claims the rental!

Luckily, however, we did not know oldish maids and their sentimental mental scents, nor were we as yet much troubled with ghoulish landlords.

At least we were not while we stood in a perfect trance before that dynamo, freshly unpacked, standing there in its virgin beauty of brightly red lacquered field castings, dazzling green magnet wire covering graceful limbs, and bright nickel binding posts, the whole mounted on a heavy real oak base. While we stood there gazing with love and admiration in our eyes, like a mother gazes at her first born babe, a delicious shiver ran up and down our back when we thought of the sumptuous monument that would garnish the public square which a thankful world had erected in our honor, after our death! The inscription was to read:

"To the inventor of the first Perpetuum mobile."

To make an unpleasant tale abbreviated, let us disclose the fact, that little time was lost in trying out the great invention. Everything was connected carefully, the belt was tightened correctly, and the bases of both motor and dynamo screwed down tight. The supreme moment had arrived.

We connected the wire to the last binding post and gave the belt a push—nothing happened. We gave it a harder push—an ominous quietude. What could be wrong? Ah, of course, oil! Mother's can of sewing machine oil was promptly secured and soon the dynamo and motor were drown-

(*Continued on page* 280)

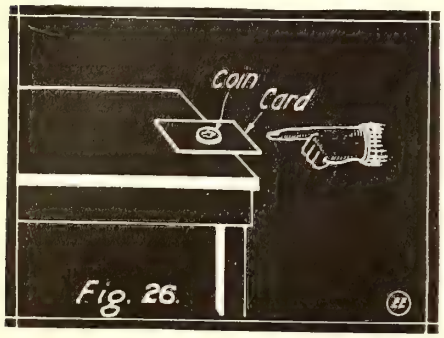
AMONG the hundreds of new devices and appliances publisht monthly in The Electrical Experimenter, there are several, as a rule, which interest you. Full information on these subjects, as well as the name of the manufacturer, will be gladly furnisht to you, free of charge, by addressing our Technical Information Bureau.

Experimental Physics

By JOHN J. FURIA, A. B., M. A.
Instructor in Physics and Science Master, Riverdale Country School

LESSON 6.
Newton's Laws.

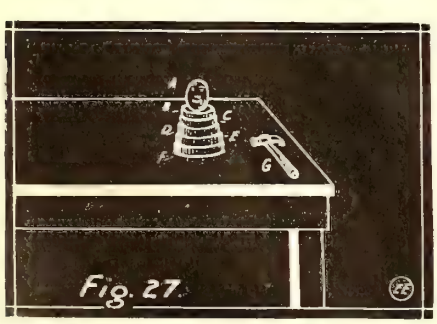
THE branch of Physics known as *Mechanics,* of which *Statics* and *Dynamics* are subdivisions, is conceded by scientists to be the foundation for all Physical Science if not of Science as a whole. Mach, in his "Science



A Simple Example of "Inertia." If the Card Is Snapt by the Finger it Will Fly Off, the Coin Dropping Directly Underneath Its Previous Position.

of Mechanics," says that since the time of Newton no essentially new principle has been stated but that all that has been accomplisht has been a deductive formal development of Mechanics on the basis of Newton's Laws. The man who establisht this basis two centuries ago was a truly great man if during all these years of excellent scientific research and discovery, no essentially new principle has been stated.

Sir Isaac Newton was born in 1642, which was the year in which the great Galileo died. While a boy, Newton spent a great deal of his time in constructing many mechanical toys. He didn't like school, and since he stood at the bottom of his class in scholarship, his teachers didn't like him. His thoughts instead of being on his schoolwork, were usually on other worlds than ours. Not being very healthy and being considered a dunce, he was bullied by the other boys. He stood for this as long as he could, and suddenly one day he "got mad and beat up the bully," who was first in athletics and scholarship. In his anger he developed great strength, and he himself was more surprised than anyone else to see the licking he gave the bully. That night he decided that if he could beat up the strongest boy in the class he could also study and beat him intellectually. Henceforth Newton stood at the head of



A Nifty Mexican Game. The Idea Is to Knock Out Each Block One by One, Finally Leaving the "Head" A, on the Table and in the Same Vertical Line. "Inertia" Again.

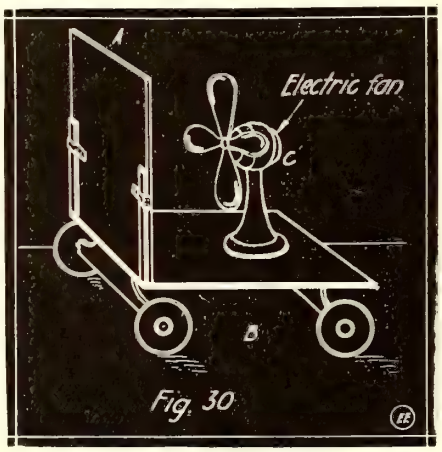
his class and was never bullied again. Therefore, my friends, if you find that you are at the bottom of the class or not up at the very top, beat up the strongest bully of the class and then study hard and get first place, and perhaps you will be second Newtons. While an undergraduate at Trinity college he studied the works of Galileo, Huygens and Keplar, became interested in mathematics and physics, and paved the way to his great future contributions to those sciences. At his death in 1727, he left those sciences establisht on a firm foundation. He was a great scholar, not only in his field, but also in the Classics and hence we are not surprised to find his great work the immortal *"Principia"* written entirely in the Latin language.

Among his many contributions, and first in importance, was his formulation of what are known as Newton's Three Laws of Motion. He stated them as follows:

LAW I. Every body perseveres in its state of rest or of uniform motion in a straight line, except in so far as it is compelled to change that state by imprest forces.

LAW II. Change of motion (i. e., momentum) is proportional to the moving force imprest and takes place in the direction of the straight line in which such force is imprest.

LAW III. Reaction is equal and opposite to action; that is to say, the actions



Illustrating "Action" and "Reaction." With Board "A" Removed the Fan Propels the Wagon; With "A" in Place the Wagon Stands Still.

of two bodies upon each other are always equal and directly opposite.

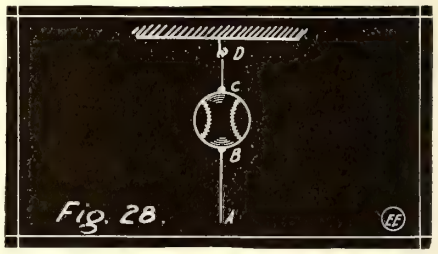
Among Newton's definitions, these two are of especial importance in connection with his laws of motion:—

DEFINITION II. Quantity of motion is the measure of it by the velocity and quantity of matter conjointly.

DEFINITION III. The resident force (i. e., the inertia) of matter is a power of resisting, by which every body, so far as in it lies, perseveres in its state of rest or of uniform motion in a straight line.

These laws are to be regarded as axioms incapable of rigorous experimental proof. The most powerful argument for their validity rests on the fact that their application to the solution of problems in Physics and Astronomy leads to results that always agree with those of observation. For example, the time for a coming eclipse is calculated by assuming the truth of these laws and the remarkable agreement between the calculated time and the subsequent observed time confirms the laws.

EXPERIMENT 31—Take a ride in the subway. You will notice that the company very generously furnishes straps to hang on. Newton's Laws are responsible for making the company adorn its trains with straps. (If you live outside the city and have not had the opportunity of riding on the straphanger's route, by all means take the first train for the city and enjoy this "pastime".) The

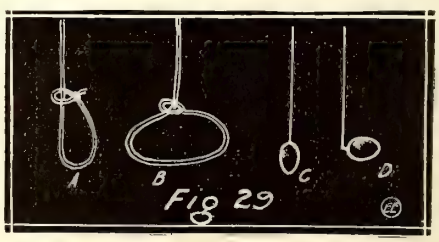


By Means of Thumb-Tacks, a Baseball Is Suspended as Shown. Pulling Suddenly on Thread at "A", it Breaks Between "A" and Pin "B": Pulling Slowly the Thread Parts Between "C" and "D".

bodies in the moving train tend to move toward the *rear* of the train when the train starts, and toward the *front* of the train when the train stops. This serves to illustrate Newton's first law, that a body in motion tends to keep in motion and that a body at rest tends to stay at rest. (This experiment is apt to prove unsuccessful if tried during the rush hour, when we are packed so tight that we cannot move.) If the train should turn a curve while in rapid motion we are thrown into the lap of a pretty young girl or (if we are sitting) said young girl falls into our lap and we are duly thankful for Newton's first law in either case.

EXPERIMENT 32—If father should be after you for having gone to the ball game instead of to school (he having seen you by going to the game instead of to work), run into the dining room and grasp the rug firmly in both hands. As he enters the threshold, pull the rug and he will sit down on the floor in great haste, thus giving you ample time to escape. This is a case of the First Law—Pa's body tended to stay at rest while you pulled his feet from under him.

EXPERIMENT 33—Another interesting phase of this experiment, which you can try on a good friend (preferably one who can't lick you), is as follows: Ask your friend to place his right foot behind and to the left of his left



Several Interesting and Easily Performed Experiments to Demonstrate the Law of Centrifugal Force.

foot. Then let him place a long pole or broomstick on his right toe, holding the pole loosely in his left hand. Count three slowly and have him kick out rapidly at the word three to see how far he can send

(*Continued on page* 281)

The RADIO LEAGUE of AMERICA

HONORARY MEMBERS
CAPT. W.H.G. BULLARD, U.S.N. NIKOLA TESLA.
PROF. REGINALD FESSENDEN. DR. LEE DE FOREST.

H. Gernsback, Manager — *W. H. Kirwan, Master of Radio Relays*

Mr. Amateur, This Means You.

By THE EDITORS

THERE are still a few amateurs scattered over the country, who fail to comprehend that this nation is now engaged in the most stupendous war the world has ever known.

Being at war is a mighty serious business and it is not good patriotism for a few thousand disgruntled amateurs to pass judgment upon our government. Whether we think that the Navy Department acted wisely or not in depriving us of our stations, is of small concern to the nation at large. At any rate, the facts are that we can't use our outfits the same as before, and being placed in this position, we must try and make the best of it, as good and law abiding Americans should do.

On the other hand, we should show a little more spunk than we have shown during the past three months. It is decidedly un-American to "chuck up" our hands and say:

"Oh, well, what's the use. Wireless is as dead as the Dodo. Forget it!"

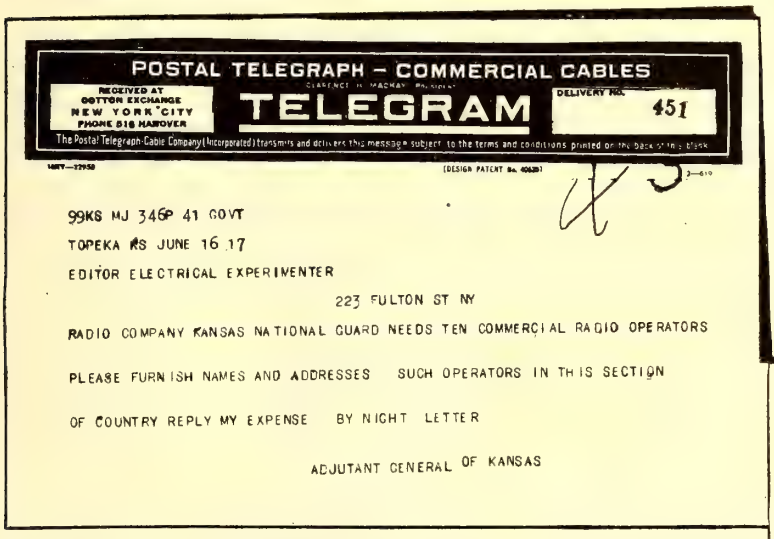
And this is just what a few chicken-hearted Amateurs have been doing. Luckily our reports show that their numbers are far from large. Things are beginning to shape themselves nicely. The situation is becoming rapidly better; there is a light gray mist where last month there was nothing but inky darkness. The Navy begins to see that the curbing of Amateur Wireless has proved a boomerang. Operators are becoming scarcer than hen's teeth, and we need countless thousands of good operators. How to get them quick? In Philadelphia the Navy Department a few weeks ago took over a private wireless school in order to speed things up. As we go to press a government official calls on us asking for a list of all New York and vicinity Radio Clubs in order to get in touch with them and keep their interest in wireless alive. Reason: The government needs lots of operators. It will get most of them from the amateur ranks. Yes, perhaps you don't believe it, but the Government is with us now, not against us.

We think we will have some good news for you next month. Don't think that we are asleep, and if some of you have given up the ship, the Editors have NOT. So watch! The telegram and the letter reproduced herewith speak volumes to any amateur *who wants to see the light.* Amateurs, GOOD AMATEURS, not Hams, are wanted more than ever.

It's up to you if you prefer the trench to the Radio tent behind the lines. You can be heroic and manly in either. Which do you choose? But you must know your business, and if you are a "ham" now, go to some good radio school or if you cannot do this take a correspondence school course. Then again as a beginner, you can drill at home at little or no cost. There are a number of good instruments with which to learn how to send and how to receive the code. In less than three months you can be an expert in sending and in receiving, with an outfit operated right at home. An hour a day suffices. If you have a radio outfit, keep it in good trim, even if you can't connect it to an aerial. After that go to a good radio school and "brush up." Also with a simple buzzer arrangement, you can send yourself messages, using your receiving apparatus, and no aerial. A muffled or silent buzzer along side of you will send out sufficient waves across the table, to be audible in your receiving apparatus. This makes for efficiency, as very careful and sharp tuning is necessary. Besides it is not against the law, and also it keeps you in trim.

Next month we will have a lot of new stunts, *"What to do with your Radio Outfit."* Several thousand suggestions—some *very* good ones—have already been received.

In the meanwhile, "don't give up the ship." As "Fips," our dear office boy, was wont to say: "It's an ill wind that has no silver lining!"



POSTAL TELEGRAPH – COMMERCIAL CABLES

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EDITOR ELECTRICAL EXPERIMENTER

223 FULTON ST NY

RADIO COMPANY KANSAS NATIONAL GUARD NEEDS TEN COMMERCIAL RADIO OPERATORS

PLEASE FURNISH NAMES AND ADDRESSES SUCH OPERATORS IN THIS SECTION

OF COUNTRY REPLY MY EXPENSE BY NIGHT LETTER

ADJUTANT GENERAL OF KANSAS

The Radio Amateurs Who Think That All Opportunities to Do Something Worth While Have Ceased Will Do Well to Note the Accompanying Official Recognition of the Service Which the Radio League of America Will Be Called Upon to Furnish Right Along. The Moral Is Mr. Amateur—"Prepare!"

STATE OF KANSAS
ADJUTANT GENERAL'S DEPARTMENT
OFFICE OF THE ADJUTANT GENERAL
TOPEKA

June 25, 1917.

Mr. H. Gernsback, Editor,
The Electrical Experimenter,
233 Fulton Street,
New York, N. Y.

Dear Sir:—

Kindly accept my thanks for your kindness in furnishing me with the names of radio operators in this section of the country.

As a part of the troops alloted to Kansas by the War Department I was authorized to organize a battalion of Signal troops consisting of one wire company, one radio company and one outpost company. Each Company comprising seventy-five enlisted men and officers. In the organization of the radio company which is stationed at Topeka I was advised by the War Department that at least ten Commercial Radio operators should be included in the membership of the company. I am not quite clear as to whether the term "commercial radio operators" as used by the War Department is intended to cover only licensed Commercial operators, or operators who are capable of handling Commercial business but has not been granted their Commercial Radio licenses.

Captain Elmer G. Stahl, Topeka, Kansas, is commanding officer of the Radio Company, and it is probable that Captain Stahl and the members of his organization would be interested in electrical and radio publications published by your Company. It might be well to send him a list of such publications and possibly a catalogue of apparatus.

Yours very truly,

C. I. Martin

The Adjutant General.

ALL RADIO AMATEURS ATTENTION!

The Navy Department has been delegated by our President to close all amateur or experimental radio stations, no matter whether equipt for transmitting or receiving, licensed or unlicensed, and therefore we shall all have to abide by this decree, whether we like it or not.

Therefore, "THE ELECTRICAL EXPERIMENTER," will endeavor to feature the Electrical Laboratories in preference to any radio stations in the awarding of the monthly prize of $3.00 in this department. Now is the time to get busy and freshen up your electrical apparatus, and incidentally improve your understanding of electrical matters, which perhaps you have unwittingly slighted to a large degree in your pursuit of radio-telegraphy. Let her go, boys!



RADIO DEPARTMENT



Bell Telephone Engineers in U. S. Signal Reserve Corps

THE Signal Corps forms one of the most important divisions of any army. The U. S. Signal Reserve Corps have had the good fortune to enlist in their ranks some of the best telephone, telegraph and radio engineers in the country. The extensive and ever progressive Bell Telephone System has, among numerous other worthy accomplishments, developed a particularly efficient engineering staff, comprising thousands of men, practically all college-trained and men who have proven ability in these now supremely important branches of applied electricity. This widespread organization has had not only the problem of furnishing trained officers and men to the Signal Reserve Corps, but also to face the gigantic task of maintaining its nation-wide lines of communication which it had built up.

The presidents of the various Bell Companies thruout the United States at a conference held in New York in November, 1916, approved a plan which had previously received the approval of the directors of the American Telephone and Telegraph Company, to encourage the formation from the telephone companies' personnel of a reserve of officers and men, in accordance with the provisions of the National Defense Act of June 3, 1916. This plan had received the approval of the Army authorities.

In March, 1917, the detailed plan was presented to the employees of the Bell System thruout the country, with an opportunity given all men from eighteen to forty-five years old to volunteer.

Mr. J. J. Carty, chief engineer of the American Telephone and Telegraph Company, had received his commission from President Wilson as senior major, and twenty-five Signal Corps Reserve companies were to be formed from the Bell operating companies, each company to be made up of one captain, two first lieutenants and an average of about one hundred non-commissioned officers and men, with one major and an extra lieutenant (his adjutant) for each two companies, a total of about one hundred officers and 2,500 non-commissioned officers and men.

The New York Telephone Company was to provide five of these companies. A total of 2,871 volunteered. Two companies have been formed from the Manhattan-Bronx and Westchester Divisions, one from the Long Island Division, one from the New Jersey Division, and one from the Albany-Syracuse-Buffalo districts.

In addition a number of the engineers of the Western Electric Company have been commissioned in the Signal Officers Reserve to do special development and research work in connection with wireless and other systems of communication. Maj. F. B. Jewett is the ranking officer in charge of this work and will be stationed in New York. Maj. N. H. Slaughter is in direct charge of the radio development work in Washington, where he will have a separate organization reporting to him, which he is now engaged in organizing.

As war with Germany had not been declared when the plan was put into effect, provision was made for employees who joined the Signal Reserve Corps during times of peace, as well as in times of actual or threatened hostilities. The following regulation is in force since the country is now at war:

Leaves of absence will be granted to such employees when ordered to duty by the President of the United States in time of actual or threatened hostilities. Such leaves of absence will be subject to the following conditions:

"(*a*) The leave will cover the period of the employee's necessary absence on such duty during the remainder of the term of the commission or enlistment under which he is serving at the time he is ordered to duty, and during renewals thereof in time of war.

"(*b*) The employee will be allowed full pay, at the normal rate in effect when he is ordered to duty, until the end of the calendar month in which he is thus called into service; thereafter, for the period of leave of absence, but not exceeding twelve months, he will be allowed full pay at such normal rate less the amount which he is entitled to receive from the Government. If the necessary absence on duty continues beyond such twelve months, further consideration will be given to the matter of payment.

"(*c*) The employee will retain his eligibility to benefits under the 'Plan for Employees' Pensions, Disability Benefits and Death Benefits' during the period of leave of absence, and such period of absence will not be deducted in computing his term of employment for purposes of said Plan.

"(*d*) Upon return from such duty (after honorable discharge if the employee has left the United States military service), the employee will be given such employment as the needs of the service permit and as he is able and fitted to perform."

These officers and men of the Bell System, trained and experienced in "the art of construction and maintaining telephone and telegraph lines," have been accepted and commissioned by the Government, and are being instructed in military duties.



A Group of Future U. S. Signal Reserve Corps Engineers Receiving Instruction in the Engineers' Conference Room, American Telephone and Telegraph Co., New York City.

MEXICO CITY RADIO MAY REACH GERMANY.

The accompanying photograph shows the new wireless station erected close to the Castle of Chapultepec in the City of Mexico. The Mexican government has had a wireless station at that point for several years, but it was practically useless, because, it was said, the towers for the aerials were not high enough. They were 85 meters high, or about 278 feet. Recently the towers have been made higher. They are now 125 meters high, or 410 feet, and one of these towers is shown in the accompanying photograph. The other tower is not in the picture, but the supporting stay wires leading to its top may be plainly seen to the right.

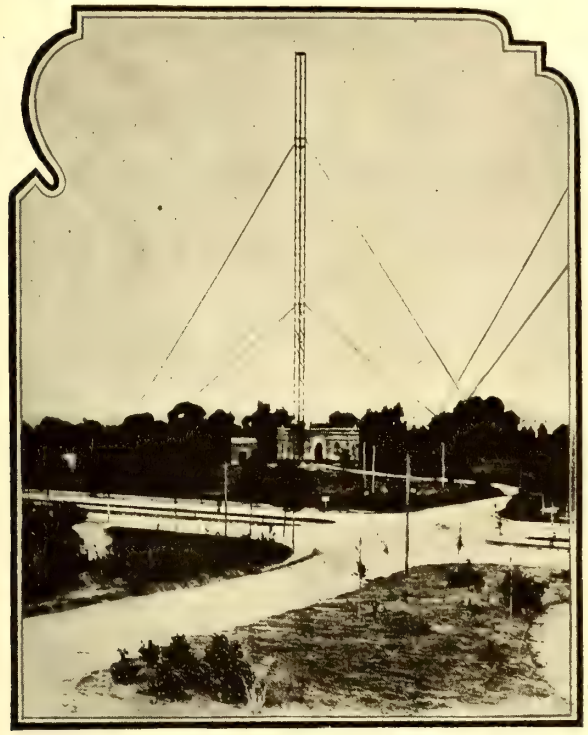


Photo from New York Herald.

One of the Gigantic Steel Radio Masts, Each 410 Feet High, in Mexico City. This Plant It Is Thought Can Easily Communicate With Germany.

While this wireless station is owned and operated by the Mexican government, it is common talk in Mexico City that the recent additions and improvements have been made possible by German capital and that the station is of far greater value to the Germans than to the Mexican government. Mexico, it is indicated, has no merchant marine and practically no navy, so that the erection of an expensive wireless station at the capital would seem to be a useless and superfluous luxury.

A Mexican account says "that the wireless station installed at Chapultepec has been communicating directly with the North American city of Houston, in the State of Texas, and with some cities of South America, especially Panama.

"This fact signifies that our wireless service is improving daily and that its field of action is extended more and more."

The inspired "explanation" of why Mexico has suddenly added such a powerful station to its wireless service—to be prepared to report merchant ships after the war ends in Europe—has been received with some amusement by foreigners who read it in Mexico City in the government organ. It was commented that the station might be of far greater value to German submarines in Gulf waters if possibly the Zimmerman note inviting Mexico to become an ally of Germany should prove to be something more than a mere "scrap of paper."

It is said that there is another wireless station in Mexico somewhere near Salina Cruz, as well as the one installed between the towers of the parochial church in Tampico, the latter having been transferred from the interned Hamburg-American steamship Antonina at Tampico.

It is known that Mexico City has been holding wireless communication with San Salvador and also with Colombia, and it is also known that the German Minister in Havana has received mysterious wireless messages having to do with Mexican affairs.

MOST ANYTHING SERVES EXPERT FOR A WIRELESS.

The police at the Second Precinct station in Cleveland, O., recently received an impromptu lesson in wireless that curled their hair and left them wondering.

A. D. Silva, equipment expert, was taken to task because police thought he had not dismantled his wireless plant in compliance with the President's order.

"But I took down my aerial," protested Mr. Silva.

"Won't do—you must take your instruments off the table—put them out of commission," explained the police.

"But I can sit right here in this room, and with materials you see on this desk I can make an outfit with which I can receive from a distance of 200 miles," said Mr. Silva.

Whereupon he took the sergeant's safety razor blades, a pencil, a telephone receiver, some wire and—(deleted by censor)—gave a demonstration that proved so interesting that it lasted for two hours.

"Or one could do the same with clock parts—if he knew how," said Mr. Silva.

KEEP UNIV. OF PENN. WIRELESS OPEN.

Permission has been granted the University of Pennsylvania by the Government to keep its wireless station open for the receiving of messages, but no messages will be sent. Eight members of the wireless class have agreed to watch the apparatus to prevent tampering with the station and to pick up any enemy messages that might be sent from hidden wireless plants nearby.

In the past two weeks thirty-two undergraduates have enrolled in the Signal Corps of the students' battalion and are receiving instruction in wireless work. Experienced drill sergeants are needed at once for the University battalion, in which nearly 2,000 students have enrolled. Men who have had experience in military schools, the National Guard or the regular service will be accepted, and will be on duty each afternoon from 1 to 6 o'clock. The pay is $45 a month.

OSCILLATORY DISCHARGES.

Ten little coulombs looking jolly fine,
One was discharged, and then there were nine.

Nine little coulombs made to oscillate,
One jumped a spark gap, and then there were eight.

Eight little coulombs sent off to heaven,
One became earthed, and then there were seven.

Seven little coulombs playing funny tricks,
One strained the ether, and then there were six.

Six little coulombs looking quite alive,
One got damped, and then there were five.

Five little coulombs feeling somewhat sore,
One got resisted, and then there were four.

Four little coulombs in a battery,
Someone switched the current on, and then there were three.

Three little coulombs wondering what to do,
One got polarized, then there were two.

Two little coulombs, after all this fun,
One caught hysteresis, and then there was one.

One little coulomb, feeling rather glum,
He was short-circuited, then there was none.

—R. C. D., in *Wireless World.*

"How to use your radio instruments for short range communication without aerials (sending and receiving)" is the title of an article to appear in the September "E. E." Don't miss it, "Radiobugs!"

THIS RADIO MAST RESEMBLES EIFFEL TOWER ON WHEELS.

Herewith is pictured one of the newest inventions for military purposes. It is a portable wireless telegraph outfit, mounted on top of a fast automobile. The transmitting and receiving apparatus is connected to a latticed steel aerial tower which looks like a miniature Eiffel tower and has a hinged top which may be raised and lowered as desired. The contrivance attracted much attention when it was recently driven about the streets of New York City.

It is possible to transmit and receive radio messages while the car is moving at any speed. It is intended to be fitted with machine guns and may serve as an elevation from which to signal by wig-wag flags or by heliograph.

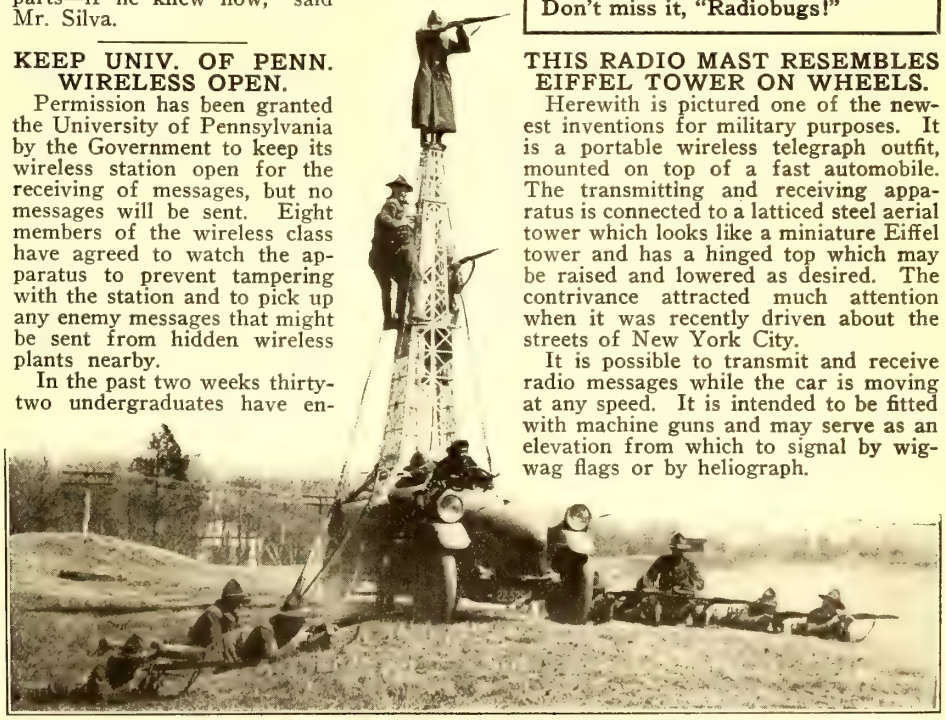


Photo by American Press Association.

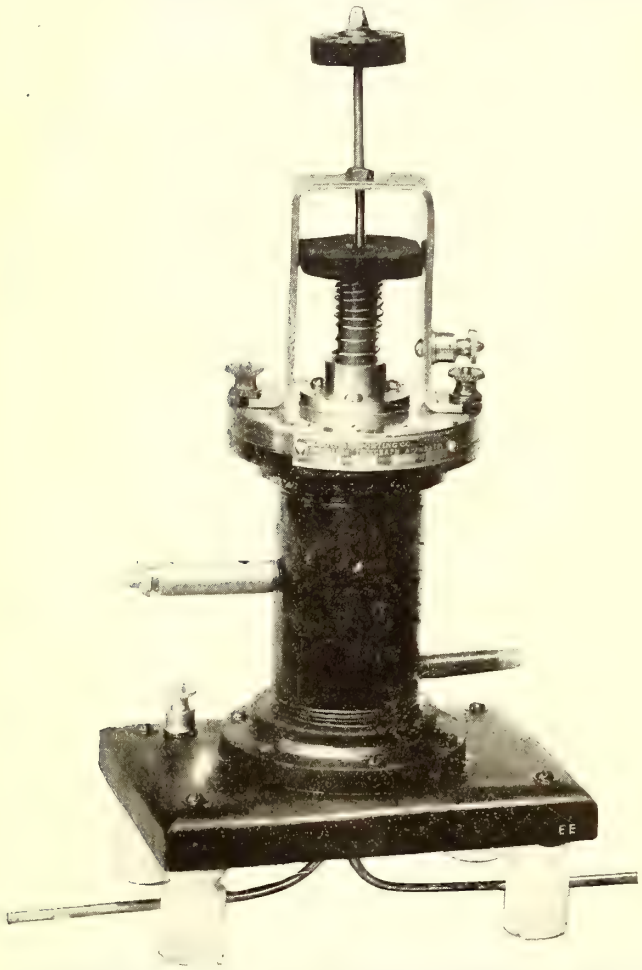
The Newest Combined Radio, Signal and Observation Tower Mounted On Fast Auto Truck, Which Is Being Used By U. S. Signal Corps.

The Amateur and Experimental Radio Research

By RAYMOND FRANCIS YATES

Part II—Suggestions for Research Work

WE may bring radio research work under two general captions. (1)—That involving the electrical and mechanical design of instruments without changing the theoretical principle. (2)—That involving the design of apparatus that operates on a new theoretical principle. During the past few years, many new instruments have been invented that would come under the first classification. We have seen scores of new detectors, tuning transformers, variable condensers—et cetera, that possess the same basic principle of operation but differ only in mechanical design. In many cases, the manufacturers permit novelty of design to interfere with the most efficient construction of the instrument, and this is indeed a mistake. There is much in the design of an instrument, but novelty plays the smallest part. Those experimenters who wish to invent new designs should first assure themselves that their new design will give greater satisfaction in either one of the following ways; *i. e.*, efficiency, (first and foremost), economical construction without loss of efficiency, and convenient manipulation. The design of instruments forms a very lucrative field of research and experiment for the amateur and it is indeed encouraging to see that many amateurs in the United States have invented new instruments of merit and practicability. Eugene V. Turney of New York City offers a splendid example of the work experimenters, who possess a little originality, can do in the way of new designs. If an instrument can be built more cheaply, function more accurately or efficiently, or made easier to manipulate, it can find a place of ready sale on the market and its inventor will be well paid for his effort, both in money and in distinction for advancing the art. The man that found that comprest air was preferable to glass as a di-electric in condensers discovered a new principle of great importance, yet most any amateur could have made the same discovery.



An Experimental Poulsen Arc Will Prove Extremely Valuable for All Classes of Radio Measurements and Tests with Dummy Antennae. This Piece of Apparatus Should Be Found in Every Radio Experimenter's Laboratory. It is Provided with Gas Jacket and Water Cooled Anode.

We find very few new instruments on the market that operate on a new basic or theoretic principle. There are many cases where an instrument can be designed so that it will accomplish a certain function by a different fundamental principle. The Audion is a good illustration. It is a substitute for an ordinary detector that not only operates on a new principle, but performs its part more efficiently. There are many instruments that would perform more efficiently on different principles. Thus, the *quenched* spark gap operates differently than the rotary and the variometer differently than the tuning transformer. In some cases, mechanical and electrical design are so closely related that we cannot alter one without considering the other.

Aside from the invention of new instruments and the discovery of new principles, the problem of hook-ups also forms an important field for wireless research work. There is much in the method of connecting a wireless outfit and our present systems are as young and undeveloped as wireless itself, and it is only logical to conclude that, as the art advances, so must the methods of connections and many important changes will take place. In many cases, patents may be procured on wireless hook-ups and if an experimenter really discovers a method of connection that increases efficiency, he may protect it and in all probability realize something from it.

Question—What Is There to Invent?

The room for improvement is so great and the multitude of suggestions so vast that it would indeed take a volume to cover them. In the following we will outline a few of the more important and popular problems of the day.

At the present time the Audion detector is not being used by many amateurs because it is too expensive to operate, due to the cost of the flashlight batteries. Is it not possible to find means that will obviate the necessity of using a high potential battery? It indeed seems very reasonable that the basic construction of the Audion can be changed to accomplish this result. If this cannot be done, why not invent a "new" Audion that will possess this desirable feature? Another possibility of improvement in the "Audion" is in the fact that a glowing filament is not the only agency that will produce ionization in a vacuum. If some other agency could be utilized, "Audions" could be constructed that would last forever.

Another conspicuous problem of the day, and one that is preventing progress in radio-telephony, is the heavy-current transmitter. At first thought, this is a seemingly simple problem, but this is not so, as many great minds have worked on the problem and there is yet a great fortune in store for the inventor of a real practical arrangement.

The spark gap of today, whether rotary or quenched, is a very inefficient instrument and an extravagant user of energy. Will it ever become possible to make a circuit oscillate without a discharge in connection with a transformer? If such a discovery was made, the high-frequency alternator would probably never need to be perfected.

While the high aerial today forms an indispensable part of a wireless equipment, without a doubt, it will be entirely obviated in the equipment of the future. At the present time experiments are being carried on with a "concentrated" aerial and it has been found to give remarkable results. The "concentrated" aerial is probably the fore-runner of the aerial of the future. It is only logical to conclude that the aerial of the future must be small, for at that time man will have perfected transmitting instruments to such a degree of efficiency, and brought receiving apparatus to such a point of sensitivity, that the large and lofty aerial will no longer be necessary. The question today is, what type of concentrated aerial is the most efficient? This is, of course, left open to experimental determination. When we realize that the greatest item of expense in a powerful radio station, is the aerial-supporting towers, we can readily conceive what an important



The Spark Gap of To-day, Whether Rotary or Quenched, Is a Very Inefficient Instrument and an Extravagant User of Energy. Why Not Try to Find a Substitute for It?

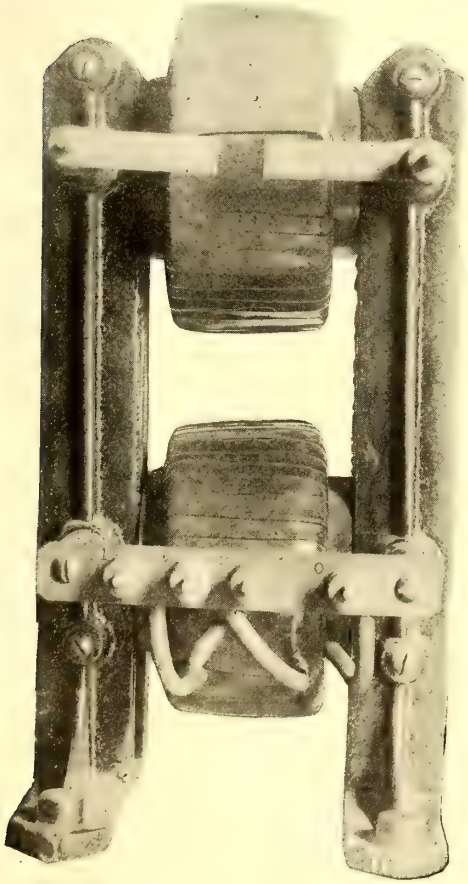
question it really is. Many may be inclined to say that it is too early to experiment with the "concentrated" aerial, but this is not so as that degree of perfection in radio apparatus is so rapidly approaching that this type of aerial will soon be a necessity.

Every instrument in a radio equipment, no matter what it is, represents only a small degree of efficiency. The 'phones, condensers, tuners, detectors, gaps or transformers are all in the embryo state. To obtain suggestions for improvement, the experimenter need only sit down at his instruments and gaze at them, at the same time analyzing each one and asking himself where and how they can be perfected.

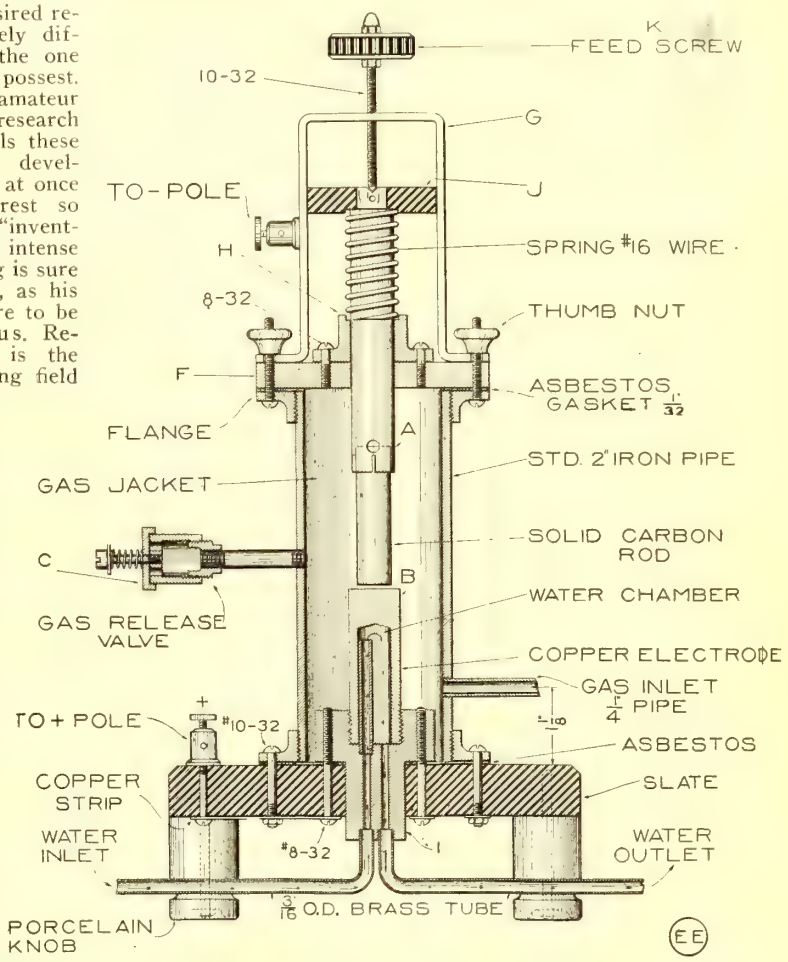
Methods of Attacking Problems

Before entering into research on any special subject, the experimenter should first properly prepare himself in what may be called the "preliminaries." If his idea concerns tuning transformers, he should not depend wholly upon the knowledge he already has in connection with this particular instrument, but should go further and make a complete study of it. Every available bit of literature should be read. Probably the idea has been tried before, or it may be that during his investigations he will conceive of a better way to accomplish his object. Above all, he must know the theory and operation of the instrument he is concerned with. Every experiment he makes should be inspired by a definite conception of the circumstances and conditions to be involved as well as a concrete pre-determination of the result being sought. An experimenter may start a certain investigation with an isolated idea of the result he wishes to obtain, but as he gets into the practical research work, he will be surprised to find that his idea is suffering evolution. If it has no evolution, something is wrong, for when an idea is put to practical test, one invariably finds many ways of improvement, and, in many cases these are so numerous and severe that our later conception of obtaining the desired results is entirely different from the one we originally possest. When an amateur gets into research work and feels these circumstances developing, he will at once find his interest so keen and his "inventing mood" so intense that something is sure to come of it, as his efforts are sure to be conscientious. Research work is the most interesting field of endeavor open today, and it is safe to say that without proper and rigid investigation — *Research* — no important invention will be made. There are exceptions to every rule, but it is invariably true that, we cannot get something for nothing.

The best paid radio and electrical engineers to-day are those engaged in research work. But they must be thoro in their knowledge.



A Common Form of Step-up Transformer Used for Radio Transmitting Purposes. There Should Be Many Opportunities Offered in This Direction for New Ideas.



Sectional View of ½ K. W. Experimental Poulsen Arc for Radio Requirements (See Opposite Page Also), which the Radio Student Will Find Highly Interesting and of Many Uses in Various Investigations and Tests. It Has Talked Wirelessly 25 Miles. Excitation Is By Direct Current.

MUSIC BY WIRELESS

Tina Lerner's Playing on Board Ship Heard on Other Vessels 500 Miles Away

Imagine sailing on a ship in mid-ocean and being able to hear your favorite pianist in a concert that she is giving on board a vessel hundreds of miles away! The possibility is not so remote as one might surmise, for on Washington's birthday last, Tina Lerner, the distinguished young Russian pianist, gave a recital on board the Ventura on her homeward journey from Honolulu, and enjoyed the unique thrill of feeling that her music was being heard by wireless operators on board passenger and freight steamers as far as 500 miles away.

In the concert room where Miss Lerner was playing, a transmitter was placed, and by means of a recently perfected wireless telephone apparatus, the music was sent out over a large radius.

The experience of listening to this concert was far more novel than participating in the demonstrations which have recently been tried successfully, when singers and speakers in San Francisco were heard at meetings and banquets in New York and other cities. At these functions the guests were provided with telephones thru which they heard every tone distinctly. Even the applause that the singers received on the Pacific Coast was accurately transmitted, and all the thrills that attended the real concert were felt by this "proxy audience" on the other side of the continent.

That, however, was over telephone wires. To play the piano while isolated in mid-ocean and have the notes float thru the air and bring pleasure to those far distant, does much toward the complete annihilation of space and causes us to wonder what tomorrow may bring forth.

When we are far from home—and think of the loved ones left behind, shall we be able to commune with them thru music?

NAVY RESERVE WANTS WIRELESS OPERATORS

An opportunity for amateur wireless operators having a knowledge of wireless or land telegraphy to join the navy reserve force was announced at the Great Lakes training station at Lake Bluff recently. It was stated that radio operators soon will be needed and that facilities for giving the instruction have been provided by the navy.

Heretofore the number of radio operators who responded to the call to the colors has been so great that all positions were filled, the schools of instruction were overcrowded and all enlistments in the branch had to be stopt until further arrangements could be made.

PROF. TAYLOR DIRECTS U. S. RADIO.

Professor A. H. Taylor of the physics department, University of North Dakota, was recently appointed district superintendent of communication at the Great Lakes Training Station. He is a radio expert and has been given the rank of lieutenant in the Navy.

"ELECTRO"

THE "ELECTRO" CODOPHONE

(Patents Pending)

AMATEURS! ATTENTION!!

Now that we are for the time being, deprived of using our Radio outfits, it behooves us as good Americans to become proficient in learning the Wireless as well as Telegraph Codes. Operators who know the Code are, and will be, in ever rising demand. The Army and Navy need thousands of operators right now.

So far the Government has not been able to obtain any way near all the operators it requires. Not alone does the Federal Government call for thousands and thousands of operators for the army and navy, but nearly all of our many states require operators for the militia. Here is the great opportunity of a life time for you.

Would you rather fight in the trenches, or punch the key behind the lines? Either way you benefit your country. **Which do you prefer?** And it is SO easy to become an operator. You do not necessarily require a teacher, nor do you have to go to a school to learn. 30 days of intelligent study will make you proficient. **Can you qualify** NOW? **Are you proficient?** Can you send and receive when your country calls you?

THE "ELECTRO" CODOPHONE

(Patents Pending)

which we present herewith is the outcome of several months of intense study and experimentation of our Mr. H. Gernsback. It supersedes our former Radiotone Codegraph, which comprised a **Radiotone silent Buzzer, a loud talking telephone receiver** and **a key.** As in all of his work Mr. Gernsback strives for simplicity. So he combined the three above mentioned instruments with one stroke into **ONE** single instrument. He combined the Radiotone Buzzer and the loud talking receiver into a single unit, not only mechanically, **but electrically as well.** This involves **an entirely new principle,** never before attempted, and on which basic patents are now pending.

What this remarkable instrument is and does.

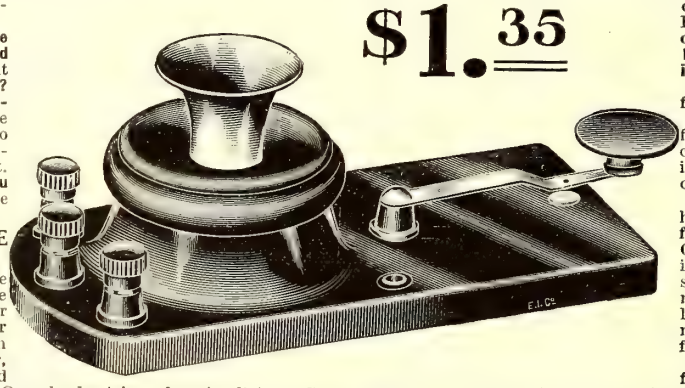
The "Electro" **Codophone** is positively the only instrument made that will imitate a 500 cycle note exactly as heard in a Wireless receiver, so closely and so wonderfully clear, that Radio operators gasp in astonishment when they first hear it. And you need no receivers over the ears to hear the imitation singing spark, which sounds for all the world like a high-pitched distant powerful Radio Station. No, the loud-talking receiver equipped with a horn, talks so loud that **you can hear the sound all over the room,** even if there is a lot of other noise.

THAT'S NOT ALL. By lessening or tightening the receiver cap, a tone from the lowest, softest quality, up to the loudest and highest screaming sound can be had in a few seconds.

FURTHERMORE, this jack-of-all-trades marvel, can be changed instantly into our famous silent Radiotone test buzzer, simply by replacing the metal diaphragm with a felt disc, **which we furnish with every instrument.**

FOR INTERCOMMUNICATION. Using two dry cells for each instrument, two **Codophones** when connected with one wire and return ground, can be used for intercommunication between two houses one-half mile apart. Any one station can call the other, no switches, no other appliances required. No call bell either, the loud-talking phone takes care of this.

AS AN ARMY TYPE BUZZER. Last, but not least, **two Codophones** with two 75 ohm receivers can be used to converse **over miles** of fine (No. 36 B & S Wire), so fine that no one can see the wire. Or you can use a long metallic fence and the ground, or you can communicate **over your 110 volt line up to several miles, using no wires, only the ground.**



$1.35

Full directions how to do all this furnished with each instrument.

One outfit alone replaces the old-fashioned learner's telegraph set, consisting of key and sounder, which is all right to learn the telegraph code but not the wireless codes.

The "Electro" **Codophone** is a handsome, well made instrument, fool proof, and built for hard work. Contacts are of hard silver ⅛ inch in diameter, that will outlast the instrument. Base and housing is of metal throughout, horn and key lever nickel plated and buffed. Three new style metal binding posts are furnished.

There is also a neat code chart and full directions **enabling any intelligent young man or girl to learn the codes within 30 days,** practising one-half hour a day.

Sizes: 6¾ x 3 x 2⅝". Shipping weight, 4 lbs. **$1.35**

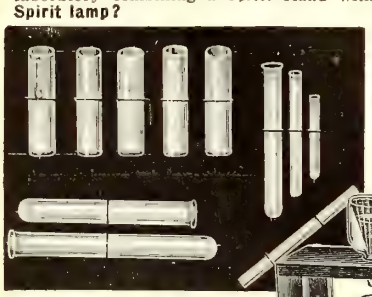
The "Electro" Codophone as described, complete

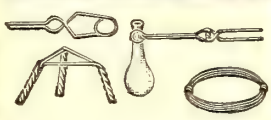
Money refunded if instrument is not as represented or does not come up fully to expectation.

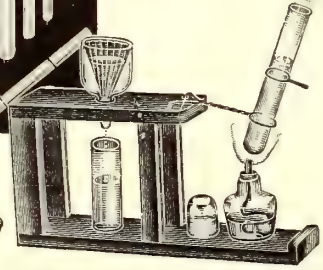
Ready for delivery July 25th. There will be an enormous demand for this new marvel—place your order now. All orders filled in rotation. Better order two instruments today.

LABORATORY OUTFIT!

How often have you wished to possess a compact outfit in your laboratory combining a **Filter-stand** with a **Test-tube holder** and **Spirit lamp?**







$1.50

We have spent considerable time to combine just such a practical outfit and present it herewith to our friends.

The outfit is complete as per illustration and consists of:

1 **Stand,** made of well quartered oak, varnished three times, so as to be acid proof and grooved on top and bottom, so that it will not warp in getting wet. Size 5¾ inches high by 11½ inches long.

1 **Glass Spirit Lamp.** Size 3½ inches by 2 inches. Uses wood alcohol and is invaluable to the experimenter. Besides being used to heat test-tubes contents as per illustration, it can be used to bend glass rods and tubings, to solder wire, etc.

1 **Glass Filter Funnel.** This funnel is made of heavy glass that will not break easily. It fits accurately in the hole on top of the Filter stand and is provided with a thick rim on the outlet, so that a rubber hose can be attached to it, without slipping off.

1 **Glass Rod,** to be used in stirring and mixing.

10 **Test Tubes,** made from the best imported glass. A new feature of some of the test tubes is that they have a flat bottom and therefore can be placed on any table if desired, needing no special stand.

1 **Roll of Copper Clad Steel Wire.** This wire is to be used to make a number of useful articles as shown in the illustration, such as test-tube holders, tripods to support retorts, etc. We furnish a blue print with the outfit, showing how to make all these wire articles.

Now this whole outfit as described costs you only..... $1.50

Postage extra. Shipping weight, 4 lbs.

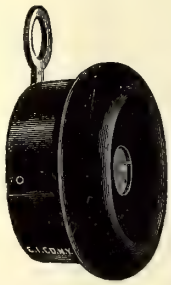
Order one today, even if you don't need it now.

We have only 500 outfits on hand, and as some of the glassware is imported, it will be impossible to make up more during the present war. **First come, first served. Money returned if sold out. Send for it today.**

"Electro" Pony Receiver

Our Pony receiver is without doubt the best article for the money to-day.

Points of superiority: Hard rubber composition shell beautifully polished. Powerful permanent steel magnet, soft iron core, fibre coil heads, very thin diaphragm, brass posts **inside.** Hanger can be unscrewed and receiver will then fit our No. AX8077 headbands.



No. EK 1024

SOME USES. —

For all telephone work. Also for making the small testing outfits for repair men in circuit with only one dry cell or flashlight battery. It can also be used for wireless though its low resistance won't permit of such good results as a higher resistance phone.

This receiver is single pole; 2¼ x 1⅛ inches; wgt. 4 oz.; resistance, 75 ohms.

IF TWO OF THESE RECEIVERS ARE USED, IT IS POSSIBLE TO SPEAK AT A DISTANCE OF 150 FEET WITHOUT USING BATTERIES, ONE WIRE BEING SUFFICIENT IF GROUND IS USED.

No. EK1024 Pony Receiver, 75 ohms **50c**

IMMEDIMATE SHIPMENTS

THE ELECTRO IMPORTING CO. Manufacturers

NEWS

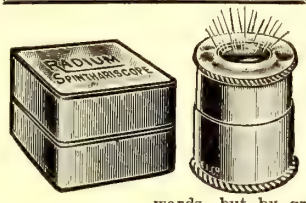
THE "ELECTRO" SPINTHARISCOPE

As usual we lead—others follow. Now the **Spinthariscope,** first to be introduced to the American public by us. The **Spinthariscope** was originated by the famous English Radium expert, Sir William Crookes. Everyone knows that Radium gives off a tremendous amount of energy which goes on for several thousand years, with undiminished force.

Radium gives off a number of rays of which the **Alpha rays are known chiefly for their great power.** These electric rays are invisible to the naked eye, the same as are X-rays. But if we take a small amount of Radium and place it in front of a zinc-sulfide screen, the latter lights up. If the radium speck is arranged suitably the Alpha rays will bombard the zinc sulfide with a veritable hail of electrons and the screen begins to scintillate like Fourth of July fireworks.

This is the principle of the **Spinthariscope,** which we present herewith. It is a little instrument made of two neatly nickeled metal tubes, one telescoping into the other. The top tube has a powerful lens. The bottom contains the zinc-sulfide screen and a minute quantity of **REAL RADIUM, too small to do any harm.** The instrument can only be used in the dark. After the top tube with the lens has been adjusted to the right focus, we observe a vividly illuminated green background, glowing in a soft light. As the eye becomes accustomed to it, we begin to see the **ELECTRONIC BOMBARDMENT** of the Alpha rays from the Radium. It looks exactly like tiny fireflies flashing off and on in the dark night. The more we look the better we see the miniature fireworks. We are now in the presence of the most marvelous substance man ever knew, **RADIUM** and its uncanny forces—Radium, which some day will turn the world upside down.

MAKING RADIUM VISIBLE

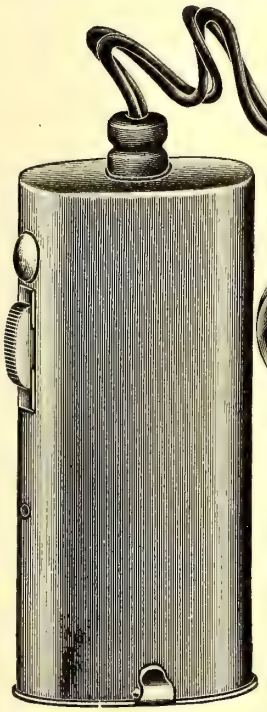


The **Spinthariscope** up to now sold from $10.00 upwards, but by greatly simplifying it the cost has been brought down by us to such a nominal figure, that no one can afford to be without this most important and marvelous instrument.

You owe it to yourself to own one. It is small enough to be put into your vest-pocket, and interesting enough to show it to all of your friends. **It will continue to operate after you are dead 2500 years!** We guarantee the instrument to be genuine and to contain a minute quantity of **real Radium salts.** "Electro" Spinthariscope, in neat box and directions for use, as described..... **$1.00**
Sent Prepaid. **IMMEDIATE SHIPMENTS.**

BOYS!

Here Are the Stars and Stripes in All Their Glory.



Be the first one in your town to wear this patriotic emblem. Think of it: An electrically illuminated boutonnière worn in the lapel hole of your coat. It illuminates our National Flag in the original colors with a brilliant electric light. Just insert Flag in buttonhole of your coat, put flashlight case in vest or coat pocket and every time you press the button, the flag in your button-hole flashes up with a beautiful color effect.

Illuminated flag, cord and **plug** (to be connected to any 2 cell flash-light) **60c**
(Postage 10 cents.)

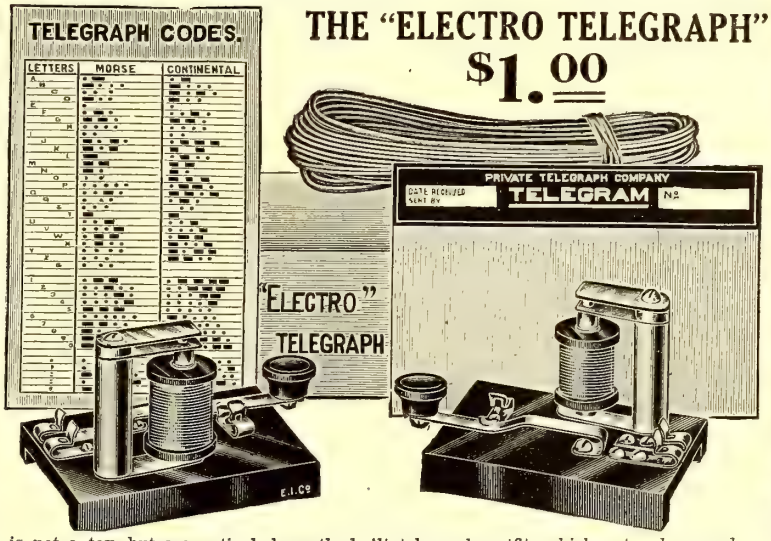
Illuminated flag, flashlight case and **battery, cord** and **plug,** complete as per illustration, **$1.10;** postage 15c.

DEALERS: Write for our proposition today.

IMMEDIATE SHIPMENTS

THE "ELECTRO TELEGRAPH"

$1.00



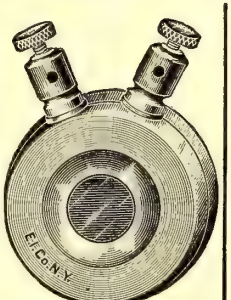
is not a toy, but a practical, honestly built telegraph outfit, which not only sounds but works like the big commercial instruments. By studying the code for 30 days you can become a first-class telegraph operator. Such operators are in big demand now. Outfit consists of TWO complete telegraph instruments each measuring 3½ x 2½ x 2¼. All metal parts are highly nickel plated, including key lever. Note hard rubber knob. Telegraph Code Chart, telegraph blanks and connecting wire comes with set, but no batteries. Outfit works on 2 dry cells (one cell for each instrument). The "Electro" is the ONLY Outfit that works both ways, each station can call; no switches, no extras. Nothing to get out of order. Guaranteed to please you or money back.

Price Complete as illustrated..... $1.00

At all good dealers and department stores. If your dealer cannot supply you send us $1.00 for outfit and add mailing charges for two pounds, otherwise we ship express collect.

Selenium Cells

Everybody has read about the experiments of telephotography (sending photographs over a wire hundreds of miles) made by Professor Korn and others. It is also known that if the problem of television is ever solved, the selenium cell will play an important role. At present we are the only concern in the United States selling these cells. They are the most sensitive ones made.



No. FX517

Better send for a cell today and try making an electric dog that will follow a lamp, or an electric burglar alarm. It's very instructive and great fun. (See November, 1916, issue **"Electrical Experimenter."**)
No. FX517 Selenium Cell, each..... $6.00
Shipping Weight, 4 oz.

IMMEDIATE SHIPMENTS

"The Livest Catalog in America"

Our big, new electrical cyclopedia No. 18 is waiting for you. Positively the most complete Wireless and electrical catalog in print today. 200 Big Pages, 600 illustrations, 500 instruments and apparatus, etc. Big **"Treatise on Wireless Telegraphy."** 20 FREE coupons for our 160-page FREE Wireless Course in 20 lessons. FREE Cyclopedia No. 18 measures 7x5¼". Weight ½ lb. Beautiful stiff covers.

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Now before you turn this page write your name and address on margin below, cut or tear out, enclose 6 cts. stamps to cover mail charges, and the Cyclopedia is yours by return mail.

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231 Fulton Street, New York City.



231 FULTON ST., NEW YORK, N.Y.

"ELECTRO" NEWS

THE "ELECTRO" CODOPHONE

(Patents Pending)

AMATEURS! ATTENTION!!

Now that we are for the time being, deprived of using our Radio outfits, it behooves us as good Americans to become proficient in learning the Wireless as well as Telegraph Codes. Operators who know the Code are, and will be, in ever rising demand. The Army and Navy need thousands of operators right now.

So far the Government has not been able to obtain any way near all the operators it requires. Not alone does the Federal Government call for thousands and thousands of operators for the army and navy, but nearly all of our many states require operators for the militia. Here is the great opportunity of a life time for you.

Would you rather fight in the trenches, or punch the key behind the lines? Either way you benefit your country. **Which do you prefer?** And it is SO easy to become an operator. You do not necessarily require a teacher, nor do you have to go to a school to learn. 30 days of intelligent study will make you proficient. **Can you qualify NOW? Are you proficient?** Can you send and receive when your country calls you?



THE "ELECTRO" CODOPHONE
(Patents Pending)

which we present herewith is the outcome of several months of intense study and experimentation of our Mr H Gernsback. It supersedes our former Radiotone Codegraph, which comprised a **Radiotone silent Buzzer, a loud talking telephone receiver** and **a key.** As in all of his work Mr Gernsback strives for simplicity. So he combined the three above mentioned instruments with one stroke into **ONE** single instrument. He combined the Radiotone Buzzer and the loud talking receiver into a single unit, not only mechanically, **but electrically as well.** This involves **an entirely new principle,** never before attempted, and on which basic patents are now pending

What this remarkable instrument is and does.

The "Electro" **Codophone** is positively the only instrument made that will imitate a 500 cycle note exactly as heard in a Wireless receiver, so closely and so wonderfully clear, that Radio operators gasp in astonishment when they first hear it. And you need no receivers over the ears to hear the imitation singing spark, which sounds for all the world like a high-pitched distant powerful Radio Station. No, the loud-talking receiver equipped with a horn, talks so loud that **you can hear the sound all over the room,** even if there is a lot of other noise.

FURTHERMORE, this jack-of-all-trades marvel, can be changed instantly into our famous silent Radiotone test buzzer, simply by replacing the metal diaphragm with a felt disc, **which we furnish with every instrument.**

FOR INTERCOMMUNICATION. Using two dry cells for each instrument, two **Codophones** when connected with one wire and return ground, can be used for intercommunication between two houses one-half mile apart. Any one station can call the other, no switches, no other appliances required. No call bell either, the loud-talking phone takes care of this.

AS AN ARMY TYPE BUZZER. Last, but not least, two **Codophones** with two 75 ohm receivers can be used to converse **over miles** of fine (No. 36 B & S Wire), so fine that no one can see the wire. Or you can use a long metallic fence and the ground, or you can communicate **over your 110 volt line up to several miles, using no wires, only the ground.**

$1.35

Full directions how to do all this furnished with each instrument

One outfit alone replaces the old-fashioned learner's telegraph set, consisting of key and sounder which is all right to learn the telegraph code but not the wireless codes.

The "Electro" **Codophone** is a handsome, well made instrument, fool proof, and built for hard work. Contacts are of hard silver ⅛ inch in diameter, that will outlast the instrument. Base and housing is of metal throughout, horn and key lever nickel plated and buffed. Three new style metal binding posts are furnished

There is also a neat code chart and full directions **enabling any intelligent young man or girl to learn the codes within 30 days,** practising one-half hour a day.

Sizes, 6¾ x 3 x 2¾". Shipping weight, 4 lbs. **$1.35**

The "Electro" Codophone as described, complete

Money refunded if instrument is not as represented or does not come up fully to expectation.

Ready for delivery July 25th. There will be an enormous demand for this new marvel—place your order now. All orders filled in rotation. Better order two instruments today.

LABORATORY OUTFIT!

How often have you wished to possess a compact outfit in your laboratory combining a **Filter-stand** with a **Test-tube holder** and **Spirit lamp?**



$1.50

We have spent considerable time to combine just such a practical outfit and present it herewith to our friends.

The outfit is complete as per illustration and consists of

1 Stand, made of well quartered oak, varnished three times, so as to be acid proof and grooved on top and bottom, so that it will not warp in getting wet. Size 5¾ inches high by 11½ inches long.

1 Glass Spirit Lamp. Size 3½ inches by 2 inches. Uses wood alcohol and is invaluable to the experimenter. Besides being used to heat test-tubes contents as per illustration, it can be used to bend glass rods and tubings, to solder wire, etc.

1 Glass Filter Funnel. This funnel is made of heavy glass that will not break easily. It fits accurately in the hole on top of the Filter stand and is provided with a thick rim on the outlet, so that a rubber hose can be attached to it, without slipping off.

1 Glass Rod, to be used in stirring and mixing

10 Test Tubes, made from the best imported glass. A new feature of some of the test tubes is that they have a flat bottom and therefore can be placed on any table if desired, needing no special stand.

1 Roll of Copper Clad Steel Wire. This wire is to be used to make a number of useful articles as shown in the illustration, such as test-tube holders, tripods to support retorts, etc. We furnish a blue print with the outfit, showing how to make all these wire articles.

Now this whole outfit as described costs you only **$1.50**

Postage extra. Shipping weight, 4 lbs.

Order one today, even if you don't need it now.

We have only 500 outfits on hand, and as some of the glassware is imported, it will be impossible to make up more during the present war. **First come, first served. Money returned if sold out. Send for it today.**

"Electro" Pony Receiver



No. EK 1024

Our Pony receiver is without doubt the best article for the money to day.

Points of superiority: Hard rubber composition shell beautifully polished. Powerful permanent steel magnet, soft iron core, fibre coil heads, very thin diaphragm, brass posts inside. Hanger can be unscrewed and receiver will then fit our No. AX8077 headbands.

SOME USES. —

For all telephone work. Also for making the small testing outfits for repair men in circuit with only one dry cell or flashlight battery. It can also be used for wireless though its low resistance won't permit of such good results as a higher resistance phone.

This receiver is single pole; 2½ x 1⅝ inches; wgt. 4 oz.; resistance, 75 ohms.

IF TWO OF THESE RECEIVERS ARE USED, IT IS POSSIBLE TO SPEAK AT A DISTANCE OF 150 FEET WITHOUT USING BATTERIES, ONE WIRE BEING SUFFICIENT IF GROUND IS USED.

No. EK1024 Pony Receiver, 75 ohms **50c**

IMMEDIMATE SHIPMENTS

Patents:

No. 842,950 Feb 5, 1907

No. 902,069 Oct 27, 1908

No. 948,275 Feb 1, 1910

No. 951,788 Mar. 8, 1910

No. 961,855 June 21, 1910

No. 978,999 Dec 20, 1910

No 988,456 April 4, 1911

No 988,767 April 4, 1911

No 1,016,138 Jan 30, 1912

No 1,033,095 July 23, 1912

No 1,057,820 April 1, 1913

No 1,124,413 Jan 12, 1915

No 94,990 Jan 20, 1914

8 Patents Pending in Patent Office

E. I. Co. Patents

THE "ELECTRO" SPINTHARISCOPE

As usual we lead—others follow. Now the **Spinthariscope,** first to be introduced to the American public by us. The **Spinthariscope** was originated by the famous English Radium expert, Sir William Crookes. Everyone knows that Radium gives off a tremendous amount of energy which goes on for several thousand years, with undiminished force.

MAKING RADIUM VISIBLE



Radium gives off a number of rays of which the **Alpha rays are known chiefly for their great power.** These electric rays are invisible to the naked eye, the same as are X-rays. But if we take a small amount of Radium and place it in front of a zinc-sulfide screen, the latter lights up. If the radium speck is arranged suitably the Alpha rays will bombard the zinc sulfide with a veritable hail of electrons and the screen begins to scintillate like Fourth of July fireworks.

This is the principle of the **Spinthariscope,** which we present herewith. It is a little instrument made of two neatly nickeled metal tubes, one telescoping into the other. The top tube has a powerful lens. The bottom contains the zinc sulfide screen and a minute quantity of REAL RADIUM, **too small to do any harm.** The instrument can only be used in the dark. After the top tube with the lens has been adjusted to the right focus, we observe a vividly illuminated green background, glowing in a soft light. As the eye becomes accustomed to it, we begin to see the **ELECTRONIC BOMBARDMENT** of the Alpha rays from the Radium. It looks exactly like tiny fireflies flashing off and on in the dark night. The more we look the better we see the miniature fireworks. We are now in the presence of the most marvelous substance man ever knew, **RADIUM** and its uncanny forces—Radium, which some day will turn the world upside down.

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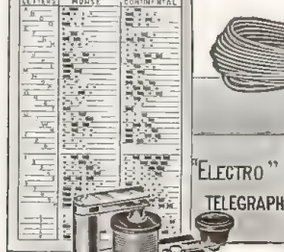
Illuminated flag, cord and plug (to be connected to any 2 cell flashlight) **60c**

(Postage 10 cents.)

Illuminated flag, flashlight case and battery, cord and plug, complete as per illustration, $1.10; postage 15c

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At all good dealers and department stores. If your dealer cannot supply you send us $1.00 for outfit and add mailing charges for two pounds, otherwise we ship express collect

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Everybody has read about the experiments of telephotography (sending photographs over a wire hundreds of miles) made by Professor Korn and others. It is also known that if the problem of television is ever solved, the selenium cell will play an important role. At present we are the only concern in the United States selling these cells. They are the most sensitive ones made.



No. FX517

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THE ELECTRO IMPORTING CO. Manufacturers

231 FULTON ST., NEW YORK, N.Y.

Details of a 20,000 Meter Undamped Radio Receiver

By WM. BURNETT, JR.

A GREAT deal has been accomplished in the last few years in the reception of undamped wave trains. In this description I will endeavor to relate some details of the experimental work that has been successfully carried on at our laboratory. A great deal of the apparatus ordinarily involved in this work is rather expensive, and unless the person has a good knowledge of electrical laws he is quite apt to get poor results.

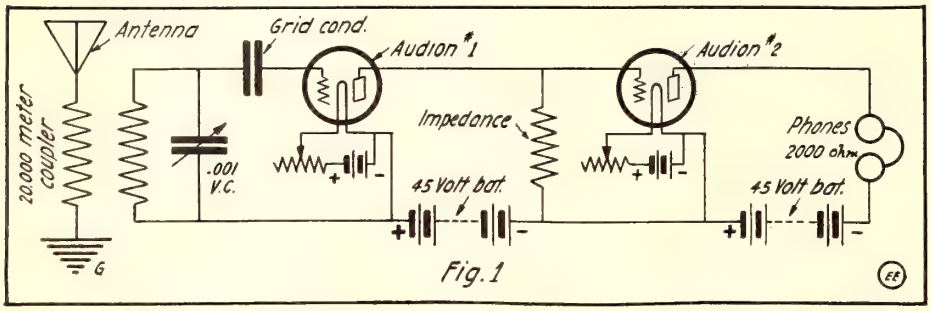


Diagram of Circuits for 20,000 Meter Undamped Wave Audion Receiving Set Which Has Given Highly Satisfactory Results.

The subject of ultra-high frequency currents has set the amateur electrical "bug" afire, and at the present time it is hard to tell from one day to the next just what will turn up in the way of a new invention.

In the accompanying diagram (Fig. 1) is shown a very good set of connections for the reception of long undamped waves. This consists of very few pieces of apparatus and works admirably well. Any one who has access to two Audion (round or tubular) bulbs will find that this is one of the most simple hook-ups.

These connections give a very sensitive circuit and by spending a little time in adjusting the Audions the experimenter will find it possible to attain excellent results. It is advisable not to connect a variable condenser across the 'phone terminals, as this paralyzes them to such an extent that the diaframs refuse to move. The impedance which is connected in the diagram is one of about 9,000 ohms; a ½" spark coil secondary, having an iron wire core running thru it, will answer the purpose.

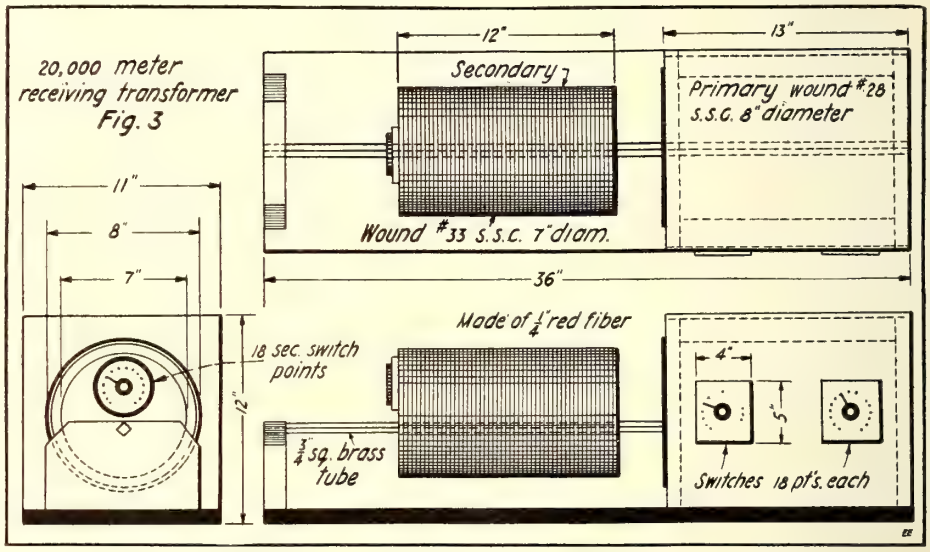
This hook-up produces a very strong regenerative effect. This can be partly done away with if the proper attention is paid to the adjusting of the filament rheostats. In regard to the resistance of the 'phones, I am convinced that the 2,000 ohm type will work better than the 3,000 ohm type. The usual care should be taken in connecting the filament of the bulb to the negative binding post of the lighting battery and the rheostat to the positive post of the lighting battery. However, all who have had experience with the Audion, know that the characteristics of the bulbs differ and the experimenter will be able to adjust these minor difficulties by using good judgment.

The loose coupler used in this hook-up is one built after the so-called Cambridge Receiving Transformer design. Its overall length is 36 inches and the secondary slides on a ¾" square brass tube. (Fig. 3.)

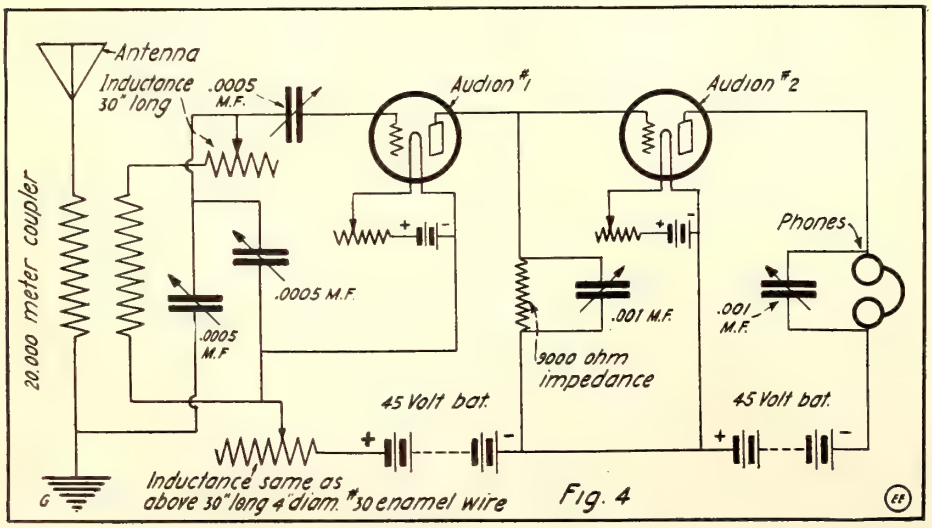
The primary is 12" long and 8" in diameter, wound full of No. 28 single silk covered copper wire, and is divided into 19 equal parts. Being of the Navy type, the first 18 taps are brought out to switch points and the remaining section is divided into 19 equal parts and these brought out to as many switch points. The accompanying illustration (Fig. 2) will explain this.

Rather than count the turns, wait until after winding and then by direct measurement locate the position of the taps. The secondary is 12" long and 7" in diameter and is wound full of No. 33 S. S. C. wire and divided into 19 equal sections and brought out to the switch points on the front of the secondary. As the drawing below is self-explanatory, giving the principal dimensions, no further space will be given to the construction of the receiving transformer.

My best results have been obtained with the following set of connections: (See Fig. 4.) The loading coils or inductances are 4" in diameter and 32" long. These are wound with No. 30 enameled magnet wire. Taps are taken off at 10 different places, thereby giving a great variation of in-



Details of 20,000 Meter Loose Coupler for Undamped Wave Reception.



Detailed Circuit Diagram for Two-Audion Continuous Wave Radio Receptor Operating On the "Heterodyne" Principle.

USEFUL HINTS ON THE AUDION.

By Frank J. Collins.

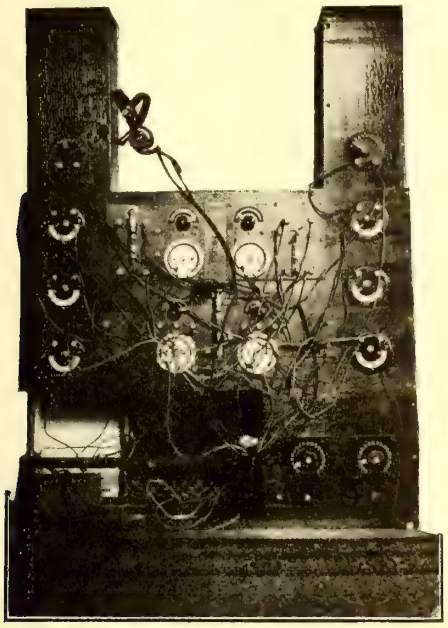
IN this paper an attempt will be made to clear up certain misunderstandings current among numerous amateurs in regard to the required amount of apparatus employed in the Armstrong Regenerative Audion receiving circuits.

Numerous articles have appeared in past issues of electrical magazines, to the effect that the Grid and Wing coils are unnecessary; that certain condensers could be eliminated; that the body could not approach the apparatus without affecting the tuning considerably (due to the capacity of the operator's body) and that the oscillations were unsteady, to say the least.

There were furnished with these articles, "newly discovered" hook-ups by the authors, claimed to do the same thing as the Armstrong arrangement, employing the minimum of apparatus and giving the same results!

(*Continued on opposite page.*)

ductance. An advanced form of the Armstrong regenerative circuit is used and is here given for *Amateur* use only.



The Complete 20,000 Meter Audion Receptor for Undamped Waves, With Loading Inductances and Large Loose Coupler.

Large values of inductance and small values of capacity give the best results. N.A.A., W.L.S. and N.A.J. have been heard 40 feet from the 'phones. Two pairs of 3,000 ohm 'phones work very well in place of the one pair of 2,000 ohm. The antenna from which this set is operated is 100 feet high and 100 feet long, of the "T" type.

USEFUL HINTS ON THE AUDION.

(*Continued from opposite page*)

In the first place, the Grid inductance not only acts as a wave length tuning inductance, but also as a storage of energy. This stored-up energy discharges back into the Wing inductance (which also acts as a storage of energy). The Wing inductance transferring the energy back again into the Grid circuit, causing a greater amount of current to flow, than would ordinarily occur in the absence of these inductance coils, and therefore, a greater drop of current across the telephones upon the reception of signals.

It is impossible to obtain maximum signal strength, or to hold the oscillations steady, for the reception of undamped waves, unless these coils are employed and adjusted properly.

The complaint that the body cannot be brought near the apparatus during the reception of signals without interferring with the signals, can be overcome to a large degree by grounding the Grid circuit between the secondary of the loose-coupler and the negative side of the telephone battery, also by short-circuiting the unused or idle turns on the Grid and Wing inductance coils, and also by grounding the headband thru a small condenser.

These precautions will enable the operator to work the arrangement with little or no trouble from capacity effects.

Instead of using long coils, 30 to 40 inches in length, four tubes of 6-5½-5 and 4½ inches respectively in diameter, and 8 inches long may be wound full with number 32 S.S.C. magnet wire and placed within one another, using insulating rings to separate the windings, taking care the windings do not oppose one another. This arrangement of coils will work the same as the longer coils and take up far less room.

The use of extremely large loose-couplers for long waves is not necessary. The mutual inductance between primary and secondary of such large couplers is very great and when used in conjunction with the Armstrong circuits requires very long (or loose) coupling. An air space of 8 and 10 inches between primary and secondary is not uncommon.

Practically the same results will be obtained on a much smaller coupler, giving smaller coupling between primary and secondary; the signal strength and tuning properties remaining the same as for the larger coupler.

It has been stated that one should never use finer wire on the primary of the loose-coupler and the primary loading coil than number 24. That is all right theoretically and in the reception of shorter wave lengths, but in dealing with undamped wave lengths the frequency is much lower, the current penetrating further into the wire.

Number 32 wire is found from experience to give practically the same results as number 24 wire, when used as primary loading inductances in receiving long waves, besides requiring a minimum of space.

While it is admitted the high frequency currents travel on the surface of the wire and granting the surface of a number 32 wire is not as great as a number 24; in practise, the same signal strength will be obtained and the sharpness of tuning is not affected by the finer wire.

There is no necessity of building receiving transformers for the reception of wave lengths in excess of 12,000 meters, as there are few stations at the present time using wave lengths above that value (12,000 meters).



Close View of 20,000 Meter Loose Coupler. Primary Control Switches at Right; Secondary Coil at Left.

A variable condenser should not be shunted across the primary inductances for tuning in the long wave-lengths, but a variometer employed instead, as it is well known, a condenser so used, decreases the current strength of received signals considerably. (Dr. Cohen.)

That a short antenna is suitable for the reception of long wave undamped signals is quite true, but all things remaining the same, the higher and longer the antenna, the stronger the received signal, providing the fundamental wave length of the antenna remains below that of the received wave. The above assertion holds true in all cases.

Finally, every piece of apparatus as used in the Armstrong circuits is absolutely necessary and the elimination of any one piece of apparatus *decreases* the efficiency of the set proportionally.

There is only one fault to find in connection with the working of the apparatus, and that is the unexperienced amateur who condemns it before learning how to work it.

There is no doubt but what it requires experience to do real, serious long-distance work, and the trouble lies mostly in the inability of the amateur and not in the apparatus, if connected properly.

The apparatus should consist of a primary loading inductance; a loose-coupler—Grid and Wing inductance; Grid condenser; secondary tuning condenser; Wing coil condenser, and telephone condenser, in conjunction with the regular Audion detector apparatus.

In conclusion, the long tubular bulb with the filament entirely surounded by the Grid and Wing, will give better results for the reception of undamped waves than the ordinary round form, as it is more stable in operation.

HOW TO EXTINGUISH ELECTRIC FIRES.

In the extinguishing of electrical fires there is large opportunity for the display of good judgment and prompt action. The element of time is exceedingly important. The operator should observe whether conditions warrant the cutting of current from affected part before the fire is attacked. His knowledge of the apparatus under his charge should be such as to guide him promptly, says H. L. Ganett in *E. D. & C.*

Sand and powder bicarbonat of soda have been found to have some merit as extinguishing agents in certain kinds of electrical fires, but their use is limited.

Where sand is provided for fire-extinguishing purposes, it should be carefully sifted thru a sieve of window screen of 14 mesh to remove the larger particles, especially scraps of metal. It should be kept in a clean and dry condition and should not be used where there is a liability of its getting into the bearings of moving parts.

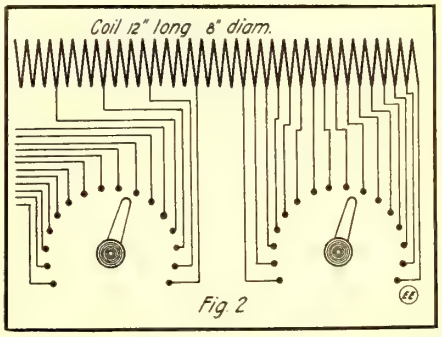
In tests recently made in extinguishing oil fires, wet sawdust impregnated with sal ammoniac has been found to have considerable merit.

Carbon tetrachlorid has shown up well as an extinguishing fluid and has the advantage of being a non-conductor to a high degree, which is a very valuable attribute.

In many modern plants the liability of structural fires is vastly less than the liability of the occurrence of fire in apparatus, and much of this apparatus is so constructed that in case of fire occurring in the interior it is very difficult or impossible to use an extinguishing agent with success

CONTROL BY SOUND.

At Lady Drogheda's Aircraft Exhibition at the Grafton Galleries, an interesting model airship constructed by Lieut. Roberts, in which the control is effected by sound, was recently exhibited. Electric circuits are worked by a telephone diafram, and this is tuned by an air column so as to respond to any desired note. On sounding this note the electric apparatus goes into action, the diafram acting as a relay, and by bringing this relay into action a sufficient number of times any particular motor can be put into operation.



Connection Scheme for Primary of 20,000 Meter Loose Coupler.

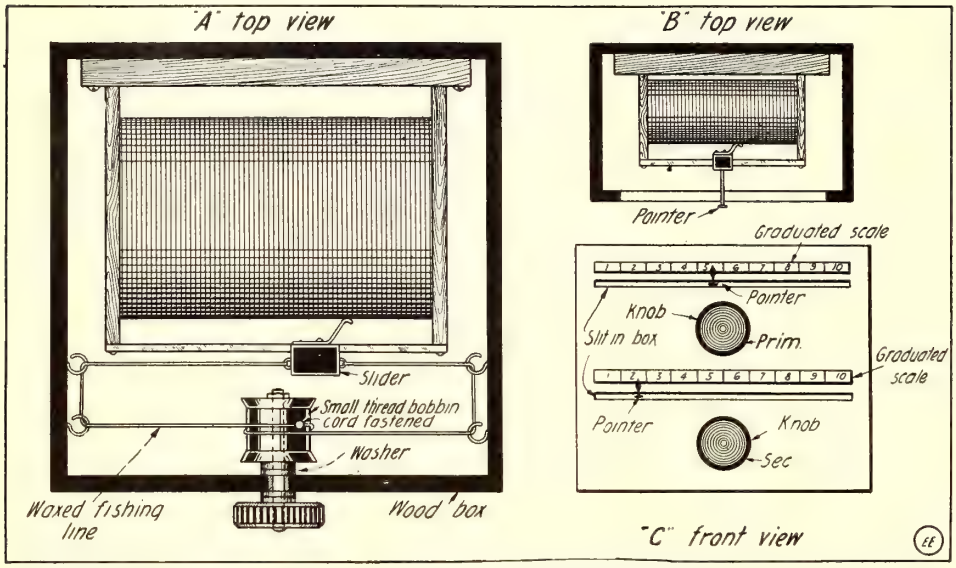
Converting a Tuning Coil into a Cabinet Tuner

By N. H. ALLEN

THE accompanying idea is to convert a one, two or three slide tuning coil into a cabinet tuner with rotary control at small cost.

First, secure a suitable box, similar in size to the tuner and slightly larger as shown in the drawing, and fasten the base tuner is used, the top knob may be marked *Primary* and the bottom one *Secondary*. The whole of the box, except scales, may be varnished for good appearance.

If a chart be prepared as shown here, the operator will be able to immediately adjust his tuner for listening in to any desired sta-



Now Is a Good Time In Which to Re-design Your Radio Apparatus. Here's a Fine Idea for Converting Your Old Tuning Coil Into a "Cabinet" Style Set. By Changing Around the Connections a Number of Effective Tuning Arrangements May Be Had.

of the tuning coil to the back of the box. Then fasten four small screw hooks (or better still, use small pulleys) to the box in the position shown in the drawing. A small hole should next be bored in the face of box in order to accommodate the rotary control knob shaft, on the inside end of which is fastened a small thread bobbin. The drawing shows the manner of attaching much better than I could describe it, so I will not go into details, and anyway there are no two amateurs that would do it just alike. When knob, bobbin and screw hooks are all in position, a waxed piece of fish-line is fastened to the slider, run thru the hooks round the bobbin once or twice and fastened securely. Thus it will be seen that when the knob on the front of the cabinet is rotated the slider will run along the coil to any desired position. (A good way to fasten the fish-line to slider is to drop a piece of melted wax, such as used in sealing batteries, on the line and slider, effectively holding it in place and which does not injure the slider in any way.)

Next refer to figure B, in which the apparatus described above is left out for clearness and the next point will now be described. This consists in the pinching of the minute hand from an old clock or making one from tin or brass. Fasten it to the slider in the manner described above for fastening the cord in place. The end of the pointer is bent in the manner shown so as to project thru a slit in the face of the box, cut the same length as the slider rod. (This is clearly shown in Fig. C.) Looking at C, it will be seen that a graduated scale is tacked or glued to the front of box just above the slit. This scale may be graduated in any manner desired.

If a two or three slide tuner is used, simply duplicate the operations described heretofore. The completed two-slide tuner is shown in C.

Now for the climax. When knobs are moved the pointer will be moved along the graduated scale and show the position of the slider for any operation. If a two slide tion. Thus if (9XE) is found to come in loudest when Prim. pointer is at 7½ and when Sec. Pointer at 3¾ by arranging as shown below, when the operator wishes to listen to (9XE), he simply adjusts his tuner accordingly; no guess work being necessary.

Name of Operator	Operator's Address	Oper's Call Signal	Adjust. for Pri.	Adjust. for Sec.
H. SMITH	323 Oswego St. New Jersey	GEE	7.8	5.1
J. GIBSON	18 St. Paul St. New York City	WIZ	9.8	7.3

EFFECT OF WATER VAPOR ON THE PROPAGATION OF ELECTROMAGNETIC WAVES.

An interesting paper on this subject by Dr. Frederick Schwers, was recently presented before the Physical Society of London.

The author discusses the probable influence of moisture in the atmosphere on the refraction of electromagnetic waves round the earth's surface. The conclusion of Kiebitz that the presence of moisture does not affect the dielectric constant by more than 10 per cent. is shown to be erroneous, being based on the assumption that the Clausius-Mossoti formula, $\frac{k-1}{k+2}\cdot\frac{1}{d}$ = constant, holds when passing from the liquid to the gaseous state. Examples are quoted to show that this law fails in many cases, especially where the dielectric constant is high in the liquid state.

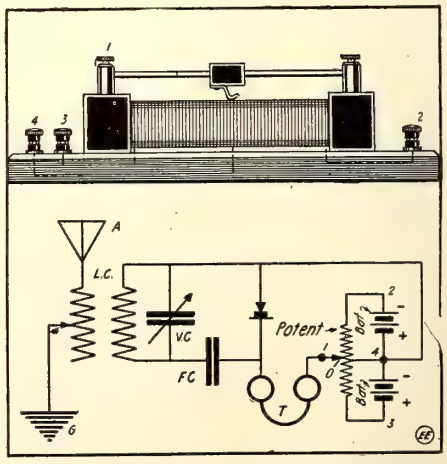
In the absence of more accurate data for ordinary temperatures, the author prefers to assume a value for the dielectric constant of water vapor obtained by extrapolating the results obtained by Baedeker for higher temperatures. The extrapolated value is almost certainly too low.

From this result, and the average conditions of the atmosphere over the ocean with regard to temperature gradient, etc., deduced from meteorological data, it is shown that the lowest layers of the atmosphere (1,000 to 1,500 meters approximately in depth) refract electromagnetic waves towards the earth, so that the greater part of the space waves will reach the receiver, contrary to the conclusion of Kiebitz.

Dr. C. Chree in discussion, says:—The author, presumably unaware of their existence, does not refer to the somewhat numerous upper air data which have been publisht in this country (England) by the Meteorological Office. A study of this data as to the temperature gradients would, I think, have proved useful. Inversions are not confined to the lowest layers, but in these layers they are exceptional, and do not suffice to reduce the average temperature gradient to such low values as the author has taken for the first and second kilometers. For these, 5 deg. or 6 deg. per kilometer would not have been too high, especially for tropical regions. If the empirical exponential formula for vapor pressure be assumed, the pressure at any given height varies directly with that at ground level, and so in temperate latitudes is much lower in winter than in summer. It thus seems rather a fundamental point whether wireless phenomena in temperate latitudes show a marked annual variation corresponding with that of vapor pressure at ground level.

A DUPLEX POLARITY POTENTIOMETER.

By the diagram given it will be noticed that two batteries are employed instead of the one battery formerly employed with the potentiometer; this by no means changes the ordinary hook-up, and while serving for the same purpose as usual, eliminates the continual shifting of battery or detector leads when inserting either one, in order to find the correct connection. I have found that this connection works very good, especially when experimenting as most amateurs do; i.e., continually changing detectors and circuits. When the slider is at the middle of the potentiometer the instrument is cut out of the circuit and a change either from positive to negative is made possible by moving the slider either above or below the point marked O, thereby making it unnecessary to shift detector or battery leads in order to get the correct polarity. Your



By Means of the Duplex Potentiometer Scheme Shown, It Is Possible to Quickly Reverse the Battery Current Thru the Detector or Other Device.

old potentiometer is easily converted for this circuit by taking off a lead from the center of the grafite rod or coil.

Contributed by EDW. T. JONES.

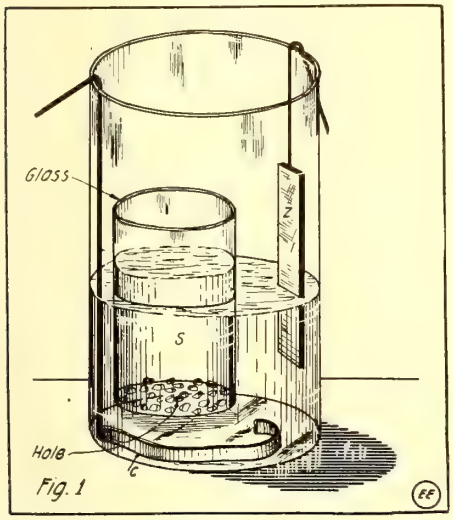
THE CONSTRUCTOR



"Bats"

By THOMAS REED

"BATS" in this case is short for batteries. All those who expected a nature-fake story, or a treatise on the kind of bats which unkind people say inhabit the belfries of electrical experimenters, may now pass out quietly thru the door on the extreme left. And please don't slam it!



"One of My First Attempts In Battery Research," Relates the Author, "Took the Form of a Modified Gravity Cell In which I Tried to Control the Action of the Copper Sulfate By Means of a Small Hole In Its Glass Retainer 'S.'"

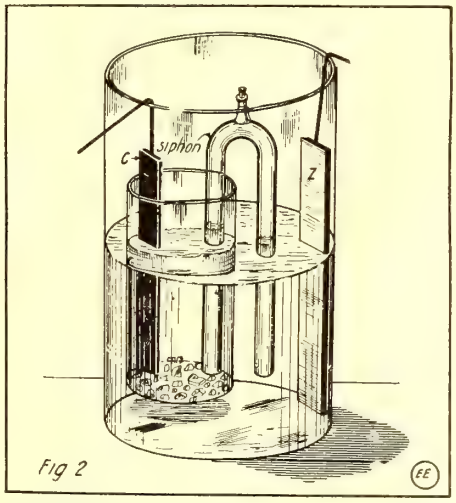
The old house where I lived and moved and had my shop hadn't been wired for electricity when it was built. You see, at that time builders were quite conservative about including electric fixtures in the specifications, because the only lighting current in existence was being produced in laboratories at a cost of about a hundred dollars per kilowatt-hour. In fact, electricity was in its infancy; and if you know anything about infancy you'll recognize that its expense-bill was running true to form.

By the time I began to take notice, electric lighting had conquered the streets and had begun to invade the houses. It was useful mostly as one of those modest means of advertising that you were "well off," same as the cast-iron hound on the front lawn. If you succeeded in blowing yourself like this without the grocer getting uneasy about his overdue bill, the inference was that you and Want were strangers, and that the mortgage had been left on the domicile simply in a public-spirited effort to keep money in circulation. As mere illumination the light was negligible, burning at various low degrees of candle-power, and usually going out whenever the neighbors dropt in to admire it.

I speak thus bitterly of the early light because it was an unsatisfied hankering of mine to have this current on tap for the operation of the various electrical machines which my young factory turned out with regularity. The Fates said me nix on that, and I defied them as one must; but it peeves me that now in my flat, when I can have all the "juice" I feel like paying for—I haven't any shop! Fates are like that: if they conclude to hand you the thing you've wished for, they wrap up with it a neat kibosh to prevent any enjoyment of it. It's just when the fish are biting fit to take your leg off, that your bait gives out, now isn't it?

However, you know we old fellows are great for finding reasons why any given calamity was "all for the best," and I can console myself for the lack of the piped lightning in this way: if I'd had the handy electric socket and one of those dinky toy transformers they sell in these days (which consume me with envy just as a great big shut-eye doll with real hair consumes a girl of any age from 9 to 90) I should have mist the pleasure of experimenting with batteries.

The question of operating current was always with me, butting in like the traditional hag among the good fairies at the christening of every new rinktum, with the threat of stunting its career thru malnutrition. To provide my scientific family with



When the Valve Action Shown In Fig. 1, Did Not Seem Very Promising, the Author Tried Out a "Siphon" for Controlling the Flow of the Copper Sulfate Solution, which Is a New One On Us.

their daily ration of wattage was a grim, endless duty; so, more from necessity than inclination, I was continually fussing with batteries.

The first battery I ever saw was the one used to actuate the family medical coil. It was a zinc cylinder suspended in a copper can, using a "straight" blue-vitriol solution as an electrolyte. In action, it bubbled and boiled, and produced whiskers on the zinc and mud on the bottom with surprising industry. It would run the coil for about half an hour, after which you had to clean it, and after that, clean yourself; so take it all together the coil gave you a lot of exercise as well as faradic effects. Father used it mostly to relieve his insomnia; after the thing was all packed away again, and he'd had his bath, he could usually sleep quite well. Electricity is life!

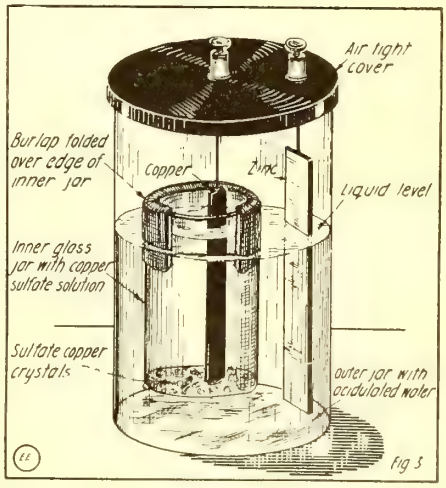
That mud-battery was the one I used on my first sounder, the one with the gate-hinge for an armature. It was quite strong while going at its proper stride, though not much stronger than the gate-hinge demanded. But when father's reserve stock of blue vit. solution was all used up, and I had duly received my "talking-to" for diverting it from its beneficent mission of nerve-relief, I saw distinctly that it was too rich for my blood. It was related to my own finances in about the ratio that three chorus-girls and a spendthrift son would bear to an elderly bookkeeper.

The flower of Bughood would have frozen in the bud but for good Père Leclanché. You remember Leclanché's original wet cell—nothing could have fitted better the wants and the pocketbook of the struggling Bug. I wish all the wattage that the old wet cells ever produced could be collected and burned in a neon lamp as big as a barrel in honor of that benefactor of the race of boys!

You could make a Leclanché cell for as near nothing as figures will come without lying. Any old cut-off bottle would do for a jar. For the porous cup we used a canvas bag. For a nickel the junkman would part with a large piece of second-hand sheet zinc; sal ammoniac and black oxid of manganese were the only cheap goods in the drugstore. For the carbon we made a raid on the gas works, where the rounded scales from the retorts were thrown out in heaps, there being no use for them in those days. Gee, but that carbon was hard! It was impossible to saw or work it in any way. To secure plates, we would shatter up a big hunk and select from the resulting hunklets such as happened to occur somewhere near the desired size.

A battery made in this way, with the jagged end of the carbon protruding from

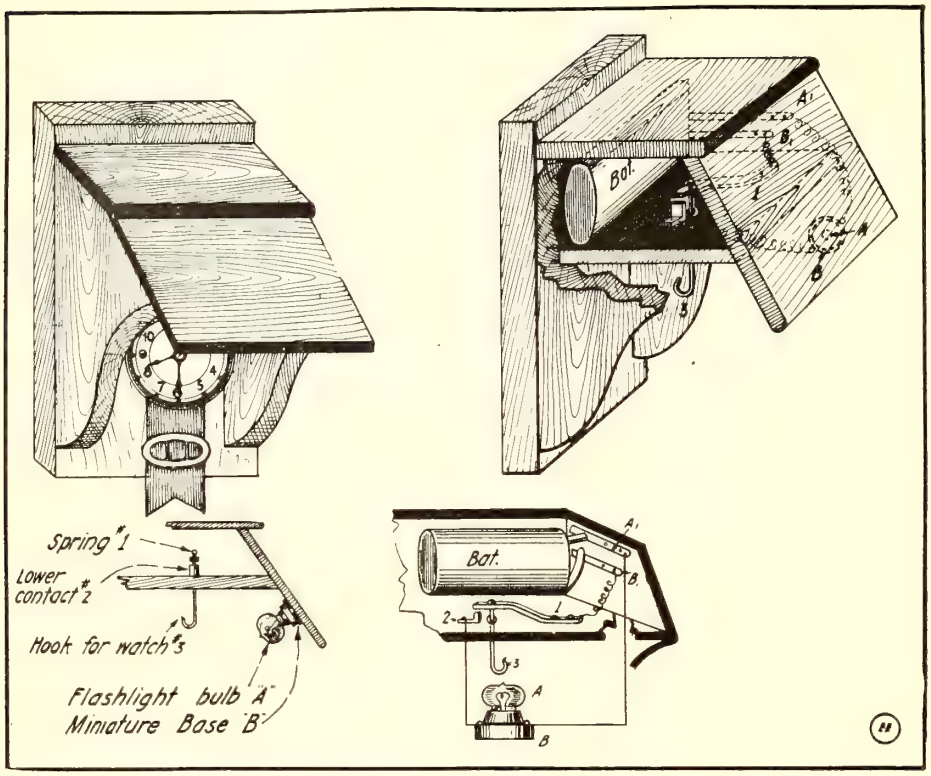
(*Continued on page 282*)



Finally the Gravity Cell Research Work Boiled Down to the Type Shown. The Copper Sulfate Oozed Out By Capillarity Thru Several Layers of Burlap Dipping In Both Solutions.

An Ingenious Battery Night Lamp

I describe herewith what I call a *night light*. It is fastened to the wall near the bed and when I wish to know the time I just give a slight pull on the watch fob and can tell the time by the light of the miniature bulb. In the drawing the battery terminals make contact with brass or copper strips, A_1 and B_1. The reason for this is so battery is easier to change in renewing than it would be if wires were soldered direct to them.



Do You Keep Your Watch Beside the Bed At Night? Here's a Nifty Battery and Lamp Attachment Which Enables One to Light the Dial by Simply Pulling on the Fob or Chain.

Contributed by J. A. SIMONIS.

MINIATURE ELECTRIC LIGHTS FROM 110 VOLT LAMP.

To do the following "stunt" will require quite some patience, so don't get discouraged if it does not pan out well at first. Procure a few burned-out 110-volt Mazda lamps, say from 10 to 15 watts, and shake or jar a bulb until all the wires are broken loose from the supports or the frame to which the fine wires are attached. Now turn the bulb so that the heavy end is pointing down and get all the broken pieces of wire on the side of the bulb where the current enters. Quickly invert the bulb and some of the wires may fall across the lead in wires—or they may not. If they do not, try it over again. When you get a wire or two to hang, connect a small current to the lamp and you will have a light, and a cheap one too. I generally connect a flashlight battery at first, in order to weld the small wires firmly in place, and then by means of a transformer and rheostat, adjust the current until the lamp burns at full brightness. I have obtained as much as 32 C. P. from nine volts on such a lamp.

Contributed by EARL MELDRIM.

HOW TO SOLDER ALUMINUM.

In soldering aluminum, it is necessary to bear in mind that upon exposure to the air a slight film of oxid forms over the surface of aluminum, and afterwards protects the metal. The oxid is the same color as the metal, so that it cannot easily be detected. The idea in soldering it is to get underneath this oxid while the surface is covered with molten solder.

First:—Clean all dirt and grease off the surface of the metal with a little benzine [bearing in mind that benzine forms an explosive mixture when in contact with air, and for that reason should not be kept near any flame whatsoever].

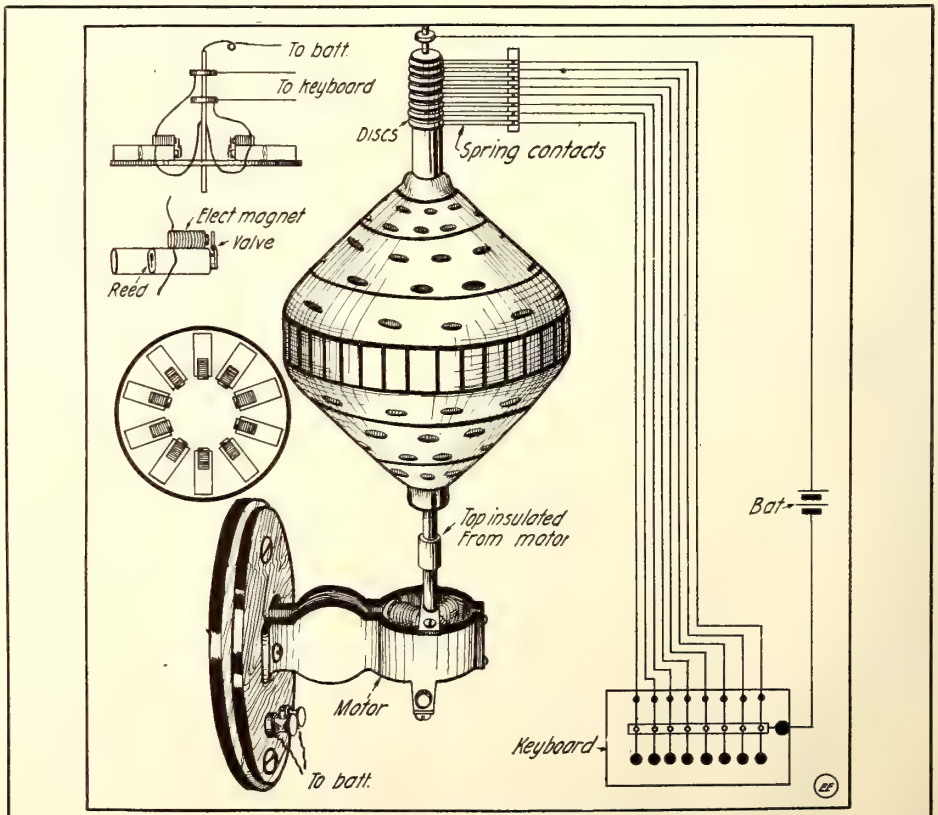
Second:—Apply the solder with a copper bit, and when the molten solder is covering the surface of the metal, scratch thru the solder with a small wire scratch brush. By this means you break up the oxid on the surface of the metal, underneath the soldering, and the solder, containing its own flux, takes up the oxid and enables you, so to speak, to *tin* the surface of the aluminum.

Contributed by ALBERT W. WILSDON.

AN ELECTRICAL MUSICAL TOP.

Here is a plan for making an electric top which will play a tune. It consists of a top run by an electric motor. On the inside of the top are placed small tubes, each fitted with a reed of different tone. On the end of each tube is a circuit-breaker which is opened by an electro-magnet. One terminal from each electro-magnet is connected to the rod running thru the top, the other terminal being connected to a small brass disc, insulated from the rod. Each magnet has a separate disc and a small brass spring brush. Each spring is permanently connected with a key on a keyboard. The discs must be separated slightly from each other. In operation, the motor is started, a key is prest on the keyboard, the current passes thru electro-magnet, causing the hole in the end of the tube to open. This permits the air to pass thru, thus causing a suction which vibrates the reed. By having enough reeds to form the musical scale a tune can thus be played. Since the electro-magnets are connected in multiple, more than one note can be produced at a time.

Contributed by EARL FINFROCK.

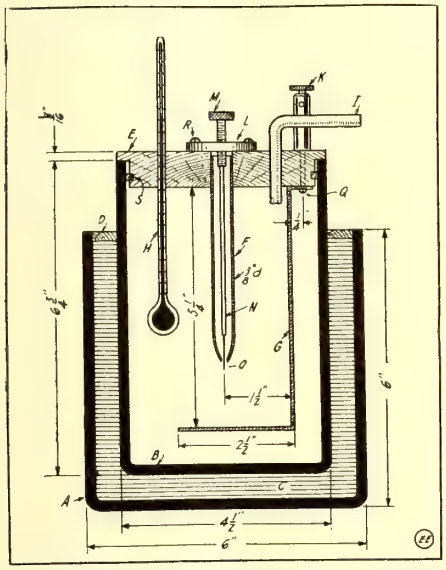


This Electric Spun and Variable Tune Top Will Interest Young and Old Alike. A Set of Keys Control Electric Circuits Actuating the Various Tone Reeds Within the Revolving Top.

An Electrolytic Interrupter for Low Voltages

By C. A. OLDROYD

THE main advantages of the electrolytic interrupter are: Increased number of interruptions per second, increased spark length and intensity and remarkable steadiness of the image when used for X-ray work. The electrolytic interrupter also makes a con-



Sectional View of Low Potential Electrolytic Interrupter for Use on Voltages as Low as 12, and Provided with an Adjustable Anode, Thermometer and Special Means for Keeping the Solution Hot.

denser for the primary of the coil unnecessary: The only draw-back is the necessity of using a voltage of about 110 volts when employing the *usual* type of "Wehnelt" interrupter.

In the following it will be shown how the interrupter may be modified to work at a potential of only 12 volts, thus enabling the experimenter who has only a storage battery or primary batteries at his disposal, to work his coil with an electrolytic interrupter. The interrupter consists of an inner stoneware jar B, and an outer one A. Both are separated by a layer of cotton-wool C. The inner jar carries a wooden cover E, which fits air-tight into B. This is achieved by using a small rubber band S, in a groove in the cover, the groove having such a depth that the outer diameter of the rubber ring in position is about 1/32 inch larger than the inside diameter of the jar. A very slight pressure will be sufficient to fix the cover E into the jar. From the cover E is suspended a lead plate G, bent as shown. This plate is held in position by the screw Q, of the binding post K. A glass tube F, ⅜" diameter is fitted into the cover E and has a small hole at the lower end to let the platinum wire O pass thru. This wire is attached to a lead rod N, which in turn is fixt to an adjusting screw M. This screw works in a small hard-rubber plate L, which is attached to E, by three wood-screws R. H is a thermometer, reading up to 120 degrees or 150 degrees centigrade; it passes thru a hole in cover E. I, is a small glass tube bent as shown and mounted in the cover E in such a manner that the lower end just projects thru E.

The reader may be puzzled why two containers are used where one would be sufficient, but the reason is that for such low voltages as mentioned above, *i. e.*, 12 volts, the diluted acid in the interrupter must be kept at a temperature of about 90 degrees centigrade to ensure proper working. The layer of cotton-wool C, keeps the heat in the inner vessel B, and once the diluted acid in B is warmed, it will remain warm for several hours. The gases produced by the interrupter can only escape thru the glass tube I, as the cover E fits airtight in B. As the small sketch shows, the tube I is connected by means of rubber tubing to a second glass tube Y, fitting into a stopper Z, both being fixt into a glass bottle containing a solution of water and washing soda, which neutralizes the gases produced by the interrupter when working. The tube Y reaches about 2" below the level of the solution and the stopper Z, has a notch on one side to let the gases escape, after they have past thru the soda solution, and thus been neutralized. To warm the solution in the inner container B, of the interrupter, it is only necessary to withdraw the jar B by gripping it at the projecting part and place it on a radiator or on a gas ring until the thermometer shows about 90 degrees centigrade. Then the container B can easily be replaced into A, in the same way. When warming the solution, care should be taken to do this gradually or the jar may crack.

To build this interrupter let us first procure two stone jars, A and B, which should be approximately of the dimensions given. Place some cotton-wool on the bottom of the outer vessel A and compress it slightly by placing B into A. The thickness of the wad of cotton-wool should be about ½". Now fill the remaining space between A and B with cotton-wool, always compressing it with your fingers. Next cut a small ring D, from wood about ¼" thick, and glue it into A. This ring serves to keep the cotton-wool in position when withdrawing or replacing the inner jar B. Next turn the cover E from hard wood ¾" thick, making the lower part fit easily into B. Cut the groove shown and place a rubber band S into it. As mentioned above the outer diameter of S when in position, should be about 1/32" larger than the inner diameter of the jar B. Drill a hole ⅜" diameter thru the center of the cover for the glass tube F and three other holes T, U and V, as shown in detail drawing of the cover. T is for the thermometer, U for the glass tube I, and V is a clearance hole for the screw Q, of the binding post K. This cover plate must now be soaked in molten paraffin wax for at least half an hour.

We turn now to the glass tube F. This is 4⅜" long by ⅜" diameter. Take a tube about 15" long and heat the middle over a Bunsen burner until the glass becomes fairly soft. Then draw the two ends apart and you will have two glass tubes with tapering ends. Cut the taper where the bore is about ⅛" and smooth it on sandpaper. Now cut off the parallel part of the tube to make the total length 4⅜" and fit the tube into E, by means of shellac varnish. We now come to the adjusting screw: Procure a screw M, with 3/16" thread, by about one inch long; solder to M a piece of lead rod N 3⅝" long by ⅛" diameter and solder to N a platinum wire O. This should be one millimeter diameter by ¾" long. If you have a slightly smaller or larger gage in your possession, you may use it, as the diameter of the wire is of no great importance. The hard rubber plate L, is next made to the dimensions given in the detail drawing, and the center hole is tapt to suit the adjusting screw M. The plate L is then painted with shellac varnish at the side, which is to be in contact with the cover and screwed to E by means of three small screws R. The next part to be completed is the lead plate G. This is made from strip about 1½" wide by 18 gage thick, and bent as shown. G is then fixt in position by screwing Q, into the binding post K. The thermometer H and glass tube I, are now put in place, using again shellace varnish.

The interrupter is now complete and has to be filled with a solution of one part of sulfuric acid in ten parts of water, and stir the water all the time with a glass rod. (Pour acid into water—never water into acid.)

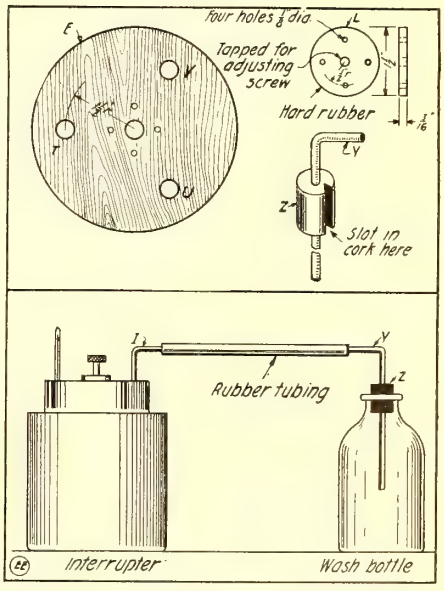
The wash bottle is next made from an eight-ounce glass bottle or any similar size. The glass tube Y is of the same diameter as I, and bent as shown. The stopper L receives a notch as mentioned before. Place some lumps of washing soda into the bottle and pour sufficient water on it to bring the water level about 2" above the end of tube Y. Finally connect I and Y by means of rubber tubing.

The interrupter is connected in series with the primary of the coil, the lead plate being the cathode. (*A lead sleeve covering a copper wire may be used instead of a lead rod for the anode.*)

HOW TO MAKE FIREPROOF PAPER.

Dip a sheet of paper in a strong solution of alum water, and, after drying it, repeat the process three (3) times; then hold it in a flame and it will not burn.

To melt steel as easily as lead, heat a



Details of Low Voltage Electrolytic Interrupter and Arrangement of Wash Bottle for Neutralizing the Gas Fumes Produced.

piece of steel in a fire until it is red, then take it out and touch it with a piece of brimstone (sulfur). As soon as the brimstone touches the steel the metal will melt and drop down like liquid.

Contributed by JAMES MILLEN.

A Hand-Feed Arc for the Experimenter

I give herewith a sketch of an arc lamp of my own design. The right hand binding post is connected to the stationary carbon. The left hand binding post is connected to the hinge F, and is fastened along the wood standard R. By turning the threaded rod A, this causes the slider C, which is not threaded, to lower or raise the brass arm I. (Fig. 1.)

It is best to make all of the parts such as the base and upright R, of slate, fiber, soapstone, marble or other non-combustible material. They may be constructed of sheet iron with a little care as to the insulation, using mica washers and bushings on the screws. The carbons may be small or large, the standard size for commercial arcs being ½ inch diameter. A spiral spring G, formed of phosphor bronze or steel wire, pulls the bar I downward. The glass lamp chimney is retained in place by a wood or fiber ring. This arc lamp is well adapted for use in small motion picture machines, post card projectors, model search-lights, wireless telephones, speaking arcs, etc.

Fig. 2, (left) shows a balanced, straight-line-feed arc lamp which the amateur electrician will find easy to construct. Iron pipe can be used with standard flanges, etc., to make it with. The toothed rack is riveted to a piece of iron or steel rod A, the rack sliding in a slot in the front face of guide bar B. A pinion is mounted in this slot to mesh with the rack, the pinion being rigidly secured to the arc adjusting handle and shaft. The balance weight should just about balance the moving carbon holder. Fig. 2, (right) illustrates the rack and pinion action in standard handfed arc lamps.

Regarding the current to be used with it, this may be either A.C. or D.C. The arc will give a powerful light on 50 to 60 volts and 5 to 8 amperes. It works best with a ballast resistance in series; this may consist of a few short coils of iron or German silver wire about No. 20 gage. The resistance should be adjustable and for 110 volt circuits some resistance is absolutely necessary. For 110 volt D.C. service the value of resistance approximates 11 to 12 ohms. It may be in the form of a water rheostat.

Contributed by JAMES PRATT.

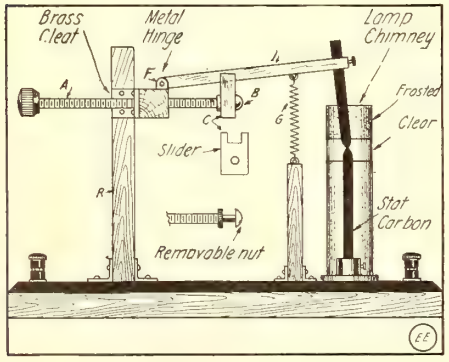


Fig. 1.—A Swinging Carbon Type of Arc Lamp for Amateurs.

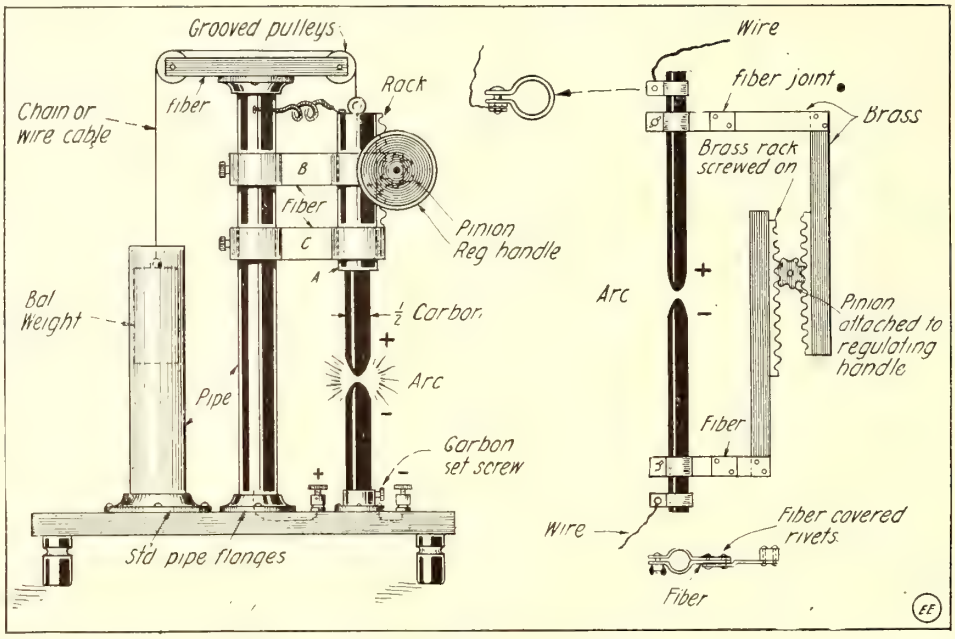


Fig. 2.—Hand-Feed Types of Arc Lamp Which Lend Themselves Readily to the Constructional Skill of the Amateur Electrician.

TO KEEP HUMAN PESTS AWAY FROM YOUR AUTO.

How many of you fellows who own an automobile are, to put it mildly, peeved, to have some person leave their hand-marks on its glossy finish, or if it happens to be covered with a light film of dust, leave their delicately inscribed monogram traced therein. Some of this of course is thru carelessness and some thru the irresistible impulse of some people to see their name or trade-mark in every possible place. The result however is the same, leaving the car in a messy looking condition, and oftentimes actually injuring the finish.

My car, however, has of late been strangely immune from this slight source of annoyance apparently due to a "short" in the electrical connections. Whenever I am in the car and some "nut" starts exhibiting his skill in engraving on the metal body of the bus this short develops, and believe me, he suddenly loses all interest in his art, and rather shows a tendency to do a little vaudeville turn, executing something similar to the "Highland Fling."

The secret, however, lies in the fact that I have a small spark-coil connected to my storage battery and in turn connected to the metal body of the car, with a push button located in a place not readily seen, but at the same time easily got at, without attracting attention. I will not attempt to describe connections of this stunt, as anyone can easily hook it up. But take it from me it gives Results, with a capital "R".

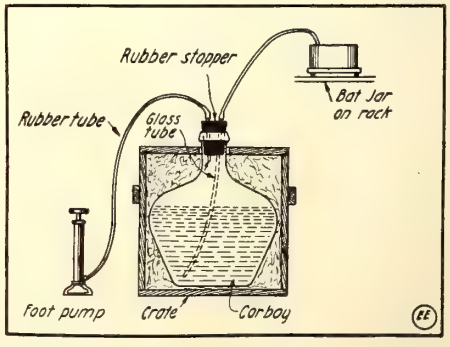
Contributed by H. H. L.

HOW TO PUMP BATTERY ELECTROLYTE FROM CARBOYS.

"Electrolyte for storage batteries is usually shipt in carboys which are heavy and unwieldy. The ordinary method of pouring the electrolyte or acid directly out of the carboy into pitchers or jars by means of which the individual battery cells are filled is a difficult task and results in considerable trouble, loss and contamination of solution, wasting of time, and frequently destruction of clothing. Where there are quite a number of stationary battery cells to be filled, as in the case of a new installation or where the electrolyte is being completely renewed," says George A. Broder, in *E. R. & W. E.*, "I find that a carboy pump similar to the one illustrated is a desirable adjunct.

"This device consists of a foot pump or bellows connected by a rubber tube to a rubber stopper in the neck of the carboy; from this stopper another tube leads to the jars or cells to be filled. The rubber stopper must fit very tightly, has two holes passing thru it and into one of these is placed a short piece of glass or hard-rubber tube to the top of which the tube from the pump is connected. Thru the other hole in the stopper passes a long piece of glass or hard-rubber tubing which is preferably curved slightly so as to reach the lowermost part of the carboy; this glass tube projects above the rubber stopper just enough to permit fastening the discharge tube or hose to it.

"The principle of the device is very simple. Air is forced in from the pump or bellows and creates a pressure on the surface of the electrolyte or acid in the carboy. This forces the electrolyte up thru the glass tube and discharge hose which can be carried to any jar or cell to be filled. The tubing should be of one-fourth or three-eighths inch internal diameter. By this device, especially if a bellows is used, a steady pressure can be maintained upon the electrolyte so as to secure a constant flow regardless of the amount of liquid left in the carboy; in fact the carboy can be emptied to almost the last drop. By placing a small pinchcock near the end of the filling or discharge hose, or by bending this hose sharply, it is possible to stop the flow of electrolyte without spilling a drop when changing from one cell to another."



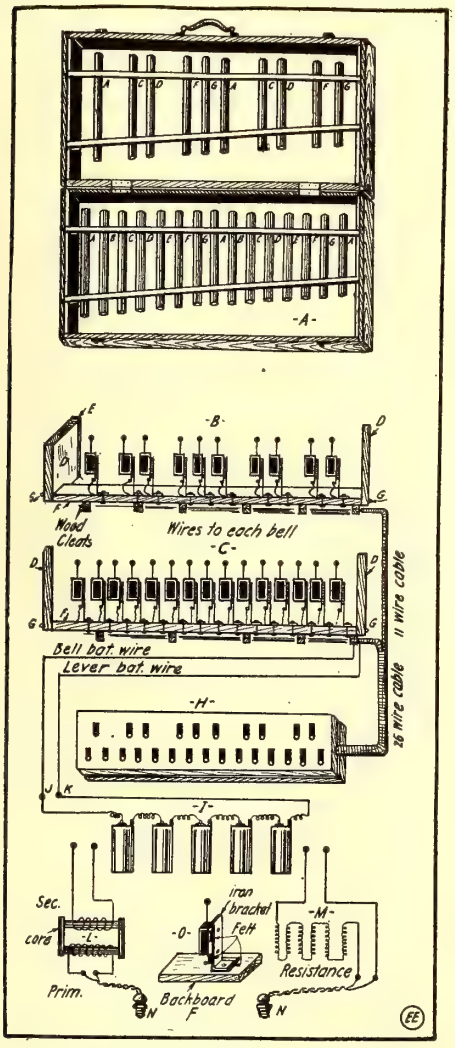
Method Whereby Battery Electrolyte Can Be Pumped by Comprest Air from Carboys Into Cells.

AN ELECTRIC PLAYER FOR TUBAPHONES.

By J. W. F. BOWLES

DOOR-BELL music would hardly appeal to city people any more than grass-hopper music to a farmer, but an apparatus, consisting of Drummers' Bells and ordinary electric house bells with the gongs removed, will produce music which is virtually door-bell music and which is finding favor with musicians patient and handy enough to construct the simple attachments.

As seen in the diagram, the working parts of ordinary vibrating bells are fastened to a frame, which sets over the rows of *tubes*. The bells as well as the frame itself are adjustable, making it possible to adjust the hammer of each bell to strike its corresponding tube squarely.



Even the Musician Finds Electricity Useful. Here We Have the Details for Making an Electric Player for Tubaphones.

Several keys may be struck at once. Any pianist or a drummer who plays bells can operate the key-board for which, however, a lingering touch is preferable to that of the pianists' staccato.

The instrument may be introduced into an orchestra as a novelty but in dance halls it may be used permanently with great success.

Description of Apparatus (See Illustration)

(A) Tubaphones in case.

(B) Frame with sharps and flats.

(C) Frame with naturals. To play the tubes the frames (B) and (C) are set over the tubes in case (A) so the hammer of bells strike the center of tubes.

(D) Supports for holding backboards.

(E) Felt under resting part of supports. Same on balance of (E) supports.

(F) Backboard containing the bells.

(G) Adjusting screws for adjusting bell to strike tubes to various pitches.

(H) Leverboard or keyboard on which are mounted the keys to make circuit to bells. The keys are arranged in an order corresponding to the tubes in order.

(I) Five one and a half volt dry cells. Wet batteries can be employed in the same manner and circuit. If open circuit batteries are employed and a greater quantity of current is required (which is necessary when the bells are in continual service) the batteries should be placed in multiple-series, which means a repetition of the present set connected, positive to positive and negative to negative. As well as the former, alterating or direct current from power lines can be attached to the outfit as described under (L) and (M).

(J) Positive binding post and bell battery wire.

(K) Negative binding post and key battery wire. (J) and (K) can be reversed, as there is no set positive and negative connections to the operating apparatus.

(L) Step-down transformer apparatus reducing the voltage from 110 volts to 8 volts on alternating current circuits. An attachment plug is connected with a length of No. 16 flexible wire, with reinforced insulation, and is then attached to the primary side of the transformer. The secondary side of transformer has wires provided to connect to (J) and (K) binding posts—eliminating battery wires.

(M) A direct current power line circuit with resistance to reduce the voltage from 110 volts to 8 volts. Connections can be employed in the same manner as described under (J) and (K).

(N) Attachment plugs that will fit any Edison socket or receptacle.

(O) Shows how individual bell is mounted to backboard (F). The band iron brackets are fastened to the backboard by means of stove-bolts. The bell is also secured to the bracket in the same manner with a piece of felt between the two, to eliminate any foreign sound while the bells are in action. The bells in this equipment have two ohms resistance and must all be of the same make and adjustment. The wire is No. 18 for sections and No. 16 for battery or main lines which are lettered (J) and (K). The wires in the present equipment are individual, have rubber insulation and are cabled. A standard cable can be employed if the distance between parts is great.

HINTS ON WEIGHING CHEMICALS.

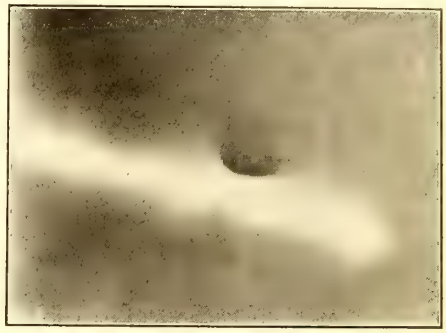
Many of the chemicals used for making up battery and other solutions used by electrical experimenters can be weighed quite well upon a small piece of tissue paper, this being used to keep the scale pans clean. Another piece of paper of the same size should be placed in the other pan to avoid errors in weighing. Some such dodge as this is particularly useful when a cheap balance is used, having the pans suspended by means of thin cords past thru holes in their edges. These cords retain small particles of the substances weighed and so give rise to impurities in solutions subsequently prepared.

A better plan than the above is to use a couple of watch or clock glasses, two being required so that one does not have to wait while the glass is washed after a previous weighing. With the tung of a file scratch a circle on the back of one glass, and a cross on the other. Then make two counterpoises from thin sheet metal, making one round and the other like a Maltese cross, to avoid all possibility of mistaking which is which.

Contributed by H. J. GRAY.

AN INTERESTING RADIOGRAPHIC EXPERIMENT.

The following experiment, which I worked up several years ago, has always proved of interest to men somewhat advanced in scientific experimentation.



Radio-Activity Is an Absorbing Study; Here We Have a Photo Made by Exposing a Covered Plate to the Rays of Uranyl-Chlorid.

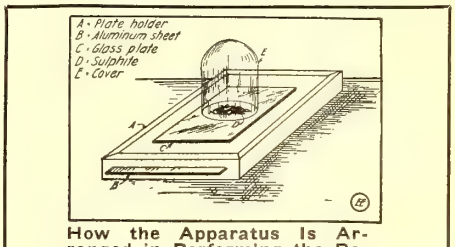
An experiment of interest to those who find pleasure in Radiography is that performed by Niewenglowski several years ago. The material furnishing the radiations is, in this case, *calcium sulfid,* such as is used in the manufacture of phosphorescent paint. A photographic plate is placed in a plate-holder A, and instead of a cover-slide, a thin sheet of aluminum, B, is inserted. Upon the aluminum are placed squares of thin glass, and on these pieces of calcium sulfid, D, previously exposed for some time to sunlight. These are protected by a cover glass, E.

The apparatus is left in the dark for twenty-four hours or so and the plate then developed. The particles radiating from the sulfid will have penetrated the aluminum and affected the sensitized photograph plate.

The phenomenon is similar to that observed about the same time as Niewenglowski by Becquerel, in respect to the salts of *Uranium.* It was later found, however, that the uranium salts exhibit this property of affecting a plate without previous exposure to light.

From the similarity to the action of the recognized radioactive elements, and from the accepted theory of radioactivity, an explanation for this phenomenon can be derived. The calcium atom in the salt *explodes,* or decomposes, as does Radium and the other radioelements, giving rise to a yet unknown substance (perhaps a *calcium emanation*), and the characteristic penetrating rays; from their nature, the B-rays. It is these B-rays which penetrate the aluminum and affect the plate. That the calcium salt must be exposed to light in order to secure this radioactivity is probably due to the radio-weakness of calcium.

(If the experimenter is able to secure any of the uranium salts, either from a reputable chemical house or from the ore, results will be much more easily attained and will be more satisfactory. The accompanying photo print was made from uranyl-chlorid.)



How the Apparatus Is Arranged in Performing the Radiographic Experiment Here Described.

Contributed by J. S. MARCUS
(University of Colorado.)

HOW TO MAKE IT



This department will award the following monthly prizes: **First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.**
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

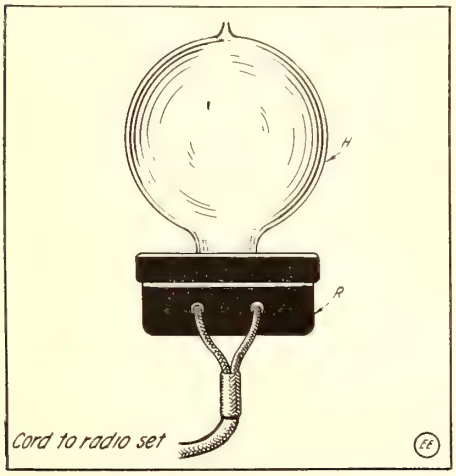
A NOVEL ACOUSTIC AMPLIFIER.

An amplifier which nearly equals an Audion in its sensitiveness and which requires no battery current to operate it is described herewith.

It is however better suited for use in regenerative vacuum detector receiving sets, that use a capacity to vary the number of beats.

Referring to the illustration, R is the telephone receiver (of 1,000 or 1,500 ohms resistance), while H is a *Helmholtz* resonator. The resonator is mounted so that the large opening fits over the hole in the ear cap of the receiver.

The number of beats is then regulated (by turning the variable condenser) until a clear response is heard. As a resonator of this type responds only to a *certain note*, the beats must be regulated until the resonator is in resonance with the receiver.



The Simplest Amplifier for Radio Is That Shown, Which Involves the Use of a Helmholtz Resonator.

The system may also be used (with somewhat less efficiency) on an ordinary wireless set, i.e., one using a crystal rectifier, by first carefully ascertaining the pitch of the incoming signal and then choosing a resonator of the proper pitch.

Contributed by F. G. THACKABERRY.

LOCATING ARMATURE GROUNDS WITH A TELEPHONE RECEIVER.

A simple method for locating a grounded coil in an armature, will appeal to all electricians having to care for motors or generators. This test can be made without removing the armature.

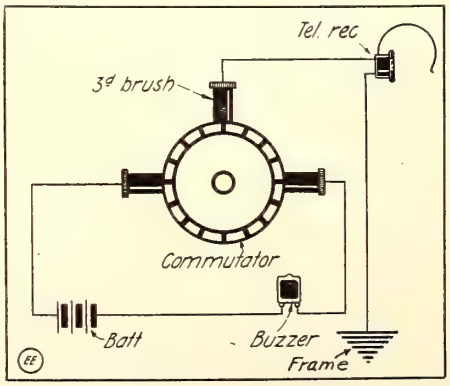
Remove all the brushes from the commutator with the exception of two located diametrically opposite. These brushes are connected to a few cells of dry battery and a buzzer, as shown in the illustration.

A telephone receiver has one terminal connected to the frame of the machine, while the other terminal is connected to a third brush, which bears on the commutator midway between the other two.

On starting the buzzer a sound will be heard in the 'phone. The armature should then be turned slowly, keeping the brushes in the same relation to each other, until no sound is heard in the telephone; this will indicate that the bar connected to the grounded coil is under the middle brush.

Due to the winding in wave-wound armatures it will be found that there are as many "silent" or nearly silent bars as there are poles in the machine. The proper one can be found by selecting the one which gives the least sound in the receiver. Should more than one be entirely "silent" increase the number of batteries in series with the buzzer until it is found that one bar gives less noise than the others in the series.

Contributed by THOS. W. BENSON.

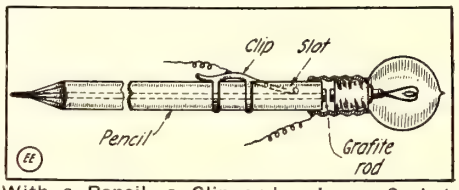


Method of Testing for "Grounds" on Motor and Dynamo Armatures with a Buzzer, Battery and Telephone Receiver.

SECOND PRIZE, $2.00

COMBINED PENCIL RHEOSTAT AND LAMP SOCKET.

Here is an improvement on my vest-pocket rheostat described in the October, 1916, issue of THE ELECTRICAL EXPERIMENTER, and as now constructed, it will be found very handy for testing the strength of small lamps.



With a Pencil, a Clip and a Lamp Socket Shell One May Construct a Vest-pocket Rheostat and Lamp Socket.

In addition to slotting the pencil and making the other details, secure a socket from a porcelain base, such as are used for miniature lamps, and force this over the end of the pencil. If necessary, an adhesive may be employed. Make the wire connections as shown, so that the current will travel via the inserted lamp after passing thru the grafite resistance, as regulated by the fountain pen clip.

Contributed by JOHN T. DWYER

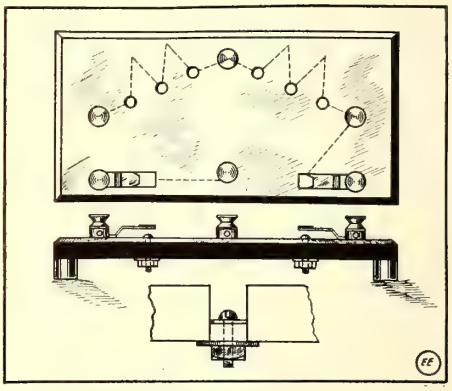
THIRD PRIZE, $1.00

A SIMPLE WHEATSTONE BRIDGE.

Select a piece of board of dimensions 8″ x 15″ x 1″ thick. This should be well-seasoned wood, preferably some non-resinous kind. Bore holes for the binding-posts and the mercury cups, as shown in the drawing.

The contact keys are made of strips of hard sheet brass, bent as shown.

For the ratio coils No. 22 B. & S. double-cotton covered, German silver wire will be found the most convenient. It is very desirable to adjust these coils to exactly one and ten ohms each respectively, but this is not essential. Good results can be obtained by simply measuring off lengths of one and ten feet very accurately. The resistance of these wires will not vary greatly from the values marked, and their ratio will be very close to 10 : 1, which is the essential thing.



The Amateur Electrician Will Find This Small Wheatstone Bridge Useful As Well As Instructive.

All permanent connections shown in the sketch should be very carefully soldered on the under side of the bridge. A coat or two of orange shellac will make a neat appearance.

This apparatus, used in connection with an ordinary resistance box (.1 to 110 ohms), will give a possible range for measurements from .01 to 1100 ohms.

This bridge will commend itself on account of its teaching value, since it follows the theoretical Wheatstone bridge design very closely. Another good feature is its low cost. The necessary materials need not cost over seventy-five cents, and the labor involved in its construction is very small.

Contributed by
PETER J. M. CLUTE.

Due to the advent of the war, we are particularly desirous of obtaining manuscripts describing original and practical "Electrical Experiments." We shall continue to publish Radio articles, but what we need is snappy "Electrical" articles. Be on guard for the enemy—Repetition!

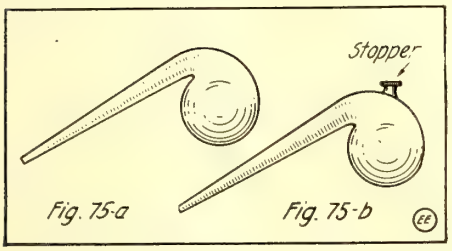
Experimental Chemistry

By ALBERT W. WILSDON

Fifteenth Lesson

NITRIC ACID. (HISTORY). (HNO_3)

NITRIC ACID was probably known to the ancient Egyptians and alchemists as Aqua Fortis (Strong Water). Geber is credited with having prepared it in the Ninth Century by strongly heating a mixture of



Glass Retorts With and Without Stopper. They Are Used Extensively in Chemical Researches.

Saltpeter (Potassium Nitrat), Alum, and Copper Sulfate, the Nitric Acid distilling over, owing to the decomposition of the Saltpeter by the Sulfuric Acid of the other salts. Nitric Acid was commonly prepared and used as a valuable reagent by the alchemists, especially as a means of separating Gold from Silver.

(*Synonyms — Aqua Fortis, Strong Water, Azotic Acid, Hydrogen Nitrat, Hydric Nitrat, Spirit of Niter.*)

Glauber about 1650 prepared it by a similar method to the one which is now used, namely, by the action of Oil of Vitriol (Sulfuric Acid) on Niter (Potassium Nitrat).

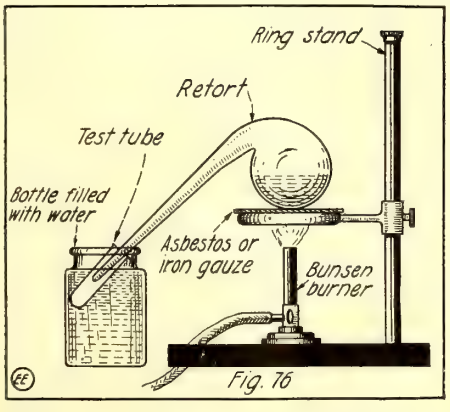
Lavoisier first determined the composition of this acid about 1776. He proved that one constituent was Oxygen, but was unable to prove the nature of the others.

Cavendish proved the exact composition and mode of formation of this acid of its salts by the direct combination of Oxygen gases in the presence of water or alkaline solutions.

Priestley, from his experiments, observed that when a series of electric sparks was made to pass thru air included between short columns of a solution of litmus, the solution acquired a red color and the air was diminished in volume.

In the place of litmus, Cavendish performed similar experiments to Priestley's, using what was known as *Soap-lees* (Caustic Potash) and Lime-water. He concluded that the Soap-lees (Caustic Potash) and the Lime-water became saturated with some acid during the operation. He proved that this was Nitric Acid, by passing the electric discharge thru a mixture of pure Dephlogisticated Air (Oxygen) and pure Phlogisticated Air (Nitrogen) over Soap-lees (Caustic Potash), when Niter (Potassium Nitrat) was formed.

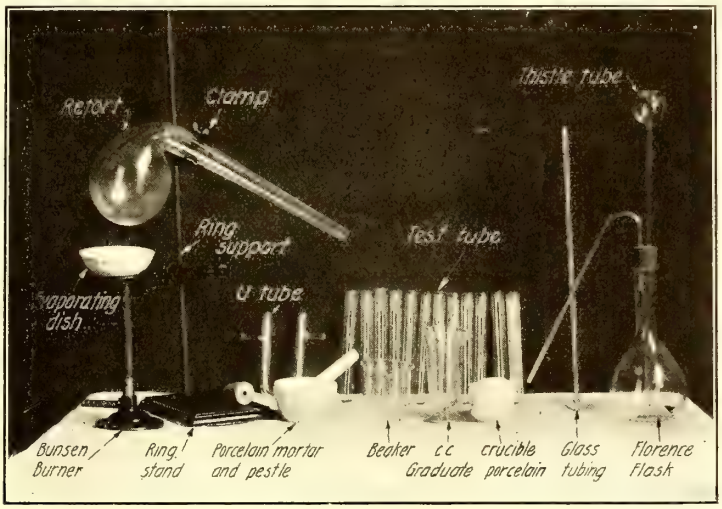
In 1816, Gay-Lussac found the ratio of Hydrogen, Oxygen, Nitrogen, corresponded with H_2O, N_2O_5.



Method of Setting Up Retort, Bunsen Burner, Condenser, Etc., in Experiment No. 82.

OCCURRENCE:

Like Hydrochloric Acid, Nitric Acid does not occur in the free state in Nature, its affinities being too strong. After thunder-storms, or electrical discharges in the air, traces are found. It occurs in large quantities combined in the form of Alkaline Nitrats, the two important ones being Sodium Nitrat [$NaNO_3$], found in large quantities in Chile, and also being known as Chile Saltpeter; and Potassium Nitrat [KNO_3] which is found in India, also known as Niter, Saltpeter, and Bengal Saltpeter.



Typical Outfit for An Experimental Chemist's Laboratory. Hundreds of Important Experiments Can Be Performed with This Equipment.

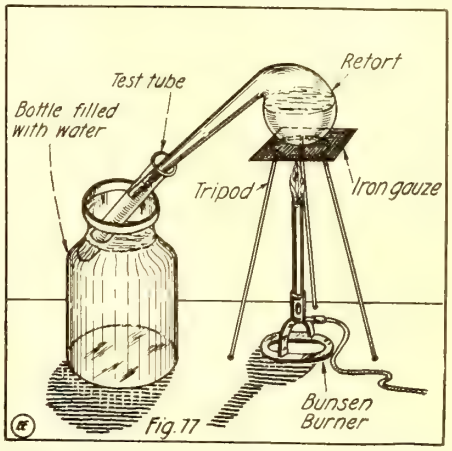
The formation of the nitrats are supposed to have their origin in the putrefaction of nitrogeneous or organic matters, the latter are assumed to be converted into Ammonia [NH_3], and this to be oxidized in the presence of the hydrat of potassium [K], Sodium [Na], or Calcium [Ca], into the corresponding nitrat.

PREPARATION:

The acid is prepared both commercially and in the laboratory by the action of Sulfuric Acid on some Nitrat.

Either Potassium or Sodium Nitrat may be employed, but owing to the greater abundance and less expensive cost of Sodium Nitrat, this is generally used.

When Sodium or Potassium Nitrat is mixed with dilut Sulfuric Acid, no obtrusive sign of chemical action takes place, altho it can be proved that a reversible change has taken place, so that the Sodium is distributed between the Sulfuric and Nitric Acids. If a mixture of concentrated Sulfuric Acid and Sodium Nitrat be heated to about 130°, Nitric Acid



Optional Method of Mounting Retort on Iron Tripod for Performing Experiment No. 82.

[HNO_3], is volatilized. The reaction is represented

$$\underset{\text{Sodium Nitrat}}{NaNO_3} + \underset{\text{Sulfuric Acid}}{H_2SO_4} = \underset{\text{Sodium Hydrogen Sulfate}}{NaHSO_4} + \underset{\text{Nitric Acid}}{HNO_3}$$

The two salts, Sodium Nitrat [$NaNO_3$] and Sodium Hydrogen Sulfate [$NaHSO_4$] are not volatile. The Nitric Acid boils at 86°, the Sulfuric Acid boils at 330°. It is thus obvious, when heated at 100°, the Nitric Acid is volatilized and the state of equilibrium of the solution disturbed, thus the Sodium Nitrat is all decomposed.

If the temperature be higher, Normal Sodium Sulfate [Na_2SO_4] is formed, requiring the use of less Sulfuric Acid.

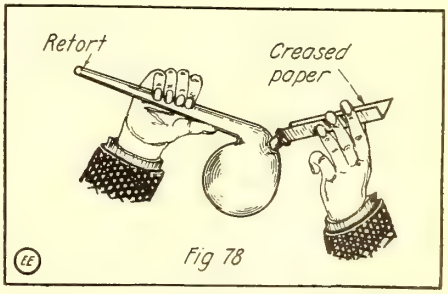
In comparison of the two equations:

$$\underset{\text{Sodium Nitrat}}{NaNO_3} + \underset{\text{Sulfuric Acid}}{H_2SO_4} = \underset{\text{Sodium Hydrogen Sulfate}}{HNaSO_4} + \underset{\text{Nitric Acid}}{HNO_3}$$

and also

$$\underset{\text{Sodium Nitrat}}{2NaNO_3} + \underset{\text{Sulfuric Acid}}{H_2SO_4} = \underset{\text{Sodium Sulfate}}{Na_2SO_4} + \underset{\text{Nitric Acid}}{2HNO_3}$$

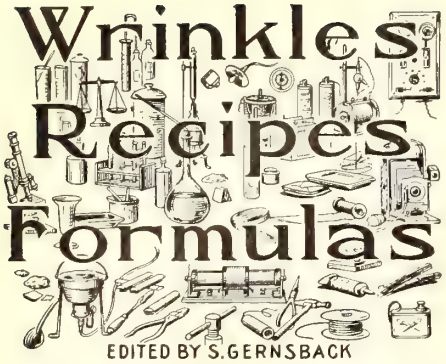
we can see that these reactions are similar to those obtained when we prepared Hydrochloric Acid [see July, 1917, issue of the ELECTRICAL EXPERIMENTER], insofar



Method of Pouring Sodium Nitrat Into Retort from a Creased Paper. Experiment No. 82.

that an excess of acid is employed, as in the first reaction, a moderate heat is re-

(*Continued on page 274*)



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

USEFUL CHEMICAL HINTS FOR AMATEURS.

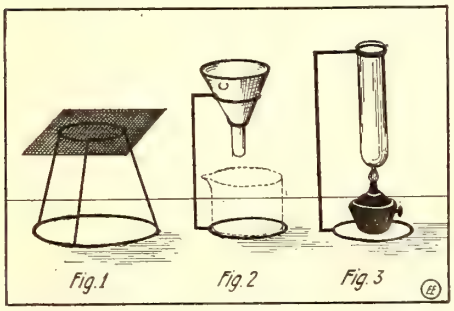
In many chemical experiments a ring-stand is needed, but as these are somewhat expensive a substitute will be welcome. The stand is made of two rings of heavy iron or copper wire, one larger than the other, with three supporting legs. The ends of these are bent around the rings at equal distances. The stand should be covered with a double thickness of screen-wire upon which the vessel to be heated is placed. The stand should be of the proper height in relation to the heater (lamp or Bunsen burner). This stand is illustrated in Fig. 1. A funnel stand is shown in Fig. 2 and a test-tube stand at Fig. 3.

An inexperienced visitor to your laboratory will be mystified and his admiration increased when you unconcernedly dip a piece of copper into a liquid in a bottle and bring it out coated with what seems to be silver. The liquid is prepared by dissolving a drop of mercury in a little nitric acid.

If some paper that has been soaked in starch solution and dried is dropt into a mixture of sulfuric acid and potassium permanganate, it will flash several times and throw a very light black residue for several inches. This experiment looks like a miniature volcano.

Invisible ink may be made by diluting one part sulfuric acid with twenty parts water. This ink is visible only when heated very hot.

Contributed by A. C. SIMPSON.



Several Useful Wrinkles for the Young Chemist Are Here Suggested. The Stands Shown Can All Be Made of a Piece of Wire, Properly Bent.

PERCENTAGE SOLUTIONS.

Many persons appear to find a difficulty in working with solutions containing *so much per cent* of an ingredient. There is no reason why confusion should ensue, for percentage solutions are as easy to prepare as those whose constitution is otherwise exprest, neither is there any greater difficulty in diluting to some weaker percentage strength. The following points are worth bearing in mind:

To convert percentage strength into ounces per pint, divide by 5. Thus, 20 per cent ÷ 5 = 4 oz. to the pint.

To convert ounces per pint to percentage strength, multiply by 5. Thus, 5 oz. to the pint × 5 = 25 per cent strength.

The rule for diluting is equally simple. To dilute a 25-per cent solution to 15 per cent, take 15 parts of the former and add sufficient water to make up to 25 parts (ounces, cubic centimeters, or otherwise). Or, to put it in general terms, for the rule applies to all strengths, to dilute a solution of A per cent strength to make one of B per cent strength, take B parts of the strong solution and add water to make A parts in all.

Contributed by H. J. GRAY.

THAT TEST FOR FREE AMMONIA.

In the May, 1917, issue of your magazine, you publisht an article written by W. R. Spurrier, on "Chemical Experiments."

In experiment number seven, Mr. Spurrier calls attention to Phenolphthalein being a test for free Ammonia. As this is decidedly wrong, kindly publish the following experiment and test, lest some young chemist be misled.

(1)—Experiment proving that any alkaline solution will turn a bright red when Phenolphthalein is added.

Make up a weak solution of Ammonia water (about five or six drops of Aqua Ammonia to four ounces of water), a few drops of Phenolphthalein (25% Alcoholic solution) will turn this solution to a bright red. Neutralize this solution by adding concentrated Hydrochloric acid (HCl), drop by drop, until it is again clear. ($NH_4OH + HCl = NH_4Cl + H_2O$.) If a small piece of Potassium metal (K), be dropt in this clear solution, it will burn and at the same time slowly redden the solution again. Try a fresh solution, using another alkali than Aqua Ammonia, (NH_4OH), eliminating the Potassium metal, (K), and note results.

Caution:—

Handle Potassium metal with forceps. Keep face from solution when adding the metal, as a small explosion frequently occurs. Do not allow any water to come in contact with K, while handling it.

(2)—Test for free Ammonia (NH_3) or Ammonium compounds (NH_4—).

Mix unknown with any hydroxid, preferably Sodium Hydroxid (NaOH), if a solid, add enough water to cover the same in a test tube. Heat gently, test the gas that is given off, by holding a piece of paper which was previously dipt in concentrated Hydrochloric acid (HCl), over mouth of test tube. If Ammonia is present, white fumes will appear. Moistened red litmus paper will turn blue when held over mouth of test tube.

The white fumes are solid particles of Ammonium Chlorid (NH_4Cl). The free Ammonia (NH_3), given off by the Ammonium compound combines with the Chlorin (Cl), of the Hydrochloric acid forming (NH_4Cl).

I am a reader of your excellent magazine and will continue to be as long as it is printed. With apologies to W. R. Spurrier.

Contributed by CHAS. A. HASEK.

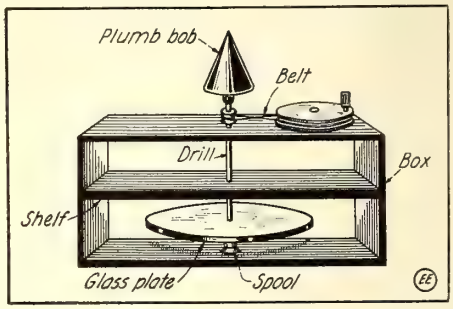
HOW TO CHANGE THE TONE OF ANY GONG.

Take the ordinary gong and cut a deep groove or a slot in it with a hack saw and it immediately changes the tone to a cow-bell.

Contributed by JULIUS FRANKS.

AN EFFICIENT PLATE GLASS DRILL.

In making a static machine, it is preferable to have the glass plates drilled in the exact center to allow passage of the spindle or axle, but the accomplishment of this task is a stumbling block to the



Simple Home-made Apparatus for Drilling Holes in Plate Glass for Static Machines, Etc.

amateur constructor and even difficult for those more skilled in workmanship. However, the simple drill apparatus shown herewith will do the trick very nicely and, while a little patience is necessary, the excellent results will more than compensate for the time and energy expended.

First procure a wooden box, size about 17″ x 10″ x 7″ and force out the top and bottom of the same, after which construct a shelf as shown. Then drill thru both the top piece and this shelf a hole, size of which should be of such a diameter as to allow the tube of an ordinary curtain rod to revolve freely and not too loosely. Take the brass rod that was inside of this tube, cut off a piece about 6″ in length and insert one extremity into the bore of a carpenter's plumb bob. This latter should be as large as possible and weigh at least one pound. Now, saw off both ends of an ordinary thread spool and then glue together in such a manner as to form a pulley, after which fasten rigidly to the top of the drill, directly underneath the plumb bob. To give greater speed to the drill, make a larger pulley as shown and connect together by means of a leather belt. I may say, however, that this method will not be found very satisfactory, as the stretching tendency of the leather will in a short time cause the belt to slip and thus prevent motion entirely. A better and simpler way is to merely hold the belt at both ends, fit into the groove of the small pulley, and then pull forward first with one hand and then the other, which action will give a continual alternating circular motion to the drill.

When everything has been completed, insert the rod, to which the plumb bob is attached, into the drill or tube, being careful beforehand to pour in a small quantity of emery. In as much as this substance is difficult to get in a loose form, I would suggest that the reader do as I did and buy a few sheets of regular emery paper. These should first be torn up in small pieces, then put in a metal pot or pan and finally set fire to. The paper will burn away, leaving the emery grains, which can be easily separated from the paper ash by sifting thru a fine strainer. For the purpose of raising the glass plate upward so that the full weight of the plumb bob is brought to bear, glue a large thread or cotton spool to its center. As the hole of the latter can be seen thru the glass, this will also act as a guide in drilling.

From time to time, in operating this drill, add a little machine oil to the emery in order to provide a lubricant and thus prevent the glass from cracking. Also roughen the end of the drill with a file, so as to give it a sharper and therefore better cutting edge.

Contributed by JOHN T. DWYER.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

$15.00 Cash in Prizes. Get Busy, Boys!!!

Here is your chance to win a cash prize for a few minutes' brain work. The big question now confronting every radio amateur is—"What can I do with my wireless apparatus?" To help the more than 400,000 loyal radio students and enthusiasts to apply their knowledge and, most important of all, to utilize their instruments for some practical electrical or communication purpose **other than wireless,** we shall pay two prizes—one of $10.00 and one of $5.00 respectively, for the best suggestion as to "what to do with your radio set during the war." Be brief; 100 to 200 words should tell your story. Remember—it's the "idea" that counts. Get busy at once, boys, as we want all suggestions in by July 25th, at the latest, so that the results can be announced in the September number of THE ELECTRICAL EXPERIMENTER. And don't forget we must have thoroly "practical" ideas. Address the Editor, Radio Problem Contest.



A GROUP OF REPRESENTATIVE AMERICAN AMATEUR RADIO STATIONS.

Radio Stations of, 5—J. A. Gjelhaug, C. E. Baudette, Minn. (Prize Winner); 1—Seefred Bros., Los Angeles, Cal.; 2—Greer W. Peck, Springfield, Tenn.; 3—George M. Stuff, So. Auburn, Nebr.; 4—Leo Hirsch, Columbus, Ohio; 6—Robert A. Gerhard, Lehighton, Pa.; 7—Everett Crump, Columbus, Ind.; 8—Donald S. Bennett, Wollaston, Mass.; 9—Maurice Pollack, Chicago, Ill.; 10—Charles Cross, Oakland, Cal.; 11—L. H. Cook, Mexico, N. Y.

TESLA'S VIEWS ON ELECTRICITY AND THE WAR.

(*Continued from page 230*)

"At the time of those tests I succeeded in producing the most powerful X-rays ever seen. I could stand at a distance of 100 feet from the X-ray apparatus and see the bones of the hand clearly with the aid of a fluoroscope screen; and I could have easily seen them at a distance several times this by utilizing suitable power. In fact, I could not then procure X-ray generators to handle even a small fraction of the power I had available. But I now have apparatus designed whereby this tremendous energy of hundreds of kilowatts can be successfully transformed into X-rays."

"Could these ultra-powerful and unusually penetrating X-rays be used to locate or destroy a submarine with?" I interjected.

"Now we are coming to the method of locating such hidden metal masses as submarines by an *electric ray,*" replied the electrical wizard. "That is the thing which seems to hold great promises. If we can shoot out a concentrated ray comprising a stream of minute electric charges vibrating electrically at tremendous frequency, say millions of cycles per second, and then intercept this ray, after it has been reflected by a submarine hull for example, and cause this intercepted ray to illuminate a fluorescent screen (similar to the X-ray method) on the same or another ship, then our problem of locating the hidden submarine will have been solved.

"This electric ray would necessarily have to have an oscillation wave length extremely short and here is where the great problem presents itself; *i.e.*, to be able to develop a sufficiently short wave length and a large amount of power, say several hundred thousand or even several thousand horse-power. I have produced oscillators having a wave length of but a *few millimeters.*

"Suppose, for example, that a vessel is fitted with such an electric ray projector. The average ship has available from say 10,000 to 15,000 H.P. The exploring ray could be flashed out intermittently and thus it would be possible to hurl forth a very formidable beam of pulsating electric energy, involving a discharge of hundreds of thousands of horse-power. The electric energy would be taken from the ship's plant for a fraction of a minute only, being absorbed at a tremendous rate by suitable condensers and other apparatus, from which it could be liberated at any rate desired.

"Imagine that the ray has been shot out and that in sweeping thru the water it encounters the hull of a submarine. What happens? Just this:—The ray would be reflected, and by an appropriate device we would intercept and translate this reflected ray, as for instance by allowing the ray to impinge on a phosphorescent screen, acting in a similar way to the X-ray screen. The ray would be *invisible* to the unaided eye. The reflected ray could be firstly, intercepted by the one or more ships in the fleet; or secondly, it would be possible for the ship originating the ray to intercept the refracted portion by sending out the ray intermittently and also by taking advantage of what is known as the *after-glow effect,* which means that the ray would affect the registering screen an appreciable time after its origination. This would be necessary to allow the ship to move forward sufficiently to get within range of the reflected ray from the submarine, as the reflection would not be in the same direction as the originating ray.

"To make this clearer, consider that a concentrated ray from a searchlight is thrown on a balloon at night. When the spot of light strikes the balloon, the latter at once becomes visible from many different angles. The same effect would be created with the electric ray if properly applied. When the ray struck the rough hull of a submarine it would be reflected, but not in a centrated beam—it would spread out; which is just what we want. Suppose several vessels are steaming along in company; it thus becomes evident that several of them will intercept the reflected ray and accordingly be warned of the presence of the submarine or submarines. The vessels would at once lower their nets, if so equipt, order their gun crews to quarters and double the look-out watch. The important thing to know is that submarines are present. Forewarned is forearmed!

"The Teutons are clever, you know; very, very clever, but we shall beat them," said Dr. Tesla confidently. [*It may be of interest to our readers to know that several important electrical war schemes will shortly be laid before the War and Navy Departments by Dr. Tesla, the details of which we naturally cannot now publish.*]

BLINDING THE SUBMARINE.

(*Continued from page 235*)

foredoomed to failure. To counteract strong sunlight on a silvery dazzling ocean requires a very strong light as every sailor knows. Also if the periscope is two or more miles off, a small searchlight would hardly be noticed by the U-boat commander, even if trained full on him. For that reason only a very powerful light will do. Perhaps large parabolic mirrors to reflect the sunlight could be used with fair cloudless skies, for there is no stronger and more blinding light than sunlight. On a clear day this would be perhaps preferable to using electric searchlights. At any rate the plan is not an expensive one and is certainly worth trying, foolish and idiotic as it may appear at first.

However, most of our everyday, mechanical reasoning is faulty. For thousands of centuries people fled in terror from lightning. No "sane" person up to Benjamin Franklin's time could have been induced to remain in a house where there was a good chance for lightning to strike. Most preposterous of all, no one would have been crazy enough to deliberately seek shelter in a house where he knew in advance that the lightning would strike, nine chances out of ten. The idea, of standing right under the lightning for protection!! Nevertheless people got over their foolish notions when Benjamin Franklin began sticking lightning rods on their houses. Today the lightning-rod protected skyscraper is hit frequently by thunderbolts, and people are so used to it that they much rather stay in a skyscraper than venture into the open during an electric storm. It is safer right under the lightning.

It is just so with the searchlight plan outlined above. Its very *apparent* danger is its safety. Think it over.

WOMEN RADIO OPERATORS TO AID UNCLE SAM.

(*Continued from page 238*)

charge of the Western Union's branch in the Leader-News building is supervising instructor in the telegraph room, and a real efficient pedagog she is, too.

Applicants for membership are required to give their vocation, their own and parents' nationality, their residence in the city, and education. The application blank states, however, that the applicant incurs no obligation. There is no expense whatever attached to the training. If women are placed thru their training in railroad service, it will doubtless require that they leave the city and take up work in small railroad stations. At least, that will be where the shortage of men employees will be most felt. Mr. Newman expects to have at least one hundred telegraph operators and a score of wireless operators qualified to take positions at the expiration of the present terms.

ELECTRIC SUBMARINE FORTS TO DESTROY SUBMARINES.

(*Continued from page 231*)

Ordinarily the device would be lowered into the sea from on board of a suitable vessel after the storage batteries are charged, the operator took his seat and the cylinder has been closed carefully watertight from outside. Suspended from a wire rope the steel unit would slowly descend to the bottom of the sea and the operator would himself feel nothing of the ever-increasing pressure of the water, but could comfortably observe his surroundings by turning on the light projector and rotating the device round its vertical axis. Through the telephone he would at all times remain in direct contact with the vessel, could at any moment stop the lowering of the device, the shock of which when striking the ground would be absorbed by a shock absorber arranged at the bottom of the device and ending in a ball, and arrived near a sunken vessel he could conduct and direct by means of the telephone any possible salvage operations.

For military purposes, however, this device can be adapted to contain at the same point in place of the camera a special arrangement of short torpedo tubes, each of which contains a special short-range torpedo which can be discharged at any moment by the operator simply by pressing a corresponding electric button, as soon as he detects a passing submarine and has his device adjusted in the right direction.

For such protective and defensive purposes the inventor believes that a number of such cylinders submerged across a given water-way, across the entrance to the harbor of New York, for instance, would doom to destruction any enemy submarine which would attempt to pass thru submerged. Each device could be connected to a floating buoy and anchored from the bottom of the bay from a special heavy casing which would contain an electrically operated drum upon which sufficient cable would be wound to allow the operator to rise to the surface and which would be controlled by the operator thru a special switch. Thus the operator could constantly oscillate slowly up and down under the water and rise every twelve hours at a certain time to the surface. A small vessel could at the same hour pass from one buoy to the other, open the cylinder as soon as its top would appear above water, let the operator out and another take his place. Where it is possible the electric current necessary could be supplied by an electric cable running from shore to all anchors and up into the devices in place of the storage batteries and also telephone connections could be established in the same way between all cylinders submerged and a coast station (fort) so that the operators could report at once everything of importance.

"Submarine chasers may be of great value," says Mr. Hartman, "but they have to limit their field mainly to the surface of the water as they cannot see a submarine which is running submerged at a certain depth; especially at night-time. It is more easy for a submarine commander to see the shadow of any dangerous small craft from below the water thru special lenses than to see the submarine at a certain depth."

QUESTION BOX

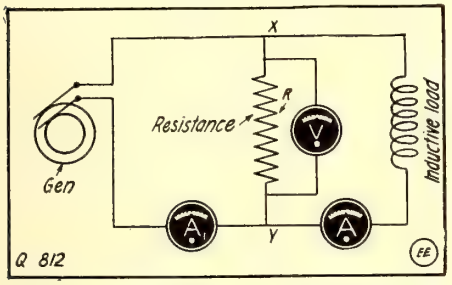
This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., **must** be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of **25 cents** is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

WIRING DIAGRAM.

(812.) David Langstrom, Chicago, Ill., desires:

Q. 1. How are the wiring connections made for the Fleming combined voltmeter and ammeter method of measuring power



Connections of Apparatus for Measuring the Power in A. C. Circuits by the Fleming Method.

in an alternating current circuit?

A. 1. The diagram herewith gives the proper connections. The true watts will be equal to:

$$W = \left(A_1^2 - A^2 - \left(\frac{V}{R}\right)^2\right) \times \frac{R}{2};$$

Where W = true watts
A_1 = Indication of generator current
A = Current consumed by load
V = Voltage across generator

If the voltmeter V, takes an appreciable amount of current, it may be tested as follows: Disconnect R and V at Y, and see that A and A_1 are alike; then connect R and V at Y again and disconnect the load. A_1 will equal current taken by R and V in parallel.

Q. 2. Why is the active pressure in phase with the current?

A. 2. The pressure used in overcoming resistance is from Ohm's law, E = RI. Hence, when the current is zero, E is zero and when the current is a maximum E is a maximum. Hence, that component of the imprest pressure necessary to overcome resistance must be in phase with the current.

FILAMENT TEMPERATURE.

(813.) Paul Hancock, Boston, Mass., asks:

Q. 1. What do you consider as the temperature of an incandescent lamp?

A. 1. A carbon filament runs at 1,700 to 2,100 degrees Centigrade. If the voltage is too high the lamp consumes too much current and the temperature of the filament becomes so high that it softens and droops until it may touch the glass bulb which cracks, allowing air to enter and burn out the filament. An abnormally high temperature also causes disintegration of the filament and causes its candle-power to drop off rapidly. Tantalum and tungsten filaments run hotter.

Q. 2. What kind of current is used in electric furnaces?

A. 2. Either direct or alternating current may be used in incandescent and some of the arc furnaces. Only the direct current can be used in furnaces dependent partly or wholly upon the chemical effect of the current, as in the production of aluminum.

REGENERATIVE AUDION.

(814.) Robert Murphy, Phoenix, N. Y., writes:

ODD PHOTOS WANTED AT $1.00 EACH!!!

Now is the time to make your Kodak pay for itself in a real practical way. We are after interesting photographs of out-of-the-ordinary electrical, radio and scientific subjects and are willing to pay $1.00 *cash for every one we can use. Please bear in mind that for half-tone reproduction in a magazine, a photograph should be particularly sharp and clear. Of course, if a subject happens to interest us particularly well, we can have the photo retouched. For the general run of subjects, however, it does not pay to go to such expense. Therefore, please take pains to properly focus and expose your pictures. It often happens that a really mediocre subject well photographed wins approval over an excellent subject poorly photographed. And don't send us plate or film "negatives"; send unmounted or mounted "prints," preferably a light and a dark one.*

As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 *to* 150 *words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.*

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, *233 Fulton Street, New York City.*

Q. 1. Do all regenerative receiving circuits change the individual tone of spark signals to a hiss when maximum amplification is employed? If not, please give diagram circuit for the de Forest round Audion, suitable for 200-600 meter spark signal reception, where the individual spark tone is retained.

A. 1. The tone received on the regenerative Audion circuit corresponds identically to that of the imprest frequency of the distant transmitter. However, in regards to the hiss in the receiver of such a system this is due to "overflow" effect ("spilling over") of the Audion at the high potential, which is essential in a regenerative circuit and which must be controlled in order to overcome this hiss. This effect is not one which is controlled by the distant transmitter but due to local conditions inherent in the system, which can be eliminated by proper adjustment.

The wiring diagram for a receiver capable of performing the duties in question is identical with the standard regenerative Audion circuit and which you will find given a complete description in the January, 1916, issue of this journal.

Q. 2. Which group of apparatus is best suited for undamped wave reception from foreign stations, the large, loose coupler using the Chamber's circuit, or the small coupler with its loading coils and condensers?

A. 2. The large, loose coupler with its accessories, such as condensers, etc., employing either the Chamber's or Armstrong circuits will be found to give best results.

Q. 3. In constructing an aerial for 200 meter transmission, what spacing of wires, what number of wires, and what length should they be, to give 160 meters natural wave length; the aerial to be of the "T" type with leads taken from the exact center?

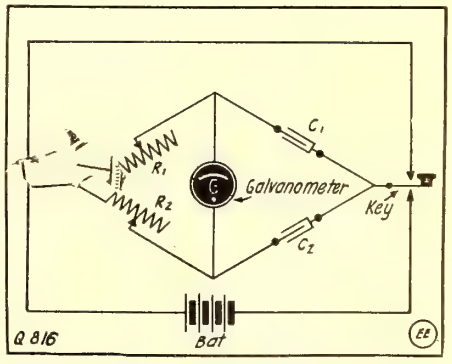
A. 3. The antenna for 200 meters should consist of four wires, 50 feet long, 60 feet high and the wires should be spaced two feet apart. The 160-meter antenna should consist of four wires 50 feet long, 40 feet high and each wire spaced the same as the 200 meter one.

CAPACITY MEASUREMENT.

(816.) J. Andricks, St. Louis, Mo., inquires:

Q. 1. What is the simplest and yet accurate method for measuring the capacity of a condenser?

A. 1. The bridge method is the simplest



Showing How the Bridge Method Is Applied for Measuring Condenser Capacities.

method for measuring the capacity of a condenser. This scheme employs a standard condenser and the unknown capacity

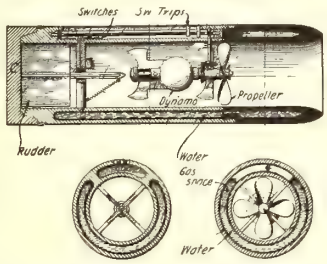
(*Continued on page* 275)

LATEST PATENTS

A Novel Electric Projectile

(No. 1,226,732; issued to Clarence W. White.)

One of the most radical projectile designs that we have come across, and which involves a novel application of electricity. The projectile is made in several sections and is

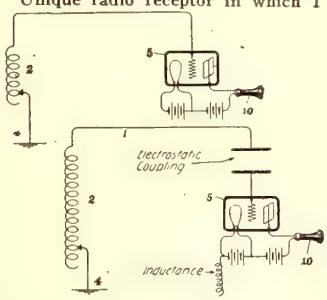


open thru the center except for detachable base cap c. By a clever arrangement of an air propeller connected to a dynamo, the inventor causes several things to happen, viz., —the cap c drops off as soon as the projectile is started on its way; a magnetically controlled rudder projects out at the back; electric current from dynamo is caused to act on a quantity of water in the annular chamber shown, causing oxygen and hydrogen gas to be evolved, and which is electrically exploded after a pre-determined time period. Moreover the projectile may be set to change its course, while in flight.

Radio Receptor

(No. 1,226,060; issued to Elmer E. Bucher.)

Unique radio receptor in which 1

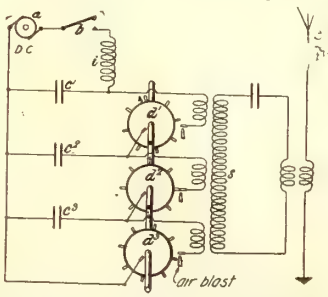


represents the aerial circuit, containing a tuning inductance 2, which is connected to the earth or a suitable capacity at 4. The aerial 1, preferably consists of a long horizontal conductor connected to the earth. The free end of the aerial being a point of maximum potential, is connected to a vacuum detector 5. The patent mentions the use of an inductance connected to the filament circuit as shown; this inductance being adjustable.

Generator of Radio Frequency Oscillations

(No. 1,226,099; issued to Guglielmo Marconi.)

A generator of radio frequency

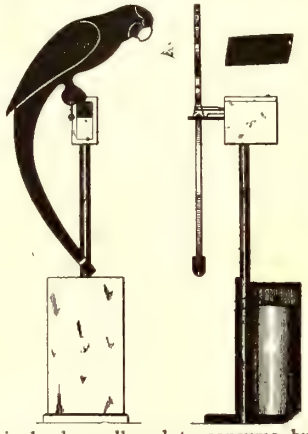


continuous oscillations intended for use in wireless telegraphy and telephony. Several series of insulated rotary spark gaps with compressed air blasts are used, and the oscillatory circuits are energized from a D. C. source a, controlled thru key b, and inductance i. The condenser C1 is caused to discharge into condenser C2, which discharges into condenser C3, which finally discharges thru a rotary gap d3, causing the oscillation transformer secondary S, to be powerfully excited, and which communicates its energy to the aerial circuit thru a second oscillation transformer.

Electrical Toy

(No. 1,226,835; issued to Allen B. Wilder.)

An efficient and simple self-acting electrical device for continuously operating swinging bodies such as toy birds and animals, advertising devices for window displays, etc. The device is claimed to operate on a

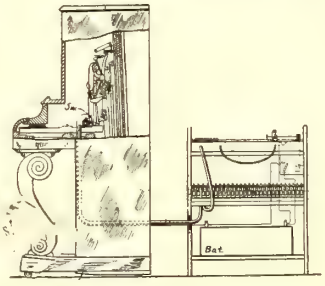


single dry cell and to consume but a very small current. The illustration shows a swinging parrot, properly counterbalanced. At the top of the upright stand is a small case containing a set of electro-magnets and a pivoted armature, provided with a contact spring which is actuated by the downward movement of the parrot. As the figure continues to swing forward, the contact is closed, and the electro-magnet at once attracts its armature which throws the figure upward, and thus the action continues to repeat itself.

Electrical Piano Attachment

(No. 1,229,122; issued to Donald Patrick Muse.)

A clever electrical piano attachment which permits of playing several instruments such as a violin

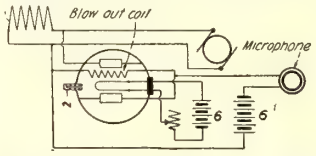


and orchestra bells in harmony with a piano when playing the latter. The desired result is accomplisht by arranging electrical contacts at the back of each piano key, and which control electric sounding devices which may play orchestra bells, a violin, etc. A flexible cable carrying one common wire and one additional wire for each sounding instrument, connects the piano with the separate cabinet containing the auxiliary musical instruments. The inventor has provided a means whereby it is possible for the musician to cut out any of the auxiliary musical instruments and their electrical playing attachments.

Signaling Device

(No. 1,223,589; issued to August J. Kloneck.)

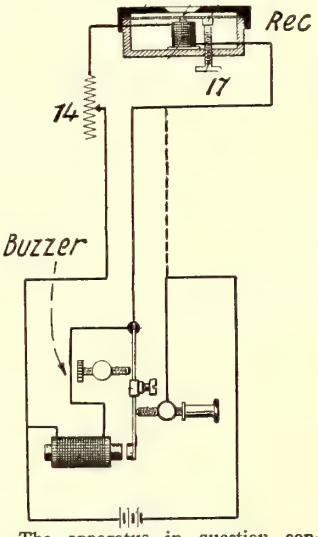
Means whereby high frequency oscillations may be produced and controlled with greater efficiency than heretofore. The invention involves the use of a special vacuum



bulb provided with a metal plug, which may be heated so as to pass gas from the atmosphere, and thus vary the degree of vacuum. The bulb also contains a heating filament, the usual grids and a small blow-out coil arranged within the chamber so as to control the thermionic currents by its magnetic field, the strength of which may be regulated by a microphone connected in the circuit. The operation of this oscillator is similar to the arc type, except that instead of the arc, the less luminous radiation of a larger area of electrodes is utilized, and the radiation of the current is occasioned by a glowing filament in the bulb.

Electrical Massage for the Ear

(No. 1,227,476; issued to Albert Maurice.)

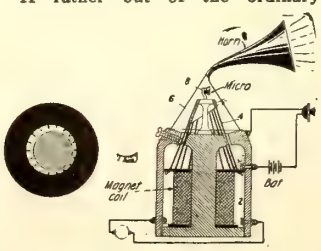


The apparatus in question consists of a telephone receiver connected with a circuit comprising a battery and a rapidly interrupted switch or contact, such as a buzzer.

Sound-Producing Device

(No. 1,228,639; issued to Erik C. Bayer.)

A rather out of the ordinary

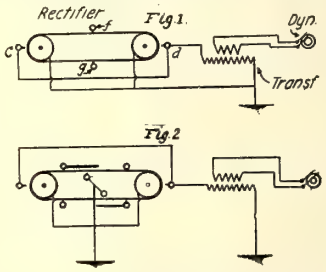


sound-producing device which may be used as a telephone relay or as a loud-speaking telephone. The apparatus produces acoustic vibrations from telephone or other currents thru the medium of a series of tightened non-magnetic wires connected in the circuit of the telephone transmitter. These wires are placed in a powerful magnetic field maintained by the large magnetizing coil 2. High amplification is claimed with this device, and by using a microphone 8, within the sound hood 6, the device acts as a telephone repeater with amplifying characteristics.

High Tension Electric Rectifier

(No. 1,228,405; issued to William H. Chapman.)

This invention is based on the fact that if a sheet of paper is laid on the surface of a grounded metallic body and a pointed conductor having an alternating charge of several thousand volts, be brought near the paper or separated there-



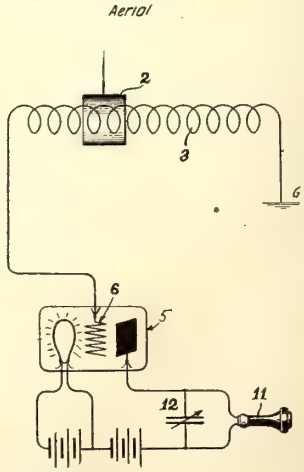
from by an air space for an instant, as it is in contact with the grounded conductor, the paper when moved from the surface of the conductor will show a very high negative charge of many times the voltage of the alternating charge.

The two metal rolls are grounded and as the paper travels around, it carries negative charges from "c" and "d" to "f" and "g." The apparatus in Fig. 2 is for producing positive electricity.

Radio Receiving Apparatus

(No. 1,228,647; issued to Elmer E. Bucher.)

The aerial connects to a metal band 2, which slides along an inductance coil 3, this coil being grounded. The free end of the in-



ductance coil is connected to the grid of vacuum bulb detector used in the manner shown, or a crystal detector may be used instead. It is seen that electrostatic coupling is thus employed and in tuning such a receiving set metal ring 2, is moved along coil 3, and also the degree of coupling may be varied by contracting or expanding ring 2.

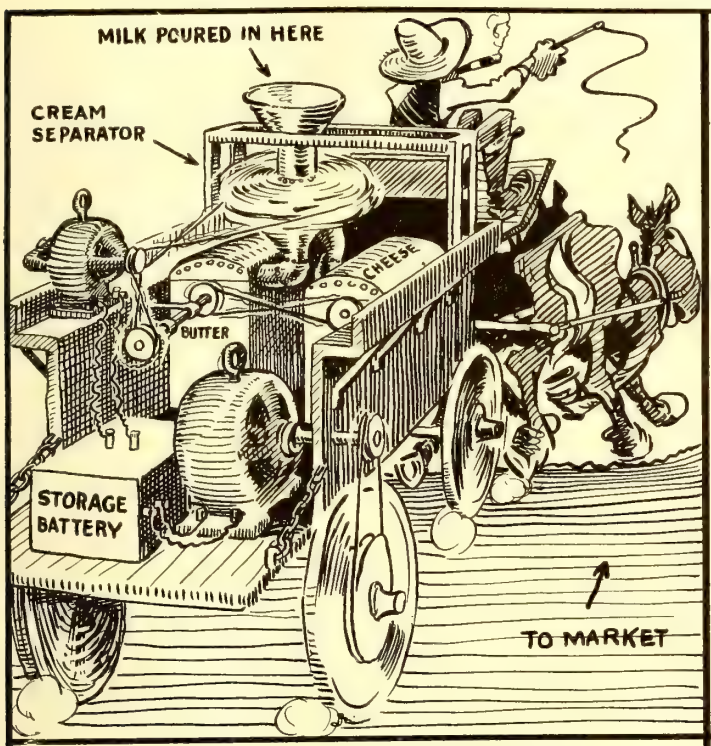
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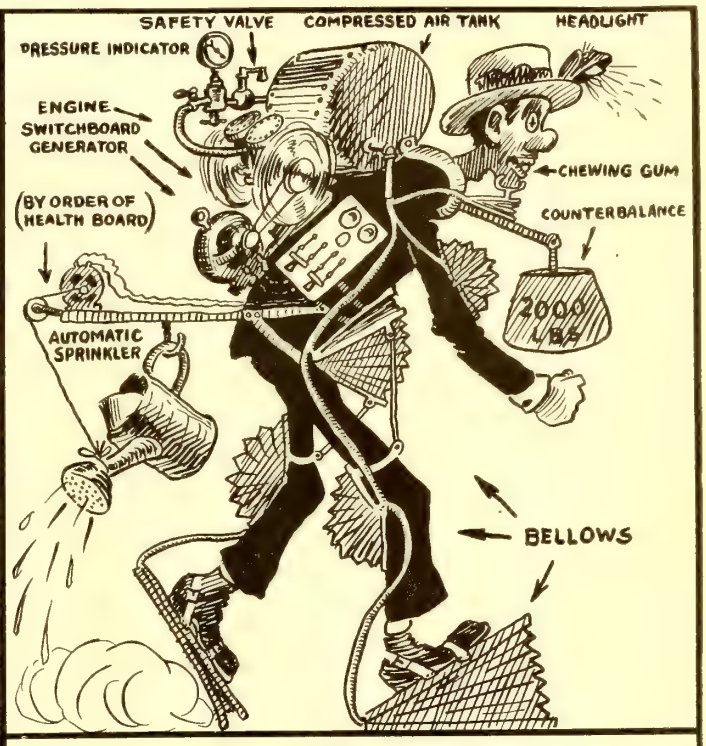
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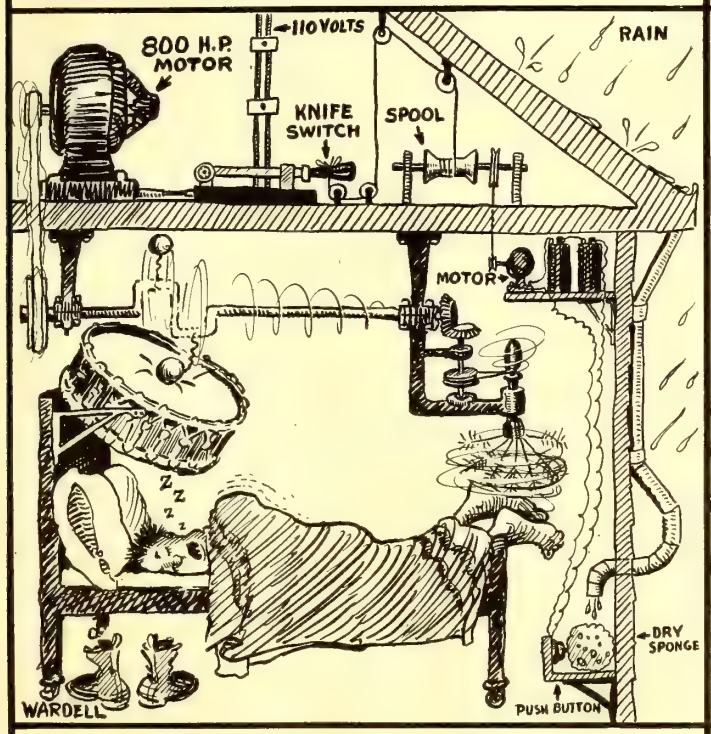
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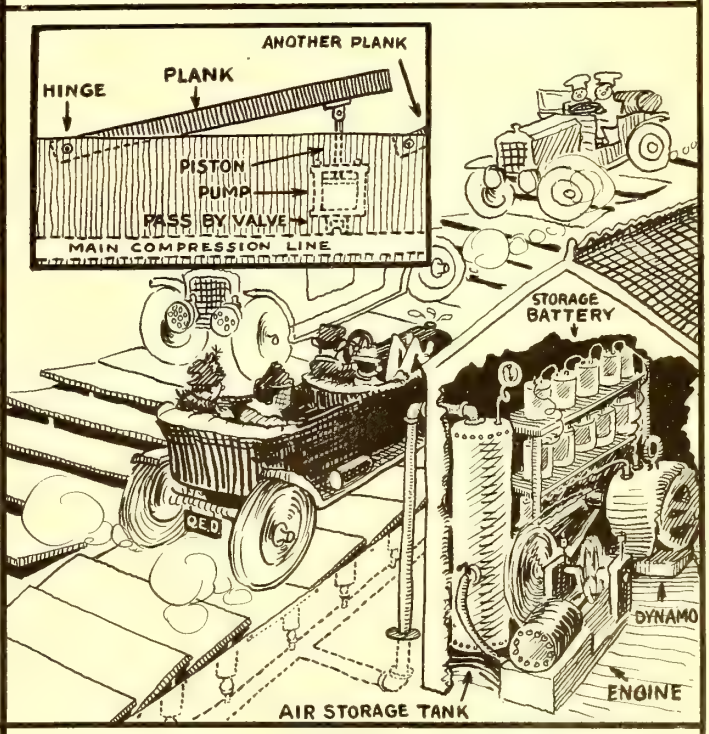
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Inventor: Nameless (He Forgot to Send His Name).



OTTOMATTICK RAIN ALARM

This Patent Rain Alarm Provides for a Dry Sponge, Which When the Rain Expands It, Presses a Push Button; This Latter Operates the 800 H. P. Motor Which Works a Loud-Speaking Drum Over Mr. Sleeper's Head. If That Don't Wake Him, There's a Feather Duster to Tickle His Soles. Real Soulful.
Inventor: James Nelson, Paterson, N. J.



ROAD-O-MOTOR

First We Take a Lot of Planks and Hinge Them Along the Road on One End. Now Then, When the Flivvers Flivver By, the Planks Will Be Deprest. Compressing Air In the Compression Pipe-line. As Soon As the Flivver Passes, a Spring Under Plank Pushes It Up Again. The Comprest Air Drives the Dynamo.
Inventor: W. C. Holber, Valdosta, Ga.

EXPERIMENTAL CHEMISTRY.

(*Continued from page 267*)

quired, which yields a readily soluble salt, Sodium Hydrogen Sulfate [$NaHSO_4$].

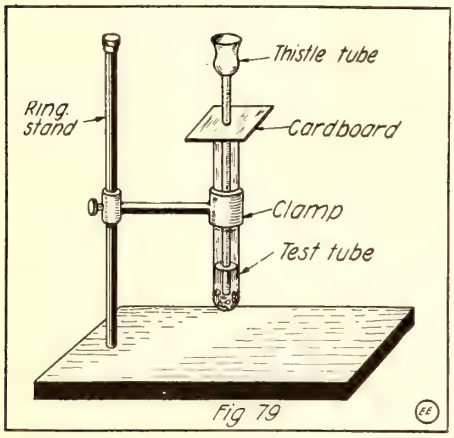
A higher temperature yields a Normal salt [Na_2SO_4]. For this reason moderate heat should be used when the acid is prepared in the laboratory.

Even at 86° some of the acid breaks up into Nitrogen Peroxid [NO_2], water [H_2O], and Oxygen [O].

$$\underset{\text{Nitric Acid}}{2HNO_3} = \underset{\text{Water}}{H_2O} + \underset{\text{Nitrogen Peroxid}}{2NO_2} + \underset{\text{Oxygen}}{O}$$

This dissociation is made apparent by the liberation of the red fumes, Nitrogen Peroxid [NO_2], and these dissolved on the acid impart a yellow or red color and increase its strength. It is then called Fuming Nitric Acid [sometimes erroneously called Nitrous Acid] and is extremely powerful and corrosive. After a time the fumes will mostly evaporate, though some combine with any water and oxygen present and form Nitric Acid.

Nitric Acid is prepared commercially by heating Sodium Nitrat and Sulfuric Acid in cast-iron retorts; the vapor being condensed in earthenware condensers, cooled by water, and collected in earthenware



Apparatus Used in Making the Copperas Test for a Nitrat. See Experiment No. 88.

jars. The last jar is connected with a tower filled with coke, down which a stream of water is allowed to flow. The object is to recover the Nitrogen Peroxid produced by the decomposition of the acid. The retort has an outlet pipe from which the Sodium Sulfate can be run when the action is completed. To reduce the amount of Nitrogen Peroxid formed during the decomposition of the Nitric Acid by heat, the stills are often worked under a reduced pressure to permit the acid to come off at as low a temperature as possible.

If the solution of Sodium Nitrat and Sulfuric Acid used to prepare the acid is weak, water will distill over first, but, if strong, Nitric Acid goes over first, an acid of quite constant composition is obtained containing about 68% Nitric Acid, which is the commercial product.

When the acid is prepared as above, it generally contains some Chlorin, and Iodin, derivatives or the Chlorids and Iodids associated with the Niter. In some cases some Sodium Sulfate, Sulfuric Acid and Iron are also carried over during the process of distillation. In order that the acid may be purified, it is distilled in glass retorts, and the first fraction which comes over is put on one side as crude acid containing Chlorin compounds. When no precipitate is observed upon the introduction of the distillat in a dilute solution of Silver Nitrat, the receiver is changed and the larger part of the Nitric Acid distilled off. The residue remaining in the retort contains the Sulfates, Iodin and Iron.

The acid can be redistilled from concentrated Sulfuric Acid to remove all the water; and the Nitrogen Peroxid can be eliminated by permitting a current of carbon dioxid to pass thru the warm acid until it is without color.

Professor Ostwald has patents on a process "For the Oxidation of Ammonia into Nitric Acid" and known as the "Ostwald Process."

Nitric acid may be prepared from the air, three important stages being involved. First, the Nitrogen and Oxygen of the air are combined to Nitric Oxid:

$$\underset{\text{Nitrogen}}{N} + \underset{\text{Oxygen}}{O} = \underset{\text{Nitric Oxid}}{NO}$$

Second. The Nitric Oxid is permitted to unite with more Oxygen:

$$\underset{\text{Nitric Oxid}}{NO} + \underset{\text{Oxygen}}{O} = \underset{\text{Nitrogen Peroxid}}{NO_2}$$

Third. The Nitrogen Peroxid thus obtained is then permitted to react with water:

$$\underset{\text{Nitrogen Peroxid}}{3NO_3} + \underset{\text{Water}}{H_2O} = \underset{\text{Nitric Acid}}{2HNO_3} + \underset{\text{Nitric Oxid}}{NO}$$

PROPERTIES:

Physical.—1. Pure Nitric Acid is a colorless liquid with a specific gravity of 1.53 at ordinary temperatures. Strong aqueous solutions, as well as the pure acid, slowly decompose when submitted to exposure to light, forming water [H_2O] oxygen [O] and Nitrogen Peroxid [NO_3], the latter giving the acid a yellow color.

2. It is very poisonous and corrosive, possessing a sour tast, pungent odor, and acid reaction.

3. The pure acid is hygroscopic and rapidly absorbs moisture from air.

4. It is miscible in water in all proportions, and, like sulfuric acid, a rise in temperature is caused in the mixture, due to the contraction of the acid when mixed with water.

5. It boils at 85° and freezes at—47°.

6. It completely dissociates at about 256° into Water [H_2O], Nitrogen Peroxid [NO_2] and Oxygen [O_2].

CHEMICAL:

1. It reacts with most metals and nonmetals to form nitrats.

2. It reacts with most compounds, and turns animal matter yellow. It readily reacts with many organic substances, forming compounds of great importance. Thus, with ordinary glycerine it forms the compound known as Nitroglycerine, which is the explosive constituent of *dynamite*. Likewise, with cellulose, the principal constituent of wood-fiber, forms Nitro-celluloses, which are used in making *smokeless powder*. When Nitric Acid reacts upon Protein matter, a yellow compound known as Xanthorprotein is formed; hence when Nitric Acid comes in contact with the skin, a yellow stain is produced.

Nitric Acid is a strong oxidizing agent due to the large percentage of oxygen which it contains, and thus readily decomposes with evolution of Oxygen. Under ordinary circumstances, in the presence of a substance readily oxidized, the acid decomposes according to the equation:

$$\underset{\text{Nitric Acid}}{2HNO_3} = \underset{\text{Water}}{H_2O} + \underset{\text{Nitric Oxid}}{2NO} + \underset{\text{Oxygen}}{3O}$$

In such cases Oxygen is not evolved, but enters into combination with the oxidizable substances present. In this way Carbon, when heated with Nitric Acid, is oxidized to Carbon Dioxid:

$$\underset{\text{Carbon}}{C} + \underset{\text{Oxygen}}{2O} = \underset{\text{Carbon Dioxid}}{CO_2}$$

3. Practically all Nitrats are soluble.

4. It does not dissolve Tin [Sn], Antimony [Sb], Gold [Au] or Platinum [Pt]. It forms white powders with Tin and Antimony.

USES:

1. The chief uses of Nitric acid are to make Nitrats, Nitroglycerine, Nitrobenzine, Gun Cotton, Celluloid, to etch Zinc and Copper, and, in the laboratory, to prepare Aqua Regia, dissolve precipitates, and as an oxidizer. The most important nitrats are Potassium [K], Sodium [Na], Silver [Ag], Barium [Ba], and Bismuth [Bi]; also Nitroglycerine and Gun Cotton. The Potassium Nitrat is used as an ingredient of Gunpowder; the Sodium Nitrat in making Nitric acid; the Silver Nitrat in Photography, in analysis, indelible inks; Barium Nitrat is used in fireworks; Bismuth [$BiNO_3[OH]_2$] in medicine.

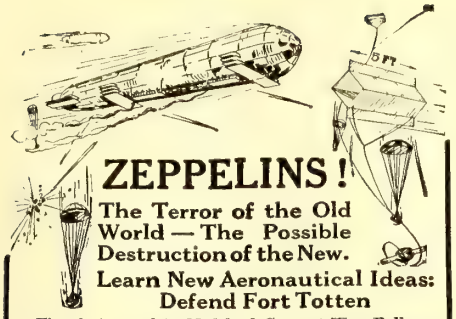
So far, in this series of articles, the writer has endeavored to make use of the simplest of apparatus, knowing that most experimenters have not funds sufficient to purchase more elaborate apparatus. In this installment we make use of a glass retort. This is essential to prepare this acid, and will be used again for the preparation of other compounds. For the benefit of experimenters who desire to equip a chemical laboratory on an economical basis, the writer heartily recommends the use of the apparatus illustrated in Fig. 75, which contains nearly all the apparatus necessary, with the exception of a few 8-ounce bottles, which can be purchased, or when an experiment calls for an 8-ounce bottle, ordinary jam bottles may be employed with good results. The apparatus shown may be obtained from several of our advertisers.

EXPERIMENT NO. 82:

Fasten on an iron stand, or tripod [Figs. 76 to 77] a large ring on which is placed an iron gauze or tin plate and asbestos. Above this fasten a clamp having three thumb screws, one of which grips the vertical rod, another the arm clamp, the third the tubulure of a 250 cc. glass retort having a sharply bent neck about 25 or 30 cm. long [Figs. 75a-75b]. Ring and clamp should be nearly parallel to the base of the stand, but the retort neck should run at right angles to it [Fig. 76], and reach within 3 cm. of the bench. Tightly fasten the three screws. The neck of the retort is then put into a large, clean, empty test tube, by lifting the entire stand and contents by the vertical rod with one hand and adjusting it with the other. Place the test tube in a wide bottle or tumbler, so as just to touch the bottom, readjusting the clamps if necessary. Fill the bottle or tumbler nearly full of water. Now raise the ring until the asbestos reaches the bulb of the retort, which should not be in contact with any metal.

Before charging the retort remove it from the tube by lifting the stand with one hand and taking out the tube with the other. Unclamp the retort by the screw. Pour into the retort thru the tubulure, from a creased paper [Fig. 78], about 10 grams of not too coarse Sodium Nitrat [$NaNO_3$], holding it with the stem slightly pointed upward so as to prevent any salt from lodging within the neck. Remove

(*Continued on page 285*)



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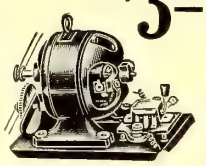
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QUESTION BOX.

(*Continued from page 271*)

is compared electrically by means of the standard.

Q. 2. Please give wiring diagram of such a simple method for measuring the capacity of a condenser?

A. 2. The diagram gives the wiring connections. The resistance arms of the bridge are represented by R_1 and R_2, while C_1 is the unknown capacity and C_2 the standard. The value of the unknown condenser is determined by the following equation:

$$C_1 = C_2 \frac{R_2}{R_1}.$$

ELECTRICAL ATTRACTION.

(817.) Lucius M. Turner, Royston, Ga., wants to know:

Q. 1. How to illustrate the experiment by which the laws of electrical attraction and repulsion are shown.

A. 1. There are several methods by which the laws of attraction and repulsion may be shown, and one of the simplest is by the use of the *electroscope*. A complete description of its construction and method of use for the experiment you desire has been illustrated in full on page 182 of the July, 1916, issue of THE ELECTRICAL EXPERIMENTER.

Q. 2. How to make a simple electro-magnet for use on 2 dry cells.

A. 2. A simple electro-magnet is made by winding several layers of insulated copper wire upon an iron core, as for instance, by procuring a four-inch carriage bolt about one-half inch in diameter and winding upon it six layers of No. 22 S. C. C. magnet wire.

POWER OF MOTOR.

(819.) William Jacoby, Brónx, N. Y., asks:

Q. 1. What determines the power given out by a motor?

A. 1. The power depends upon the pressure and current supplied to the motor, the current being regulated by the amount of work put upon the motor.

Q. 2. What causes the long flash when the field circuit is opened after the armature circuit is opened?

A. 2. This is caused by self-induction. When the current thru the magnet coil begins to drop, the magnetism begins at once to weaken. The change in the number of magnetic lines of force sets up or induces an E.M.F. that is in such a direction as to tend to maintain the current in the same direction, and at the same strength as before; the more rapid the change in the magnetization, and the larger the number of turns in the coil, the higher

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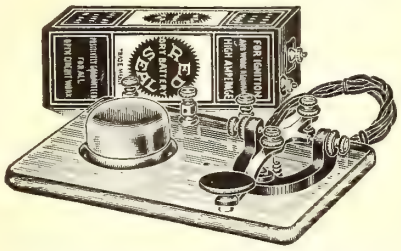
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will be the induced E.M.F. This tends to maintain the current even thru the air gap as the switch is opened. In the case of a shunt machine the E.M.F. due to opening the field circuit is likely to reach a value of several thousand volts and is liable to cause a spark to jump thru the insulation and either "ground" or "short-circuit" the field coil.

WAVE LENGTH DETERMINATION.

(819-A.) C. King Davis, Hickman, Ky., desires to know:

Q. 1. How do you determine the wave length of instruments and aerials?

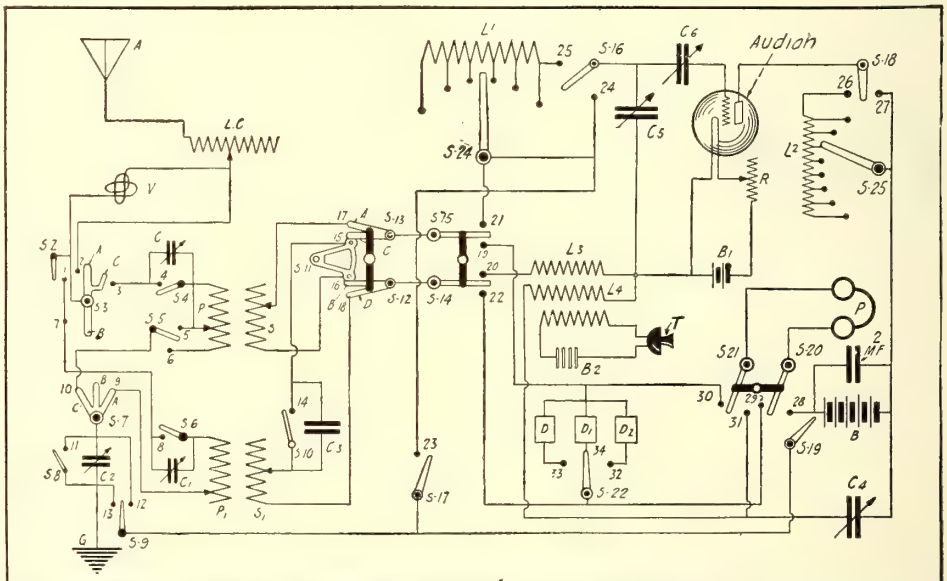
A. 1. Wave length of instruments and aerials are determined directly by means of a wave meter or by mathematical calculation if certain relations, such as dimensions, etc., of the instrument or antenna are known. These relations are substituted in definite mathematical formulæ which, when solved, will give the wave length of the instrument or antenna.

Q. 2. I have heard that amateur wireless stations have been prohibited until this present war is over; is this true?

A. 2. Yes.

MULTIPLE RADIO CIRCUIT.

(820.) H. S. New, West Orange, N. J., inquires:



Interesting Hook-up for Audion, Which May Be Operated As Interference Preventer, Heterodyne, Oscillating Audion for Generator, Amplifier for Crystal Detector, and deForest Radiophone Generator and Transmitter.

Q. 1. Would the diagram shown, by using the proper switches, be suitable for use as:

(a) Fessenden's *Interference Preventer*
(b) Fessenden's *Heterodyne* receiver
(c) Oscillating Audion for generator
(d) Amplifier for crystal detector
(e) De Forest Audion bulb as generator and transmitter?

A. 1. The circuit which you show was very ingeniously worked out and after careful examination, we find that it is satisfactory for accomplishing the results in question. It would be advisable to shunt a high capacity fixt condenser of 2 m.f. across the "B" or high tension Audion battery for reducing the impedance offered to the flow of the high frequency currents which are generated by the Audion when in an oscillatory condition.

CALIBRATION OF INSTRUMENT.

(821.) John Olsen, Jamaica, L. I., desires to know:

Q. 1. What do you mean when you speak of calibrating an instrument?

A. 1. The calibration of an instrument is the process of determining the value of the current or voltage required to move the indicator to any or all parts of the scale. This may be done either in making a new scale or in checking an instrument which has been in use. The calibration may, for example, be a comparison with a standard instrument or it may require the use or construction of new absolute standards.

Q. 2. For what range of resistance is the ohmmeter (megger type) suitable?

A. 2. It will measure resistances from about 5 megohms (one megohm equals 1,000,000 ohms) down to about 1,000 ohms. It is convenient for measuring the insulation resistance of wiring in houses that are not yet connected with the supply circuit, insulators, transmission line leaks, etc.

ROTATING FIELD PRINCIPLE.

(822.) V. R. Sullivan, Urbana, Ill., asks:

Q. 1. At the E. E. show at the University of Illinois, one of the magnetic freaks was as follows: a quarter (25c piece) was placed on a wooden base, somewhat concave, over a magnetic field consisting of three magnets, equidistantly placed, which was actuated by a three-phase current. When the current was on, the quarter given a slight start, would spin indefinitely, and the direction could be reversed at will. Please explain?

A. 1. The phenomena which explains the action of the rotation of the coin is identical to the fundamental principle of the operation of the A. C. induction motor.

As soon as the coin was started in a field of a three-phase current, currents are induced in the quarter, which reproduce a magnetic field in phase with the generated current and this field tends to follow in synchronism with the generated current, so that rotation is evident in the coin.

Q. 2. In the design of a rotary quenched spark gap as suggested by Dr. Zenneck, I believe it is necessary to revolve a wheel 30 inches in diameter at a speed of 14,400 r.p.m. This wheel may be made of either an insulator or a metal. The formula for centrifugal force is $f = \frac{m\ v^2}{r}$ and is correct for a weight on the end of a weightless string. What is the formula for determining the point of application of the force or the point corresponding to the center of gravity in such calculations? If I consider the entire weight of the wheel at the circumference, the results are impossible. You may consider the wheel as being made from a plain, unwebbed or unspoked wheel.

A. 2. You are entirely wrong in considering the rotation of a wheel for a rotary quenched spark gap at the velocity you state. It is necessary for such rotaries to be revolved at a maximum speed of 4,000 R.P.M., which is a normal speed for a wheel of 30 inches in diameter when properly balanced. There aren't any special formulae for computing centrifugal force and the equation which you give will hold true for a mass revolved at any speed, providing that the mass around the circumference is uniformly distributed.

SMALL HIGH FREQUENCY COIL.

(823.) E. E. Doherty, Dorchester, Mass., inquires:

Q. 1. What size wire should be wound on a small Tesla coil secondary, and how far apart should the turns be spaced from one another?

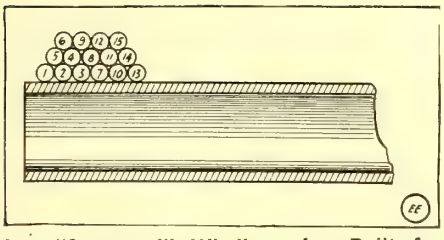
A. 1. The secondary coil should be wound with No. 28 D. C. C. magnet wire and each turn should be spaced from its adjoining turn by a 1/32-inch air space. It is advisable to wind between turns a thread which has been soaked with shellac or paraffin. This will prevent considerable leakage between turns.

Q. 2. Would the above coil work well on a one-inch spark coil?

A. 2. Yes. However, it is preferable that a two-inch spark coil should be employed.

Q. 3. About how many glass plates 4 x 5 inches would be needed for the condenser on a one-inch spark coil?

A. 3. Ten plates will be required.



How "Staggered" Windings Are Built for Radio Purposes So As to Reduce Distributed Capacity.

STAGGERED WINDING.

(824.) N. W. Smith, London, Ont., Can., inquires:

Q. 1. Please state what a *staggered* winding is?

A. 1. A staggered winding is a special method of winding inductance coils so as to minimize the distributed capacity of the coil due to its multiple layers. This method is employed considerably in winding multi-

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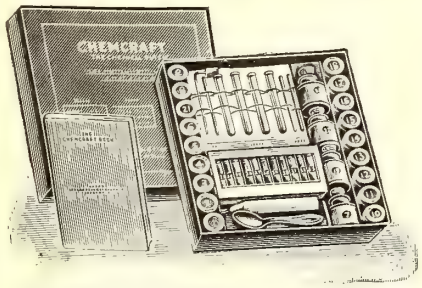
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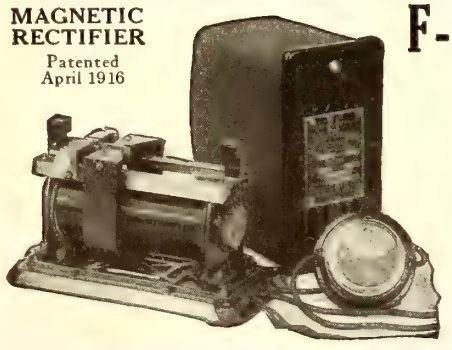
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Applicants must submit to the examiner on the day of the examination their photographs, taken within two years, securely pasted in the space provided on the admission cards sent them after their applications are filed. Tintypes or proofs will not be accepted.

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For further information address U. S. Civil Service Commission, Washington, D. C.

THE RADIO BOMB.

(*Continued from page 247*)

And then he knew—

Deep, rumbling and sinister, it was the roar of the river straining sullenly at the prison of ice which confined the rush of water coming down from the tributaries far up in the hills.

As he drest hurriedly, he glanced out the window and saw to his surprise that where there had been deep drifts of clean white snow, the evening before, there were now vast stretches of muddy earth criss-crost by rivulets of yellow water running to the swollen river. Evidently the south wind had done its work well.

Hastening down stairs he found his father pacing the length of the kitchen with quick nervous strides.

"Is it very bad, Dad?" Dick asked.

"Yes, I'm afraid it is, Son," his father replied anxiously. "The river's so high I'm afraid the ice'll go out any minute and—"

"Joe—oh, Joe!" loud voices summoned imperatively, and following his father Dick past out into the store from which the cry had come.

"What do you want?" the elder Preston asked, as he threw open the doors and confronted the group which stood outside.

Glancing past him, Dick saw in astonishment old Tom Waldon at the head of some dozen men armed with shotguns, rifles and revolvers ominously ready for use.

"Are you comin'?" Waldon demanded, opening his coat so that the constable's star could show to even better advantage.

"Coming where?" Joe Preston asked in surprise.

"To get that spy!" old Tom retorted.

Wide-eyed and face pale, Dick stared in amazement at the old constable and his posse. Did they really mean to attempt the capture of Captain Hardy? Did they mean to apprehend him simply because of their suspicions? The grim intentness of men and weapons left no room for doubt.

"Did you get your search warrant?" he managed to stammer out huskily.

"We ain't got time for no search warrant!" old Tom shot back. "Didn't you hear that bomb last night?"

"I thought I heard some one shoot," Joe Preston replied.

"Well, I reckon you did," the old man cackled, ironically. "I'd been blowed to pieces if I'd been fifty yards closer to that pile o' drift down there on the bend when it blowed up. The pieces fell all around me just as I was goin' home. Are you a'comin'?"

"But I don't see—" Joe began.

"Look here, Joe Preston," Pete Bailey burst out. "Are you goin' to stand by and let that spy blow up our houses? that's what'll be next. Tom's right. We'd better get him right now a'fore he gets a chance to do somethin' else."

"And that's what I think too," a half dozen endorsed.

"Better come along a'fore I have to deputize you," old Tom advised with a threat in his tone.

Cheeks pale and eyes staring in apprehension, Dick saw his father gaze in perplexity at the grimly armed group before him.

"I—" Joe began.

His words were lost.

With a roar like the broadside of a mighty battleship, the ice of the river shot skyward in a mad jumble of huge leaping cakes, only to fall back in a crashing grinding mass and be swept crunching and splintering down the stream on the crest of the yellow water, as it raced at whirlwind speed down the channel so suddenly freed.

Paralyzed by the shock the group in front of Preston's store stared in bewilderment at the plunging rocking mass as it surged wildly down the stream with a terrible deafening din.

And then, as one man, they turned in terror to the gorge.

They had cause for terror, for there, between the high banks, the ice had jammed in a solid immovable barrier squarely across the stream's channel.

As the group stared open-mouthed in paralyzed inaction, it grew swiftly, towering higher and higher as the swirling waters from above swept down fresh masses of ice to be piled cake on cake as the obstruction mounted steadily skyward. Higher and higher it reared itself and higher and higher rose the foaming yellow waters behind it, striving in vain to thrust aside the obstacle which blocked its path.

If it should triumph, if the swiftly widening lake behind the jam should sweep down on the little clustered hamlet— The group in front of Preston's store knew just how long their houses would survive that rush.

"Dynamite! Dynamite!" Pete Bailey shouted, and a half dozen men leaped toward the shack where Joe Preston stored his supply of the explosive.

But even as they leaped they knew that no man could live in that heaving tumult long enough to place a charge where it could blast the steadily mounting obstruction from the channel.

"The hills! Run to the hills!" they shouted, and around the store and up the muddy slope they fled to the first steep knoll where the women and children had already gathered at the first thundering break of ice.

But Dick Preston did not run. For a long moment he stared, fascinated at the wall of ice which towered in the gap restraining the impending wall of water. If that jam could not be broken before the water surged thru with its own mighty strength, he knew just how short would be the life of this little village, his home. But who could—

He whirled, dashed thru the store and sprang up the stairs to his room. At his wireless table he halted, jammed the receivers down over his ears, while his fingers slammed in switches and connections.

Then with savage speed his key tapt out, "H D, H D, H D, D P," the crackle of the spark sounding dimly weak thru the deafening roar of ice and water outside.

Again he repeated the call with frantic speed and threw over the aerial switch.

"O K, D P, H D," came the reply, barely audible thru the din.

"Ice has jammed in gorge. Can you—" the white hot spark faltered and then failed.

With a choking sob Dick peered over his instruments, trying wildly to locate the trouble. Then thru the window he caught sight of his aerial wires sagging limply along the ground where they had fallen when a guy wire peg had slipt.

"Dick! Dick! Where are you, Dick!" he heard his father calling in agonized tones, and snatching the receivers from his head he sprang up and dashed downstairs to meet his parent leaping up in search of him.

"Hurry! Hurry! It'll go any minute!" Joe Preston implored and together father and son raced up the muddy slope to the knoll where the population huddled in a forlorn hopeless mass.

Would he understand? Had the grounded aerial made his message unintelligible? Over and over Dick asked himself while he sped to safety.

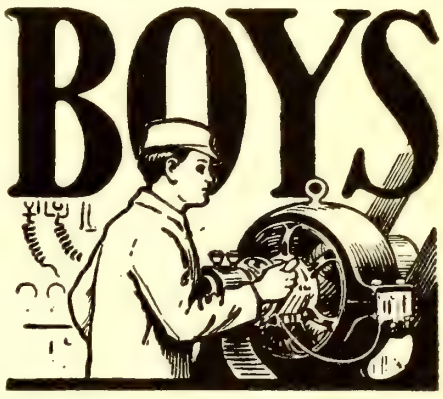
At the gorge he looked and saw the ice wall still mounting higher while the water restrained behind it spread wider and wider in a huge menacing lake.

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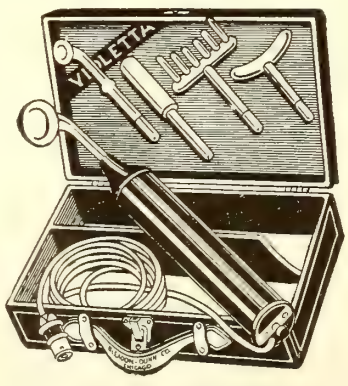
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Then with a prayer on his lips, he lookt eastward toward the mist-hidden bulk of Pine Mountain.

In an agony of suspense he scanned the blurred clouds and after an almost endless moment, caught the darker and distinct outline of an object high up in the heavens.

For an instant it appeared but a blotch against the mist. And then shaking free the vapor it shot out into the clear sunshine, a slimly cylindrical shape, the sunlight glittering from its two pointed ends as it glided at terrific speed thru the air a thousand feet above the earth.

"Look! Look!" Dick gasped, and pointed.

Straight as an arrow the uncanny thing came, showing momentarily a glimpse of a humming propeller on the tiny car which drove it forward without the presence of a man. Then into the cloud of mist which hung high above the gorge it dove and was lost to sight.

But even as it dove a huge column of spray spouted skyward from the jam to join the hovering mist-cloud, and an instant later a series of six rapid reports boomed out even above the roar of ice and water.

A minute afterward the mist drifted clear of the gorge and there—where had been the towering ice barrier, the people of Pine Flat saw the river, yellow, swift and turbulent to be sure, but running free and clear thru the gap and down past the hamlet, with a wide margin of safety between water and buildings.

* * * * * * * *

"You couldn't have placed them more accurately with gunfire!" Dick cried enthusiastically. "Why they were right where they needed to be!"

"I'm glad," the tall man in overalls beamed happily. "I was a bit afraid of the control. But I'm ready to announce results now."

"I've already—"

Dick stopt in amazement as the door of the cabin swung back. In the opening stood old Tom Waldon, mud-smeared, bedraggled and wet but strangely humble; while at his back crowded the men of Pine Flat, pushing their way inside.

"Captain Hardy?" old Tom inquired deferentially.

"Yes," Hardy acknowledged, returning the stiffly queer salute the old man gave him.

"We've come to tell you," the old constable said, "that we're mighty thankful to you for savin' us by blowin' that ice jam out o' the gorge. And more'n that we want you t' know we never would've thought you was a spy if you'd let Dick Preston here tell us that you was a United States signal corps officer inventin' that airship that dropt them bombs by wireless."

PERPETUAL MOTION.

(*Continued from page 249*)

ing in the oil. But try as we might, the rinktum wouldn't budge. Another bright idea—a few batteries, connected to the dynamo to "start her off." Once she runs we take the batteries off, and the system will run under its own power. No sooner thought than done. We fetched the 8 volt storage battery and hooked her up! And by jove it worked! Ran fine, and fast too. But alas, as soon as the storage battery was taken off, the newly wedded motor and dynamo had a private disagreement. Both became as obstinate as mules—or shall we say as a newly married couple, on their first (and subsequent spat)—and refused to budge.

After that several other schemes were

tried out, but none of them could be classed as even a tolerable success. Of course, no one was charitable enough in those days to inform us that in the transformation of energy from dynamo to motor, and in turn from motor to dynamo, we lose about 20% of our total energy, which being 100%. And 20 from 100 leaves 80%. And you can't buy a dollar for 80 cents—at least not thru the cashier's window.

But ignorance is bliss. So the other day while rummaging thru old papers, the Editor came across "Experiment 79, not tried out—looks *positively* feasible." Experiment 79, by the way, was one of the series of schemes to make the above, painfully described rinktum work. And if we do say it ourselves, for a scheme evolved by an 11 year old school boy, it is positively *épatant, extraordinaire,* as our French teacher would have said, pride oozing out of him by the handful, while he spoke.

But alas we never had the money to try it out. And what's more, we haven't got it now. And the way things look with the war, the H.C.L., and the cost of high living, there's no telling that we will ever get a crack at it.

But your Editor, who is far famed for his vast generosity (when his own pocketbook is not concerned) graciously donates his great and wonderful "Experiment 79" to all Bugdom. Anyone may try the scheme, and there is only one string attached to the offer, to wit:

In case it works, the Editor is to get a free ride at least once a week! Now that's modest, isn't it?

Well here's "Experiment 79."

Build a scenic railroad in a complete circle, as shown in illustration. Hills and valleys—the more the better—just like the regular scenic railroad. Now we know as a fact that a car launched on such a road will run the entire length of the track—almost, that is, it will *almost* come back to its starting point. But not quite. Now here's where the foxyness of the idea crops out:

While coasting down hill, the car expends a lot of useful energy. So let's harness it! We simply install a dynamo in the car, coupled to the axle of the latter. Use a third rail to convey the energy to a central storage battery. So we see that while the cars coast, we accumulate a lot of surplus energy. *Also the more cars used, the more energy we get.* That's plain.

Now then. As the car comes up the home stretch it runs slower and slower, and finally reaches a stage where the dynamo, which is "floating on the line" gives forth no more energy into the line. At this point the storage battery begins to discharge into the dynamo and the latter then must run as a motor. No electrical engineer will deny this fact. So the motor fed from the storage battery will pull up the car over the crest, and the play commences anew. If there's no hitch anywhere, the car will keep on running till the tracks are worn out!

Sounds perfectly logical, doesn't it? Now why in Sam Hill don't it work?

EXPERIMENTAL PHYSICS.

(*Continued from page* 250)

the pole. He will likewise sit down on mother earth in great haste. (It may be advisable at this stage of the experiment for you to retreat.)

EXPERIMENT 34 (See Fig. 26)—Place a card on a table with part of it projecting. Place a coin on the card. If now the index finger is rapidly snapt against the protruding end of the card, the card will fly off and the coin will tend to remain at rest and drop directly underneath. With a little practise one may acquire skill and can place the card on one of the fingers of the other hand and perform the same experiment.

EXPERIMENT 35 (Fig. 27)—This represents a little Mexican game (not the game of throwing the bull) which can be purchased in the five and ten cent store. It consists of five blocks in the shape of checkers, together with a wooden head, and a wooden hammer of slightly smaller diameter than the blocks. With a swing of the hammer G, block B is sent flying and head A drops on block C. In the same manner blocks C, D, E and F, are removed. Obviously the tendency of the blocks to stay at rest makes this game possible. Later one can learn to skip a block and try to knock off alternate ones. Finally it becomes possible to knock off block F, without the rest of the pile being disturbed.

EXPERIMENT 36—So far we have considered only part of the First Law. The fact that mud flies off a bicycle wheel tangentially leads up to the consideration that bodies tend to maintain not only the *amount,* but the *direction* of motion. It is *inertia* that keeps the water from falling out of the pail when swinging it over one's head. It is *inertia* that makes it possible for us to loop the loop in the scenic railway at the amusement parks. *Inertia* causes rotating liquids to move out as far as possible from the axis of rotation; it makes flywheels burst sometimes; it makes the diameter of the earth at the equator greater than at the poles; it makes the milk which is heavier than the cream move out farther in the cream separator. It causes the loop of cord A to assume the position B, or a perfect circle (Fig. 29), when rotating the cord rapidly. This is the underlying principle of the cowboy's lasso. An egg (good or bad) provided it is not a hard-boiled egg, after having its insides sucked out thru a pin-hole, has a string attached to one end by the aid of a piece of sealing wax. If now the string is twisted rapidly so that the egg rotates rapidly, it assumes the position B because of *inertia.* (See Fig. 29.)

EXPERIMENT 37—If an automobile engine exerts 4,000 pounds pull on an engine on a level road, at the end of one second the velocity acquired would be just twice as great as if the engine exerted a 2,000 pull. In view of this fact, Newton's second law could be stated—The rate of change of momentum takes place in the direction in which the force acts and is proportional to it.

Space does not permit giving anything but this very simple experiment. (See Fig. 28.) By means of thumb tacks attach two pieces of thread to a base ball and suspend it as shown. If the thread is grasped at A and pulled suddenly it will break between A and B. If, however, the experiment is repeated, pulling *slowly,* the thread breaks between C and D.

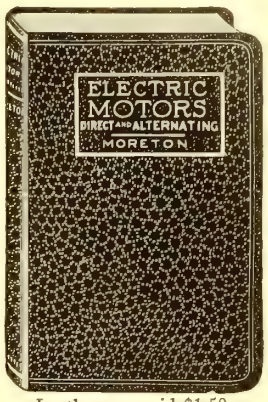
EXPERIMENT 38—If a small "Little Hustler" motor fan is placed on a light wagon (Fig. 30) with ball-bearing wheels and a board is placed in position A, then when the fan is started nothing unusual happens. If, however, the board A is removed, our little wagon moves toward the right. Every action has an *equal* and *opposite reaction,* and hence when the fan pushes against the air in front of it, the air pushes back and if the wagon is light enough and the friction at the wheels is small, the wagon moves.

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When the board A is in place the wind from the fan pushes against it, but since both the board and the fan are attached to the same wagon, no motion occurs. On a calm day, if motoring rapidly, we feel a wind. Our pushing against the air causes the air to push against us and we get the sensation of wind. The aeroplane is propelled by the reaction of the air against the wind made by the propellers.

In the case of a man rowing a boat, the man pushes against the oars, the oars against the water. The *reaction* of the water against the oars is transmitted to the boat, and it moves. When one jumps off a boat, the boat experiences a backward thrust. When a bullet is shot from a gun or a shell from a cannon, the gun "kicks" or the cannon is pushed back by the reaction. If the two bodies considered are of the same mass the *action* and *reaction* are easily seen to be *equal in magnitude,* but otherwise it may be difficult to see it at first consideration. We must remember that the quantity of motion is in each case the product of the mass by the velocity.

The importance of Newton's laws cannot be overrated, and examples of their application can be found without end. It is suggested that the reader look about him for as many examples of each as he may recognize. The writer will be glad to correspond with those further interested in this subject.

"BATS."

(*Continued from page* 261)

the top of a cloth bag of dropsical shape and knobby surface, could be truly loved for its appearance by its maker only; but it worked perfectly, and faithfully gave up its little trickle of "juice" for the operation of our apparatus. What should we ever have done without it?

Of course, like all worldly things, it had its faults. Sal-ammoniac is harmless to the human system (unless you happen to get it on a cut, when it makes you execute a few capers and forget your other troubles) but its appetite for copper is unlimited, and its cunning hygroscopic habit of creeping out of the jar and spreading itself over the surrounding landscape does not endear it to any member of the family, from the cat up. On returning from a summer vacation, I have more than once found my copper terminals eaten off and forming the center of a spongy mass of a beautiful grass-green color, while everything within several feet was covered with the damp white deposit of sal-ammoniac crystals. I always longed to try the experiment of setting one of these batteries in the midst of a boundless plain and seeing how far one jar-full of the stuff could spread itself if it had plenty of time and room; I believe it would cover the earth.

While the Leclanché battery was always our standby, it had its limitations. Its resistance was high, its current of small quantity, and on being short-circuited it promptly polarized and died. We tried Bunsen's, but they were far too expensive. But with the coming of the telegraph era, we took up gravity cells, and they soon secured a warm place in our hearts. These sturdy cells worked 24 hours a day, as long as the slightest color of copper sulfate remained in them. We were never tired of noting the clean-cut line of the blue solution, held in its place at the bottom of the jar by its excess weight over the transparent solution above—a difference, of course, not apparent to the eye.

This battery piqued our inventive faculty because it furnished so much more current than we needed. Not only when we were using the telegraph, but all the time when we were at school, or in bed and asleep, it plugged away. If one could only economize it! but it was impossible. If the circuit was left open, the blue solution rose by diffusion till it directly attacked the zinc, when mud and long strings of copper metal began to form, and soon the battery was ruined. Neither could you economize by lifting out the zinc, because again the diffusion took place, and you couldn't put it back without raising all sorts of chemical Cain.

No use; we had to stand by and see all that beautiful "juice" wasted while we needed it elsewhere. It manufactured more in one day than the Leclanché cell did in its lifetime, yet it was useless because it couldn't be held back. Even the similar Daniell cell, with its porous cup, couldn't be left on open circuit; it was necessary to use up the copper sulfate on its depolarizing job faster than it could spread by diffusion. All the text-book writers said there was no help for it.

But text-book writers have never been boys!

When clocks came in, the demand became still more pressing. Here was a mechanism which required but little current, to be sure. A wet Leclanché would run it for months; but that only made the gravity cell, in its obstinate generosity, more exasperating. A gravity cell would run three months on one charge of sulfate, producing in that time enough current to run the clock for 60 years at the lowest calculation. If one could only choke it back!

Fools rush in where scientists are afraid of getting the laugh. In spite of the text-book writers, Dr. Daniell and the Lion's Den, I puzzled over ways to strangle up that cell.

It first struck me to confine the sulfate solution in a non-porous cup, and let it ooze out over the copper plate thru a very small hole, instead of exposing a great area

(*Continued on page* 284)

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PATENT ADVICE

Edited by H. GERNSBACK

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Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

DETACHABLE HEEL.

(166.) Joseph Pacyk of Glassport, Pa., submits to us a very ingenuous idea whereby an ordinary leather heel on a shoe can be detached when it is worn out, in a very simple manner thereby making it unnecessary to take the shoes to the shoemaker or repair shop. His idea is to get the shoe people to stock these special heels, which can then be attached by any one without any tools whatsoever.

A. This is a capital idea, and no doubt a patent can be obtained. In case nothing similar has been patented before, and we doubt there has, we think a valuable patent may result. We would advise our correspondent to get in touch with a patent attorney.

Mr. Pacyk also submits to us a design of a tooth brush, the idea being that it could be used for brushing teeth on the inner side of the teeth as well.

A. We do not think this idea is patentable, and we believe several brushes similar to this one have been in use.

SUBMARINE MINE.

(167.) Elmer Wahl, of Carnegie, Pa., encloses diagram and description of a self-exploding mine for harbor defence. The mine is supposed to explode when a submarine comes in proximity to it. The principle is based upon a highly magnetized needle which the submarine is supposed to deflect, and then auxiliary contacts cause the explosion of the mine, or otherwise the current for the mines may be supplied from the shore; thus, doing away with the batteries in the mine itself.

A. We do not favor the first idea at all, as it is not practical, being too dangerous; *i.e.*, the mine might explode prematurely if a friendly steamer came into range. The second idea is not new. The United States Navy is using similar mines controlled from shore. We cannot give any encouragement on these two ideas.

GAS SPARK GAP.

(168.) Harry McLaughlin, Jr., Pawhuska, Okla., has made some experiments with a bunsen burner and spark gap, and found that by means of the bunsen burner, the spark can be lengthened out several times its original value. He wishes to know if this is a new discovery and whether the idea is patentable. Also if it is to any advantage in some form of electrical apparatus, wireless, etc.

A. Nothing new is suggested in the device, which is old. If you take an ordinary candle and spark gap, and let the spark go across the lighted candle flame, the spark will be lengthened considerably. The reason is that all flames contain large amounts of hydro-carbons, due to the combustion of carbon or whatever other materials are burnt up, and these carbon particles as well as the hot air form a much better conductor than the common atmosphere. This is the reason why the spark is lengthened out considerably. There is nothing new in this experiment, which has been performed by various physicists over 100 years ago.

SELLING PATENTS.

(169.) Fred Jeffries, Passaic, N. J., wants to know the best place to dispose of a patent. Mr. Jeffries is an electrician and has a patent on an electrical device which he desires to dispose of.

A. The Electrical Experimenter cannot officially give the names of persons that are likely to buy electrical or any other patent. The safest and best way is to advertise an illustration of the patent drawing in our advertising columns or otherwise in local newspapers. It might also be a good idea to send copies of the patent to advertisers in The Electrical Experimenter who make a specialty of manufacturing electrical appliances.



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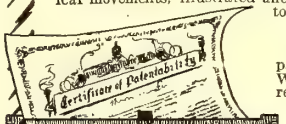
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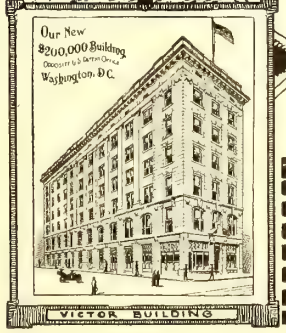
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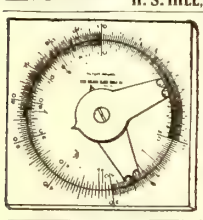


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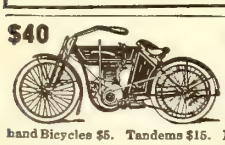
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"BATS."

(*Continued from page 282*)

of it to diffusion. That sounds reasonable, doesn't it? Well, here's what happened.

I set up a cell as shown in Fig. 1, my glass sulfate-storage cup "S" having a hole about ⅛" diameter drilled thru the bottom. That seemed to me pretty small, but bless you, it was as wide as a barn door for that elusive sulfate. On open circuit it serenely diffused out as tho my cup had been composed entirely of hole.

This sulfate was evidently an animal that had to be stalked with care if one wanted to capture it. I cleaned out my storage-cup, and in the bottom, over the hole, I placed a dozen discs of filter-paper. "Now," says I to the sulfate, "tackle that little obstruction and see what you make of it, dog-gone you." Another surprise: Mr. Sulfate sulked and refused to emerge at all. I was tickled to death at first, because I needed hardly any of it for an open-circuit proposition, and it looked as if I had it strangled good and plenty for the purpose; but as days went by and no sulfate appeared without, I concluded I had it choked too much. "Well and good," says I, "I've got you down, now I'll let you up slow." So one by one I removed my filter-paper discs until only a single one was left, and what do you think? That one was just as good, or bad, as the whole dozen! In the open air the blue solution would go thru nicely, but against the pressure of the surrounding liquid it wouldn't budge!

I wasn't disappointed; in fact I was rather pleased, because all I had to do was to continue my cautious stalking. I took a fine needle then and pricked just one little hole in the filter-paper. "Now," says I to Mr. Sulfate, "there's a place you can crawl thru, and I'll slowly enlarge it till you can get your head out, but no more, so don't you tease!"

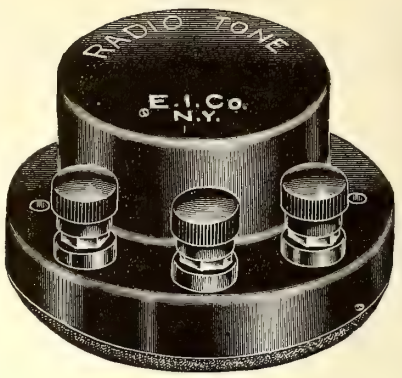
Is that so? I heard what I thought was a gurgle in the battery, but it was Mr. Sulfate giving me the grand high chuckle. He came out of that needle-hole as easily as I could get out of the State of Massachusetts (if I wanted to, that is; of course no one would ever want to do a thing like that). It was evidently either one extreme or the other with Mr. S., and that choke-valve theory had to be abandoned.

All this time my battery, electrically, worked to a charm, and I could see plainly that the only problem was controlling my supply of sulfate. My blue-colored friend had shown considerable ability in crawling out thru the cellar, but could he climb out the chimney? I plugged up the hole in the bottom of my storage-cup, and offered him a passage instead thru the *siphon* shown in Fig. 2.

I can't remember whether the sulfate did diffuse thru the siphon or not; I think it did; but the chief trouble was that bubbles of gas collected in the top of the siphon and eventually broke the liquid connection. The next step was to discontinue the siphon as a siphon, and fill it with cotton wicking, so that a connection between the two liquids was maintained by *capillarity*.

This at last was successful. The liquids did not mingle at all, while the hydrogen atoms still had opportunity to travel, as they must, from the zinc to the copper plate. My battery gave a nice little current—very slight in quantity, of course, on account of its high resistance, but of good voltage. It would stand any length of time on open circuit without mixing, while if put on closed circuit it would get busy all-same bee, as Charley One-Lung would say, and stick to its job as long as required.

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the *internal resistance.* The final form to which I carried the cell is shown in Fig. 3. This is like Fig. 2, except that the capillarity is secured thru several layers of burlap sacking, straddling the *entire* edge of the inner cup. This reduced the resistance to a point where the electric output was sufficient to work a swinging-magnet annunciator-drop very well.

Munn says the idea is patentable, but none of this patent stuff for mine. I hereby turn the invention over to Bugdom for improvement. If such a form can be given it that the capillary mass is very much larger, it will give an output big enough for a clock; at present it doesn't, but is ample for any high-resistance indicating device, electrolytic detectors, etc. As to its staying powers, I had one of these cells on open circuit in my shop for *four years,* testing it with the annunciator-drop from time to time. At the end of the period the liquid had evaporated out by a half, owing to my cover not being perfectly tight; but the zinc plate was very little consumed, the liquid in the outer jar was as clear as spring-water, the blue solution remained in the inner jar with no diminution in the sulfate crystals I had added to keep it saturated. The current would still work the annunciator-drop, tho not as vigorously as at first, probably due to the liquid levels being lower. I had to leave the old house then, and as the battery couldn't be moved the experiment was over.

Why don't you push it along, Bugs, just to while the time away till they give us back the air? That "bat's" a handy little thing as it is; and if you could devise some low-resistance form that you could couple on to a clock and run the thing 5 to 10 years at a stretch—well, s-ay!

EXPERIMENTAL CHEMISTRY.

(*Continued from page* 274)

also, by the finger or towel, any nitrat adhering to the tubulure, as it is liable to crack the retort on heating. The retort may now be readjusted in position. Pour into a tube about 20 cc. of strong Sulfuric Acid [H_2SO_4], and using a glass funnel, so as to keep the acid out of the retort neck, pour it into the retort. Rinse the funnel, replace the stopper in the tubulure, and readjust the retort in position. Apply heat for 10 or 15 minutes, or until 5 cc. or more of liquid has collected in the test tube.

Upon the introduction of the Sulfuric acid into the retort, action will probably commence at once, but a gentle heat should be applied, whereupon the volatile Nitric Acid passes over and is then collected in the test tube in the bottle or tumbler, which should be kept cool. A few pieces of ice may be placed in the water.

The reactions which will probably take place are:

$$\underset{\text{Sodium Nitrat}}{NaNO_3} + \underset{\text{Sulfuric Acid}}{H_2SO_4} = \underset{\text{Sodium Hydrogen Sulfate}}{HNaSO_4} + \underset{\text{Nitric Acid}}{HNO_3}$$

or

$$\underset{\text{Sodium Nitrat}}{2NaNO_3} + \underset{\text{Sulfuric Acid}}{H_2SO_4} = \underset{\text{Sodium Sulfate}}{Na_2SO_4} + \underset{\text{Nitric Acid}}{2HNO_3}$$

The reason for these two equations are more fully explained under the heading "Preparation" in a previous paragraph.

Note all phenomena, fumes, color, whether or not the color changes with varying temperature, effervescence, whether anything is visible in the retort tube, color of the liquid collected, etc.

As soon as the lamp is removed, pour 5 or 10 drops of Ammonium Hydroxid [NH_4OH] into a dish and dip a small piece of paper or stirring rod into it; then bring the alkaline paper or rod to the tubulure, removing the stopper with a cloth if it is hot. This must be done while the contents of the retort are hot.

Note any action and fumes [whether gaseous or solid].

To remove the collected acid, which should be done soon after the lamp is taken away, lift the entire ring stand with one hand and with the other grasp the test tube by its rim between the thumb and forefinger and set it in the rack. [Use great care at all times not to get any of this acid on the flesh or clothing, as it is very corrosive. Let down the ring stand in such a position that any acid may drip from the nozzle into the sink; then raise the retort to a horizontal position by changing the clamp screw. Put a funnel into the tubulure and pour water thru it into the retort bulb [cautiously at first, if it is hot, and from a tube]. Finally clean the entire retort, running water several times thru the neck, bulb and tubulure.

EXPERIMENT NO. 83:

Note the color of the liquid obtained in the preceeding experiment, and if you have some of the commercial acid at hand, compare with it in this respect.

Apply a piece of litmus paper to the liquid thus obtained in the preceding experiment, and if an acid is present it should give an *acid reaction* with the litmus.

Obtain a piece of colored cloth [woolen] and permit a few drops of the acid to fall upon it. Dense fumes should rise from the cloth, and the cloth become discolored, as tho rotten. From this it is obvious what would occur if this acid were to come in contact with one's suit or other cloth; thus it is obvious that great care should be exercised not to permit it to spill.

With a glass rod put a drop of the liquid on a quill, a feather or a piece of white silk; also place a drop on the finger nail, but wash it off at once. Note any change in the color of these substances. Pour into a dish a few drops of ammonium hydroxid [NH_4OH] and, using the rod, put a drop of this on the places just touched with the acid, noticing whether the color is intensified or reduced.

Dip a splint and a narrow strip of paper into your liquid, dry them, and then set them on fire, noting how they burn.

EXPERIMENT NO. 84:

Put a few pieces of copper clippings into a dish and pour over them some of the acid obtained. [This is the same experiment as No. 28 in the January, 1917, issue of the ELECTRICAL EXPERIMENTER, page 666]. In Experiment No. 28, it was stated that hydrogen was not liberated by the inter-action of Copper and Nitric Acid, the equation being:

$$\underset{\text{Copper}}{3Cu} + \underset{\text{Nitric Acid}}{8HNO_3} = \underset{\text{Copper Nitrat}}{3Cu[NO_3]_2} + \underset{\text{Water}}{4H_2O} + \underset{\text{Nitric Oxid [Note]}}{2NO}$$

[NOTE.—In Exp. 28 this was given as Nitrogen Monoxide].

As we did not take up the reason why Hydrogen is not liberated when Copper is reacted upon by Nitric acid, and this paper deals with the acid, it will not be out of place to show why the Hydrogen is not liberated.

When moderately dilute Nitric acid [density 1.2] acts upon copper, the reaction may be exprest by the following equations:

$$\underset{\text{Nitric Acid}}{2HNO_3} = \underset{\text{Water}}{H_2O} + \underset{\text{Nitric Oxid}}{2NO} + \underset{\text{Oxygen}}{3O}$$

$$\underset{\text{Oxygen}}{3O} + \underset{\text{Copper}}{3Cu} = \underset{\text{Copper Oxid}}{3CuO}$$



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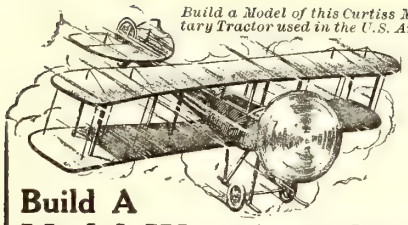
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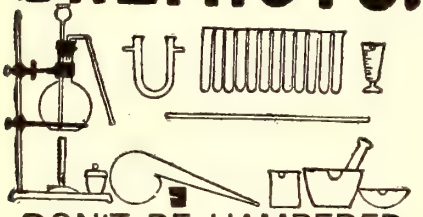


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$$\underset{\text{Copper}}{3Cu} + \underset{\text{Nitric Acid}}{8HNO_3} = \underset{\text{Copper Nitrat}}{3Cu[NO_3]_2} + \underset{\text{Nitric Oxid}}{2NO} + \underset{\text{Water}}{4H_2O}$$

If concentrated acid is used in place of dilute, Nitrogen dioxid is liberated, as shown by the following equations:

$$\underset{\text{Nitric Acid}}{2HNO_3} = \underset{\text{Water}}{H_2O} + \underset{\text{Nitrogen Peroxid}}{2NO_2} + \underset{\text{Oxygen}}{O}$$

$$\underset{\text{Copper}}{Cu} + \underset{\text{Oxygen}}{O} = \underset{\text{Copper Oxid}}{CuO}$$

$$\underset{\text{Copper Oxid}}{CuO} + \underset{\text{Nitric Acid}}{2HNO_3} = \underset{\text{Copper Nitrat}}{Cu[NO_3]_2} + \underset{\text{Water}}{H_2O}$$

Combining these into a single equation, we obtain the following:

$$\underset{\text{Copper}}{Cu} + \underset{\text{Nitric Acid}}{4HNO_3} = \underset{\text{Copper Nitrat}}{Cu[NO_3]_2} + \underset{\text{Water}}{2H_2O} + \underset{\text{Nitrogen Peroxid}}{2NO_2}$$

Hydrogen is not evolved at the same time, as in the case with Sulfuric Acid and Hydrochloric Acid, but in its place lower oxids of Nitrogen and even Nitrogen itself and Ammonia are formed. The explanation frequently given of this change is that hydrogen is first produced, but that it at once acts on the excess of Nitric Acid present, forming water and the lower oxids of Nitrogen. Thus, the formation of nitrous oxid by the action of Nitric Acid on Copper is supposed to take place in the two following stages:

$$\underset{\text{Copper}}{Cu} + \underset{\text{Nitric Acid}}{2HNO_3} = \underset{\text{Copper Nitrat}}{Cu[NO_3]_2} + \underset{\text{Hydrogen}}{2H}$$

$$\underset{\text{Hydrogen}}{6H} + \underset{\text{Nitric Acid}}{2HNO_3} = \underset{\text{Nitric Oxid}}{2NO} + \underset{\text{Water}}{4H_2O}$$

According to Veley, however, this explanation is not correct, inasmuch as pure Copper, Mercury and Bismuth do not dissolve in pure dilute Nitric Acid, but dissolve readily when nitrous acid is present, or by impurities in the metal inducing a local electric current; the first product of the Nitric Acid is Nitrous Acid, and the production of lower oxids of nitrogen he regards as due to the subsequent changes occurring between nitrous acid and the metallic nitrat or nitrit in presence of an excess of Nitric Acid, and nitrous acid being decomposed as fast as formed. [*Proceeding of the Royal Society*, 1890, 46, 216; *and others.*]

Upon the addition of the acid to the copper action should commence at once, forming a deep-green solution, and dense brown fumes of Nitrogen Peroxid liberated.

EXPERIMENT NO. 85:

Dilute the solution obtained in the preceding experiment and put in a clean test tube. Add a little Potassium Hydroxid and note results. A blue precipitat should form of Copper Hydroxid [$Cu[OH]_2$].

EXPERIMENT NO. 86:

Dilute some of the acid obtained in Experiment 84 and put in a clean test tube. Add a little Ammonium Hydroxid [NH_4OH]. Upon the addition of the Ammonium Hydroxid a dark blue solution is formed similar to the preceding, and with a blue precipitat.

Add an excess of Ammonium Hydroxid and note results. The precipitat should disolve upon the introduction of an excess of the Hydroxid.

EXPERIMENT NO. 87:

Dilute a little more of the solution obtained in Experiment No. 84 and put in another clean test tube. Add a little Ammonium Hydroxid and note results. A dark blue solution should form with a light blue precipitat. Introduce an iron nail in this solution. Upon the introduction of the nail the copper should deposit on the nail, action taking place, the nail being attacked by the solution, forming a yellow solution. Add an excess of Ammonium Hydroxid and allow to stand a few minutes. After a few minutes a brownish red precipitat of Ferric Hydrat [$Fe_2[OH]_2$] results.

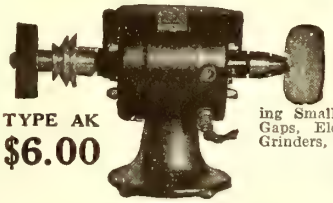
EXPERIMENT NO. 88:

Copperas Test for Nitrat:—Pour into a tube 5 cc. of Sodium Nitrat [$NaNO_3$] or other nitrat solution and the same volume, both estimated, of Ferrous Sulfate [$FeSO_4$] solution freshly made. Shake the mixture well together. Then run a thistle tube to the bottom of the mixture and pour thru it about the same volume of strong Sulfuric acid, having the two tubes perfectly quiet, or use clamps [Fig. 79], till you observe a brown ring [halo] at the junction of the two liquids. Its composition is uncertain, but it comes from the action of Sulfuric acid on the nitrat to form Nitric Acid, which is perhaps reduced to Nitrous Acid [HNO_2] by Ferrous Sulfate [$FeSO_4$], which thereby becomes oxidized to [$Fe_2(SO_4)_3$]. This experiment is sometimes done by mixing the supposed Nitrat and Sulfuric acid then, when it is cool, laying the Ferrous Sulfate solution on the surface with a pipette. The brown ring is often regarded as [$FeSO_4]_x$ [$NO]_y$ [unstable].

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FOR SALE—Single cylinder Indian engine two and a half horsepower, $6.50, f. o. b. Quincy, Ill. Ralph McLaughlin, 1318 N. 4th St., Quincy, Ill.

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Brand New Thordarson, Type "H," 1 K.W. Transformer, cost $30, condenser, rotary gap, large X-Ray Tube and Tesla Coil, giving 12-inch spark, complete $35. Also all kinds of other electrical goods for sale. Chicago Experimenters please visit. No obligation to buy. Phone Lakeview 1045. Others write your needs. Have almost anything and will almost give it away. Ralph Weddell, 1050 Buena Ave., Chicago.

FOR SALE OR EXCHANGE—Aerothrust twin cylinder 3 H.P. rowboat engine with 32-inch propeller in perfect condition for $25, or Victor Phonograph and records. Otto C. Rolli, 426 Dewalt Ave., S. W., Canton, Ohio.

FOR SALE—New Columbia Bike; Omnigraph; Audio Tron panel complete; Brandes phones, 2,000 ohms; Blitzen Electrolytic Interrupter; Variables; Receiving Condenser; Receiving Transformer; Willard 6-60 Storage Battery. Everything cheap, write for prices. Geo. Auten, Oberlin, Ohio.

FOR SALE—Electric Therapeutic Apparatus Machine Second-hand in good condition, used by physicians for rheumatism and circulation. Will sell at a very reasonable price. John Ferguson, 113 West 63d St., New York City; home, 364 West 57th St.

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FOR SALE—1913, 5 H.P. Harley-Davidson Motorcycle in perfect condition all the way round. Write C. H. Calhoun, Madison, Fla.

EXCHANGE—Meccano Set No. 4 for motor cycle engine. Stuart Cope, Highland, Middletown, Conn. R. R. No. 1.

FOR SALE—One Steffey Motor Bicycle in good running order, $15. One Charging Dynamo, $15. Write, Russell Moir, Kent, Minn.

FOR SALE—$4 Loading Coil, $2; $25 Audion, $10; $5 Film tank 3¼ x 5½, $2; $3 Boxing Gloves, $1.50; New $65 Visible Typewriter, $10. Raymond Schlegel, East Liberty, P. O. Box 329, Pittsburgh, Pa.

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FOR SALE—1-inch coil panel set, $6; 10,000 meter Navy Type Loose Coupler, $8; 4,000 Meter Arlington Navy Type Loose Coupler, $7; Crystaloi, $1.50; 500 ft. No. 14 Copper Wire, $1.50; 7 Ball Insulators, $1; Commercial Type Oscillation Transformer, $7. Everything guaranteed. Leroy Bremmer, care of Laufersweiler Furniture Co., Fort Dodge, Iowa.

WANTED—Old Edison moving picture machine or mechanism, used camera and typewriter. M. Miller, La Harpe, Kans.

MY $200 Electrical Laboratory must be sold as I am to leave for college. Have apparatus pertaining to wire and wireless telegraphy, physics and electrochemistry. Send for price list. Mark Slabodnik, Box 91, Ely, Minn.

FOR SALE—Silicon Detector without cat whisker wire, 50c; 1,000 ohm Receiver, 75c; Galvanometer, 25c; Telegraph Set, 50c; Leather-covered headband, 50c. Remittances must accompany order. Write Harry Layman, Davidsville, Pa.

UKULELE—Koa wood, $10, or trade for camera. Give size, lens, style, make, etc., or guitar. Clyde B. Marx, Kaskela, Oregon.

FOR SALE—Otis Clapp Static Machine in first-class condition. Two 19" plates on hand operated end. Ten 29" plates on power operated end. Several Leyden jars and various discharging devices to go with machine. Cabinet measures 66"x66"x30" wide. All enclosed in glass, $75, f.o.b Mattapan, Mass. Cost $450. Fritz Henrici, Mattapan, Mass.

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BARGAINS—Leaving home, must sell. New Electron Relay, $3; slightly used, $2. Loose Coupler, $1. 500 volt D. C. 1/3 horsepower Holtzer Cabot motor and rheostat equal to new, $15. D. P. 1,000 ohm phone, headband, cord, $1.25. Electrolytic detector, 75c. Telephone magnetos, solid armature, 50c, laminated, $1. $10 Remy 6 volt automobile magneto, good condition, $3. Six-inch parabolic reflector, 50c; new bulbs, 20c. High resistance ringer coils, 15c each; telephone transmitters, 50c; receivers, 50c; induction coils, 20c; ½ lb. 22 German Silver wire, 35c; 2 lb. antenium wire; 40c; quantity 2 strand steel guy wire cheap. Premo Junior No. 2 Camero, new, $1. Mechanical, electrical magazines cheap. Prepaid except magnetos, motor, wire. Stamps or money order, or write for further information. Kenneth Bard, Manawa, Wis.

EXCHANGE—Complete set of parts for a Ford engine, with exception of crank shaft and flywheel for a panel type receiving set, typewriter or wireless supplies. J. Yates Van Antwerp, 35 South Perry St., Johnstown, N. Y.

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FOR SALE—1½ H.P. Gas Engine, 500 watt 110 volt D.C. Generator, small lathe, ⅛ H.P. 110 volt D.C. motor, Jeweler's Foot Wheel. Write for description. J. H. Clemmer, Blue Creek, W. Va.

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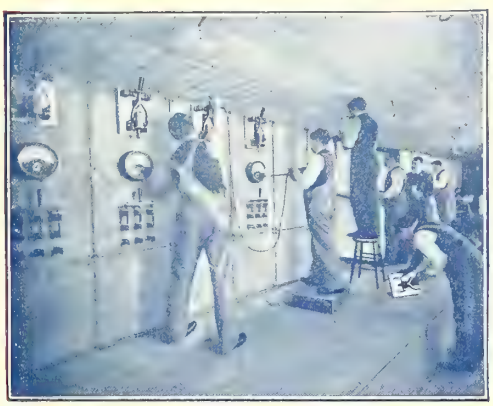
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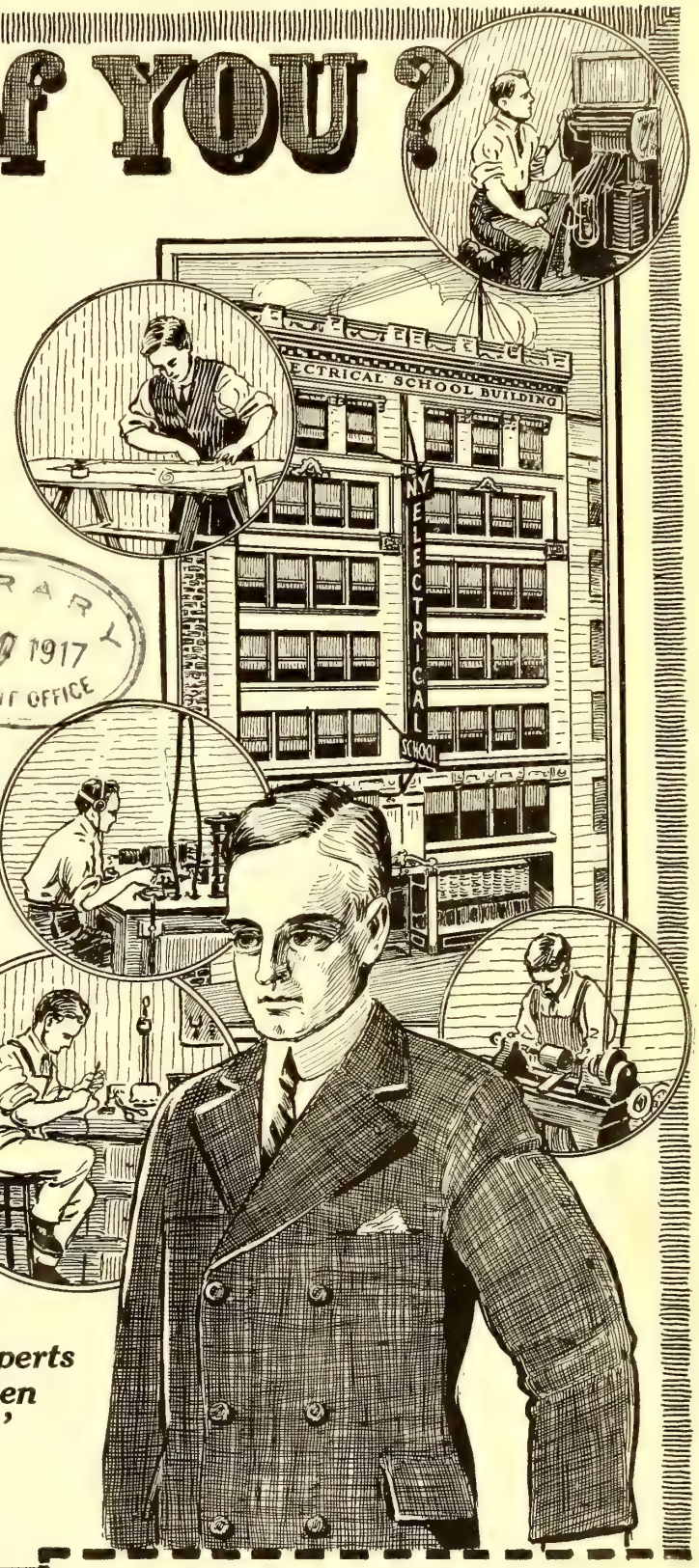
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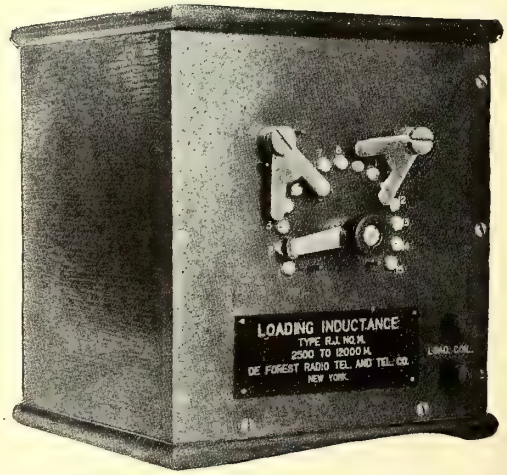
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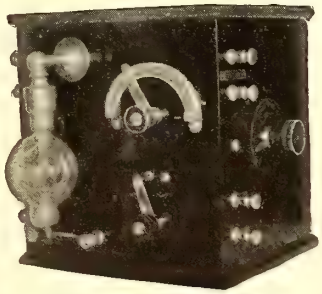
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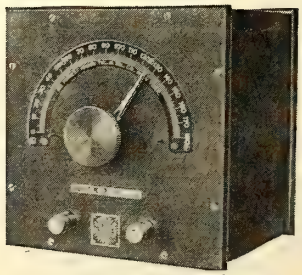
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Secret Intelligence

"*UN homme averti en vaut deux*"—a man forewarned is worth two;—so runs the well known French proverb.

To our country, surrounded by a web of spies and intrigue, this is of vital importance today. Even when we were at peace with Germany, our officials soon learned that the country where the "art" of spying is developed to a higher degree than anywhere else on this globe, stopt at nothing to secure important military information. When in 1915 we ventured the opinion that the Sayville Radio station could be and probably was used to send un-neutral messages to Berlin, we were laughed at. That same month our Government took over Sayville, after a New Jersey Radio amateur actually succeeded in "canning" on phonograph cylinders incriminating radio messages, sent out from Sayville.

Today, being at war with Germany, we are facing a tremendously more difficult problem of dealing with the spies. And evidence is not lacking that the latter are doing their work quite satisfactorily to their government just now.

When Admiral Sims took his fleet to England, Berlin knew the fact four days ahead of the arrival of our ships. Again, when our first transports were sent to France, Berlin knew that too, days before our ships reached France; hence, the flotilla of submarines lying in ambush.

The question is, how did the enemy get the intelligence? Our officials frankly admit that they don't know. In some quarters the opinion prevails that the information was sent by mail or by wire to Mexico—in clever code of course—and thence sent across the Atlantic over the powerful Mexico City radio plant. This may be possible, but we much doubt it.

We can be certain that a nation that attained as high a scientific development as Germany, will use subtler and surer means to convey priceless intelligence. Besides, the round-about route thru Mexico is certainly far too slow and too dangerous, all messages being closely watched by our alert officials.

No, we must look elsewhere. An enemy usually attacks at the most vulnerable or exposed spot. Unfortunately we have thousands of such spots, namely, our endless coastlines. On the coast of Long Island and Maine, for instance, there are countless thousands of spots where a human being is hardly ever seen. There are hundreds of secluded little inlets and sheltered spots from which intelligence could be sent out in a ridiculously simple manner, and perfectly safe too for the sender.

No, we don't think he would be so foolish as to operate even a mediocre radio outfit, for our Navy has too many ears. What, for instance, is to prevent a spy from sending messages daily to a submarine lying still some ten or more miles off the coast? This could be accomplisht by various methods. One is by means of the Fessenden underwater oscillator; twenty to thirty miles can be covered very easily. And if we don't know that this sort of thing is going on, we'll never discover the spy. And we insist once more that no man in his right senses will use a Radio Outfit—it is too dangerous.

Then again what is to prevent any enemy submarine from bringing over an electric cable ten or twenty miles long, unreeling it on a shallow sand bank (using a motor boat to accomplish this) and establishing a secure terminal in one of the secluded spots on the coast. The other end, twenty miles out in the ocean could end in a submerged buoy. The submarine then has nothing to do but to hover about that buoy, while the land operator presses his key at certain pre-arranged hours of the day. By means of an electro-magnet inside of the buoy, the metal shell of the latter is struck, spelling out the Morse or other code signals. The sound can be muffled of course to such an extent that only a submarine with underwater microphones can hear the sounds over a radius of a few hundred feet.

Then by using its own powerful radio, the submarine can send the message across the Atlantic either direct or by relaying it. By radiating certain long undamped waves, detection becomes almost impossible. For as soon as the message is sent the U-boat submerges and lays motionless for the next twenty-four hours if necessary.

Now, this may or may not be the exact means how the trick is done, at any rate we feel that the intelligence leaves by way of our coastline—it is too vulnerable and too inviting.

The remedy? Intensified and intelligent coast patrols —thousands of them. Then let us sink super-sensitive microphones two or three miles apart along our entire coastline. This will do two things: First, every underwater signal could be heard, no matter where; second, hostile U-boats could be heard readily and accurately located.

We owe it to our soldiers to take every precaution humanely possible. We do not wish to wait till a score of our transports have been sunk. H. GERNSBACK.

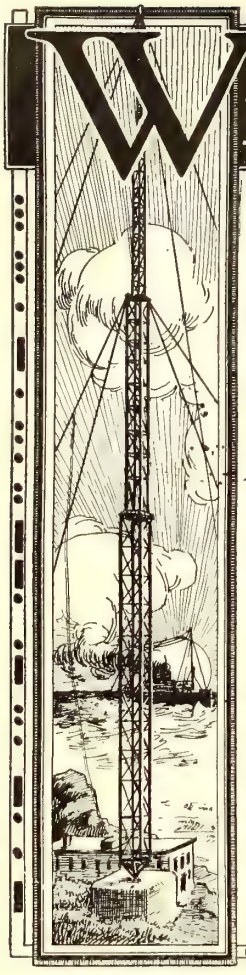
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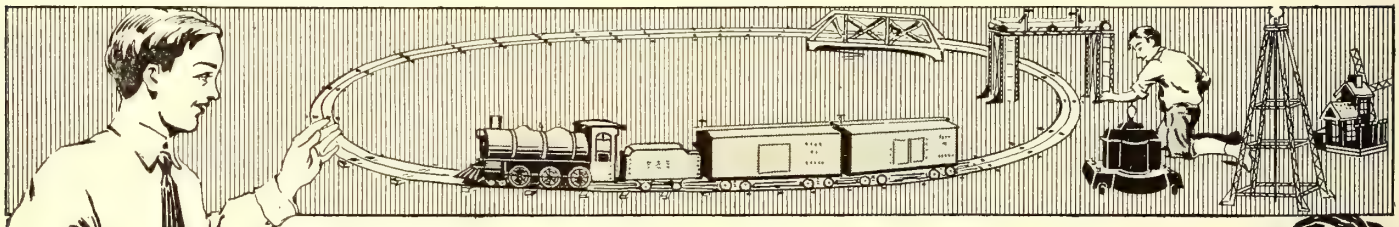
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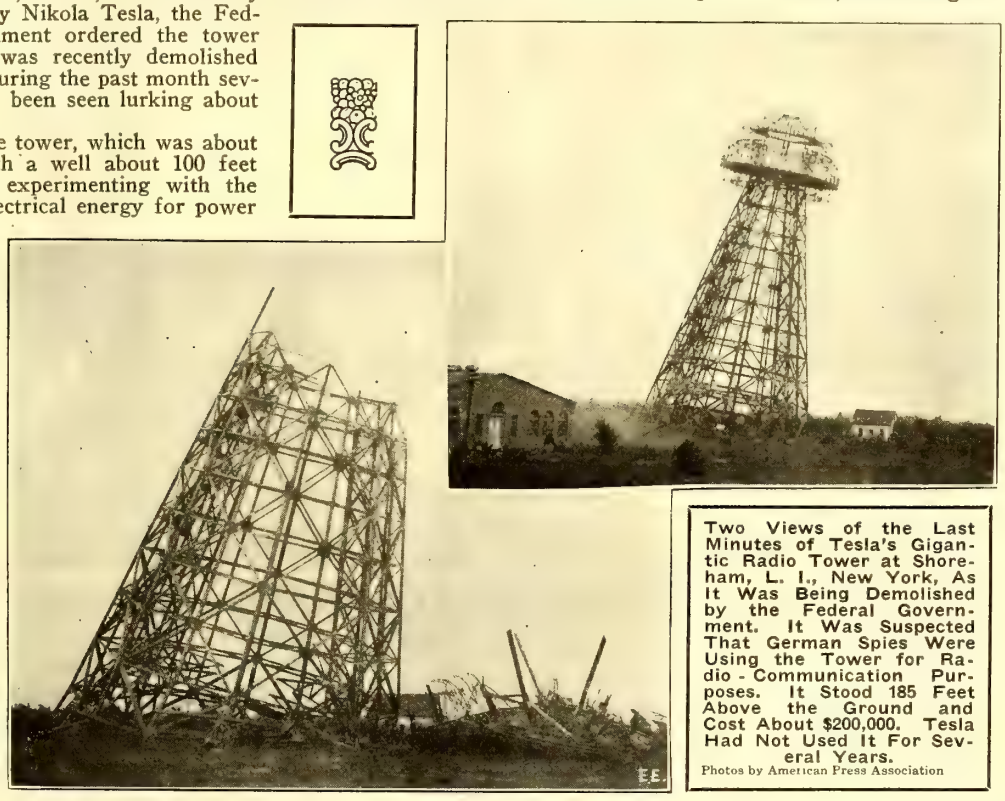
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U. S. Blows Up Tesla Radio Tower

SUSPECTING that German spies were using the big wireless tower erected at Shoreham, L. I., about twenty years ago by Nikola Tesla, the Federal Government ordered the tower destroyed and it was recently demolished with dynamite. During the past month several strangers had been seen lurking about the place.

Tesla erected the tower, which was about 185 feet high, with a well about 100 feet deep, for use in experimenting with the transmission of electrical energy for power and lighting purposes by wireless. The equipment cost nearly $200,000.

The late J. P. Morgan backed Nikola Tesla with the money to build this remarkable steel tower, that he might experiment in wireless even before people knew of Marconi. A complete description, revised by Dr. Tesla himself, of this unique and ultra-powerful radio plant was given in the March, 1916, issue of THE ELECTRICAL EXPERIMENTER. Everyone interested in the study of high frequency currents should not fail to study that discourse as it contains the theory of how this master electrician proposed to charge this lofty antenna with thousands of kilowatts of high frequency electrical energy, then to radiate it thru the earth and run ships, factories and street cars with "wireless power."



Two Views of the Last Minutes of Tesla's Gigantic Radio Tower at Shoreham, L. I., New York, As It Was Being Demolished by the Federal Government. It Was Suspected That German Spies Were Using the Tower for Radio-Communication Purposes. It Stood 185 Feet Above the Ground and Cost About $200,000. Tesla Had Not Used It For Several Years.
Photos by American Press Association

Most of our readers have, no doubt, read about the famous Tesla wireless tower, which structure involved the expenditure of a vast sum of money and engineering talent. From this lofty structure, which was designed some 20 years ago by Dr. Tesla and his associates, there was to be propagated an electric wave of such intensity that it could charge the earth to such a potential that the effect of the wave or charge could be felt in the utmost confines of the globe.

Further, it may be said that Tesla, all in all, does not believe in the modern Hertzian wave theory of wireless transmission at all. Several other engineers of note have also gone on record as stating their belief to be in accordance with Dr. Tesla's. More wonderful still is the fact that this scientist promulgated his basic theory of *earth current* transmission a great many years ago in some of his patents and other publications. Briefly explained, the Tesla theory is that a wireless tower, such as that here illustrated and specially constructed to have a high capacity, acts as a huge electric condenser. This is charged by a suitable high frequency, high voltage apparatus and a current is discharged into the earth periodically and in the form of a high frequency alternating wave. The electric wave is then supposed to travel thru the earth along its surface shell and in turn to manifest its presence at any point where there might be erected a similar high capacity tower to that above described.

A simple analogy to this action is the following: Take a hollow spherical chamber filled with a liquid, such as water; and then, at two diametrically opposite points, let us place, respectively, a small piston pump, such as a bicycle pump, and an indicator, such as a pressure gage. Now, if we suck some of the water into the pump and force it back into the ball by pushing on the piston handle, this change in pressure will be indicated on the gage secured to the opposite side of the sphere. In this way the Tesla earth currents are supposed to act.

The patents of Dr. Tesla are basically quite different from those of Marconi and others in the wireless telegraphic field. In the nature of things this would be expected to be the case, as Tesla believes and has designed apparatus intended for the *transmission of large amounts of electrical energy*, while the energy received in the transmission of intelligence wirelessly amounts to but a few millionths of an ampere in most cases by the time the current so transmitted has been picked up a thousand miles away. In the Hertzian wave system, as it has been explained and believed in, the energy is transmitted with a very large loss to the receptor by electro-magnetic waves which pass out laterally from the transmitting wire into space. In Tesla's system the energy radiated is not used, but the current is led to earth and to an elevated terminal, while the energy is transmitted by a process of *conduction*. That is, the earth receives a large number of powerful high frequency electric shocks every second, and these act the same as the pump piston in the analogy.

Quoting from one of Tesla's early patents on this point: "It is to be noted that the phenomenon here involved in the transmission of electrical energy is one of *true conduction* and is not to be confounded with the phenomena of *electrical radiation*, which have heretofore been observed, and which, from the very nature and mode of propagation, would render practically impossible the transmission of any appreciable amount of energy to such distances as are of practical importance."

"Our Navy" On The Stage

By GEORGE HOLMES

THE electrical engineer who was artist and dreamer as well, has again outdone the common-place. A spectacular theatrical effect is now playing in New York, which besides giving further publicity to "Our Navy," bids fair to rival Uncle Sam's big fleet in awe-inspiring and realistic thrill. Electricity plays the master rôle in this wonderful spectacle, which has become the talk of Broadway.

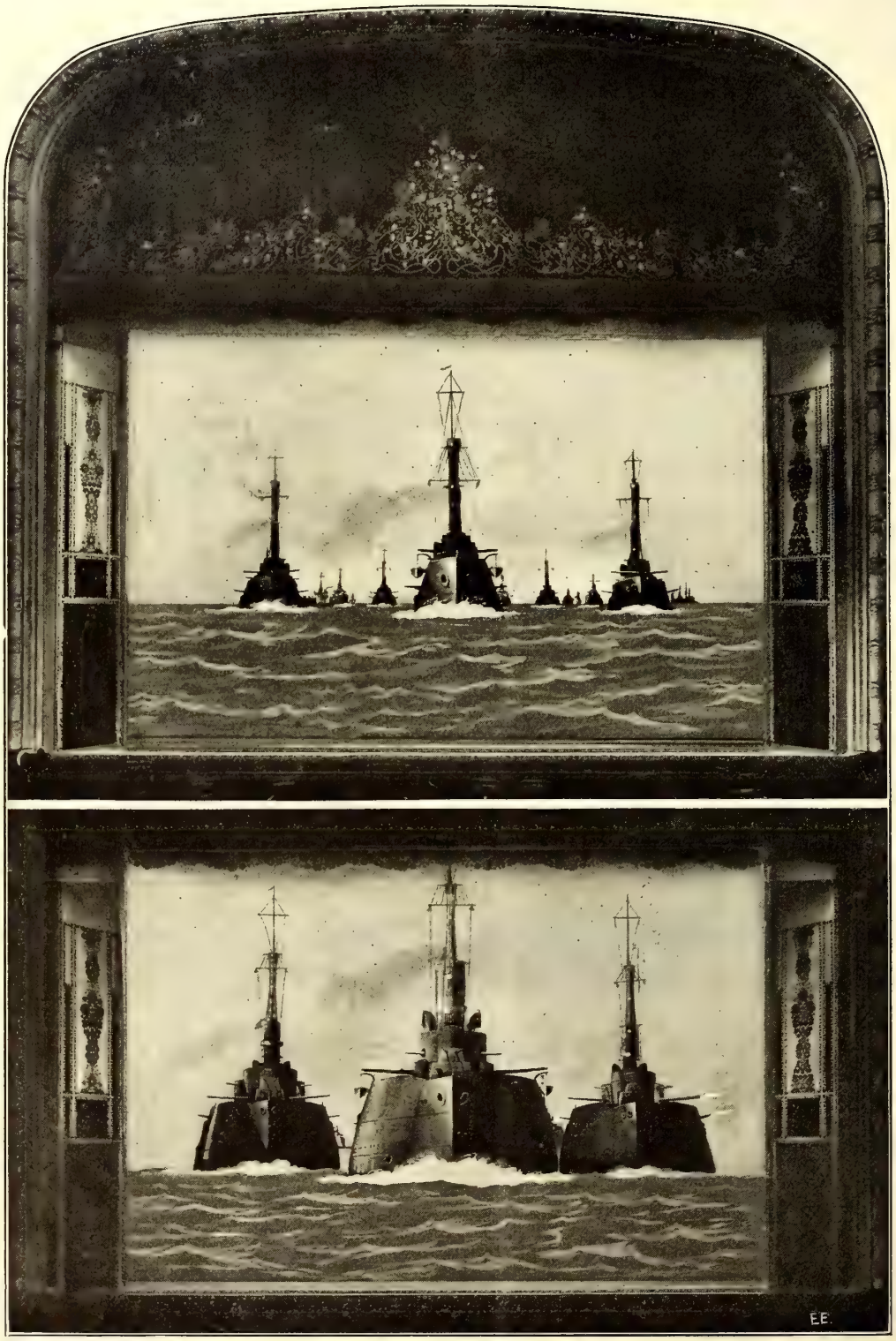
At the rise of the curtain we see a golden sunset with the sun slowly sinking in the west and night gradually approaching. With a hush we watch a fleet of war ships in battle formation steaming toward us on the distant horizon. They gradually draw nearer, increasing to three times their original (or life) size, and as they get immediately before us, we get a sensation as if the ships are going to bear down upon us. This realistic illusion is based upon the scientific principle of perspective; *viz.*, the further away an observer is from an object the smaller it appears to the eye; and that every particle of the object's contour increases in exact proportion as it enlarges in approach.

Each ship is electrically operated and controlled by a single operator, who manipulates the numerous and various devices by means of switches, push buttons and rheostats, all of which are located on a massive switchboard on the rear of each ship.

The motive power under the control of each operator is supplied by two large electric motors which are connected to the various parts of the apparatus by gears, belts and chains, thus enabling the ships to appear to travel slow or faster in their approach as desired. Each ship has its own set of motors, belts, chains and gears. An electrically heated boiler furnishes steam for the smoke stacks. The cannon are fired by electricity, the signal lights blink, searchlights play across the horizon and on "Old Glory," making a truly inspiring and lasting impression upon the audience.

The inventor of this magnificent spectacle is Langdon McCormick, and the whole apparatus was built in his New York studios, where other similar theatrical sensations like "The Honeymoon Express" and "The Forest Fire" were conceived and produced —proving that this genius accepts the stage as having no limitations. All in all it is probably the most complex and true to nature theatrical effect ever produced on any continent.

A few more electrically operated spectacles like this one would seem a big national stimulus toward recruiting. Who can sit and witness such a stirring scene without feeling the red-blooded desire to be up and doing something patriotic, even to buying *Liberty Bonds*.



New York Stage Producers Have Outdone Themselves In Evolving the Great Marine Spectacle "Our Navy." By the Aid of Electricity These Warships Are Made to Grow Larger and Larger; the Guns Boom, Searchlights Flash and Even the Smoke Is Not Forgotten.

LIGHT FROM THE FISHES?

Long strides are being taken by the biological department of Princeton University to obtain light without heat. If the discovery fully realizes its expectations it will doubtless revolutionize modern lighting. Professors Edwin Conklin, Ulric Dahlgren and Edmund N. Harvey are working on luminous animals in an attempt to fathom the cause of their luminosity, which is 99 per cent light. Modern electric light produces only from 2% to 3% light, the rest being wasted in heat.

Professor Harvey obtained a considerable quantity of the luminous material from small fish found in Japan. He has partly analyzed the substance, finding that like the proteids of the living bodies it can be kept for years by drying it and sealing it in vacuum tubes. When released, moistened and exposed to oxygen it will light into a clear, bluish phosphorescent flame.

The substance is very powerful, as it is still visible when one part of it is diluted in 1,700,000 parts of water.

SQUIRTED TUNGSTEN FILAMENTS.

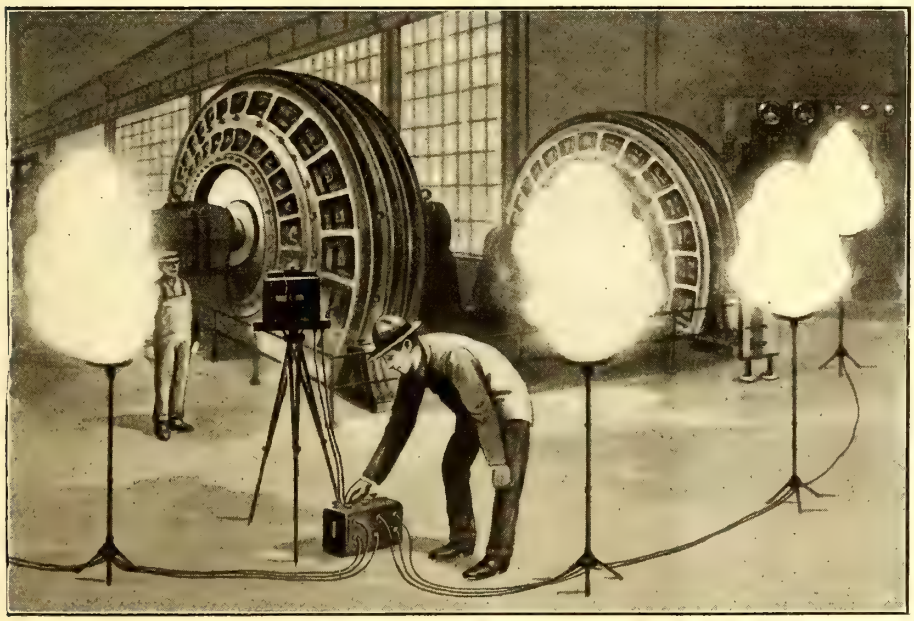
Some interesting particulars of a peculiar method of preparing tungsten filaments, which are ductile in spite of being squirted, are cited in *Engineering*, London.

The process, which was described by Dr. W. Böttyer before the December meeting of the Bunsen Gesellschaft, is employed by Julius Pintsch, and is due to Messrs. O. Schaller and Orbig. Members of the society were able to watch the process in the works after the meeting. The metallic powder is mixed with 2 per cent. of thoria and kneaded into a paste with addition of some binding agent; a thread is then squirted. The thread is first pre-heated and then rapidly heated up to 2,400° C. or 2,600° C., the object being to make the crystallization of the metal more rapid than the passage of the wire thru the hot zone. The first apparatus used for this delicate operation had the dimensions of several meters; the actual apparatus is only a few centimeters in height. The resulting wire is said to consist of crystals several meters in length, tho only a few hundredths of a millimeter in thickness, the cross-section of the wire comes out octagonel rather than circular. There are very few joints in a wire. A re-crystallization of the filament after long-continued use of the lamp is said not to occur.

ELECTRICITY OPERATES PANORAMA CAMERA AND FLASH-LIGHTS AUTOMATICALLY.

The accompanying illustration shows a novel idea recently evolved by a New York inventor, Mr. George Wall, by which it becomes possible, thanks to the flexibility of electrical control, to take large photographs, particularly those of a panoramic nature inside buildings, such as power houses, etc. A small battery box which can be carried by the photographer supplies the small quantity of electrical energy necessary in igniting the flashlight powder, which is placed in proper containers on a series of telescopic flashlight stands. The electric panoramic camera is specially designed, so that once the photographer has it focust to take in the proper view as it swings about on its tripod, propelled by means of special gears and a miniature electric motor (operated from the battery before mentioned), it causes a movable contact drum to close the individual circuits to the various electric flashlight stands progressively, as the camera turns to take in the complete view.

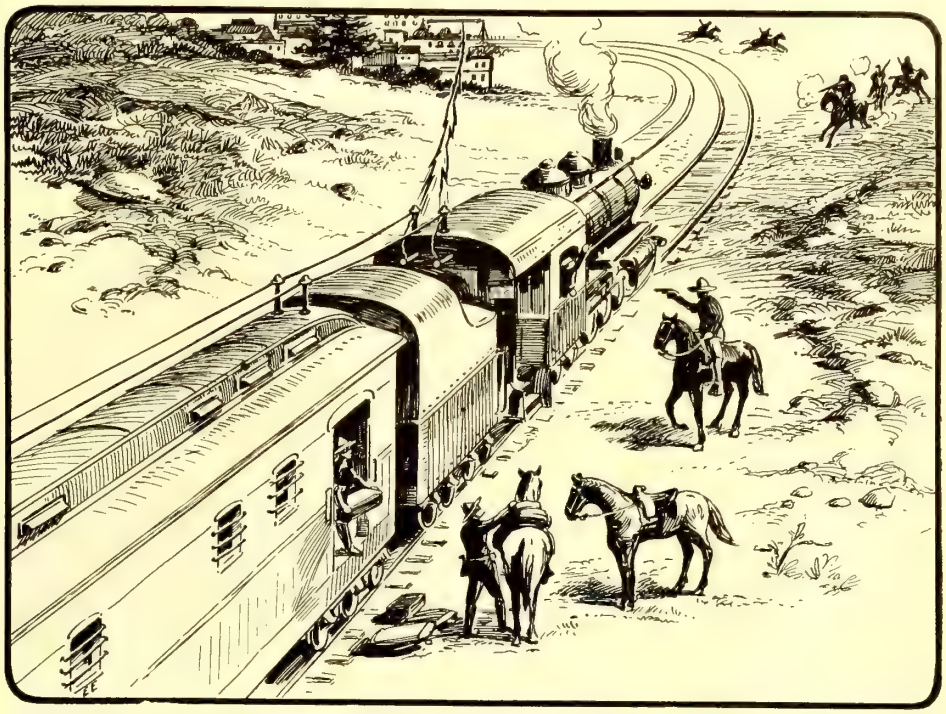
This arrangement should prove extremely practical and of great service to commercial photographers who are confronted with the problem of photographing large interiors, machinery, etc., which are often extremely difficult to handle with ordinary cameras. With Mr. Wall's invention properly applied, the panorama camera swings around the circle for the number of degrees desired, and lights up each part of the scene progressively as it turns; thus giving a very uniformly illuminated picture, which is very difficult to obtain with the usual style of concentrated flash where the magnesium powder is ignited all in one spot or in two or three spots.



A New Photographic Scheme Involving the Application of Electricity to Rotate a Panorama Camera and to Ignite a Series of Flash-Lights Successively and At the Proper Instant. In This Way an Even Illumination of the Scene Is Assured.

FOILING THE TRAIN ROBBER WITH RADIO.

A number of American railroads have experimented with wireless installations on moving trains and exceptional results have been obtained in many instances, the messages having been transmitted over distances of 75 to 100 miles from the train while in motion. These considerations have led a New York genius, Mr. George Wall, to suggest that all trains traversing barren parts of the country such as the prairies of the West and Southwest be provided with wireless apparatus particularly for use in summoning police aid in the event of being held up by train robbers.



Now That Wireless From Moving Trains Has Been Demonstrated As Practical, We May Expect to Read In Future Train Robbery Accounts That the Brave and Heroic Radio Operator Stuck to His Post Until His Frantic Distress Signals Brought the Police.

Albeit, this is not such a far-fetched idea at that, as we read quite often of a train being held up, even in this latter age of enlightenment and civilization. As the unsettled regions of the country are becoming rapidly populated, at least to a fair extent, and as mounted police are to be found at relatively short distances in practically every part of the United States, the suggestion seems very logical, and undoubtedly when the present war situation has past away, the leading railroads will foresee the distinct advantages and facilities provided by installing radio-telegraphic sets on all trains passing thru unsettled parts of the country.

Not only will the radio prove exceptionally valuable in many such instances as that here illustrated, but it has already proven of extreme efficacy in the handling of trains. It may in this way often be the means of averting a serious train wreck, especially when severe storms have caused bad washouts along the line and dismantled the telegraphic and telephone wires. One eastern railroad, the Delaware, Lackawanna and Western, has tried out a wireless train installation with excellent satisfaction, and found it of great practical use in the dispatching of trains during the winter months, when severe storms had demolished part of the communication lines.

All Aboard for "Luna's" Electric Top

ONE of the largest and most interesting rides ever constructed at Coney Island, New York's famous pleasure park, is "The Top," which is one of Luna's latest amusement devices. It is an immense structure, seventy-five feet in diameter and eighty feet high, and follows closely the design of an ordinary spinning top. There are two sets of tracks, one on the outer and the other on the inner rim, with the cars operated by a third-rail system. The entire ride covers nearly one mile. Forty-five tons of steel were used in the construction, and the ride in its finished condition, with equipment, carries fifty tons, all of which rests upon a solid concrete foundation.



Coney Island, New York's Supreme Play-Ground for Grown-Ups and Youngsters Alike, Now Boasts Something Real New In Amusement Devices. You Board a Small Car and Before You Know It You Are Whirling Around the Spiral Track of "The Top," As Luna Calls It. This Gigantic Electric "Top," 80 Feet High By 75 Feet In Diameter Rotates at a Speed of 25 Miles Per Hour.

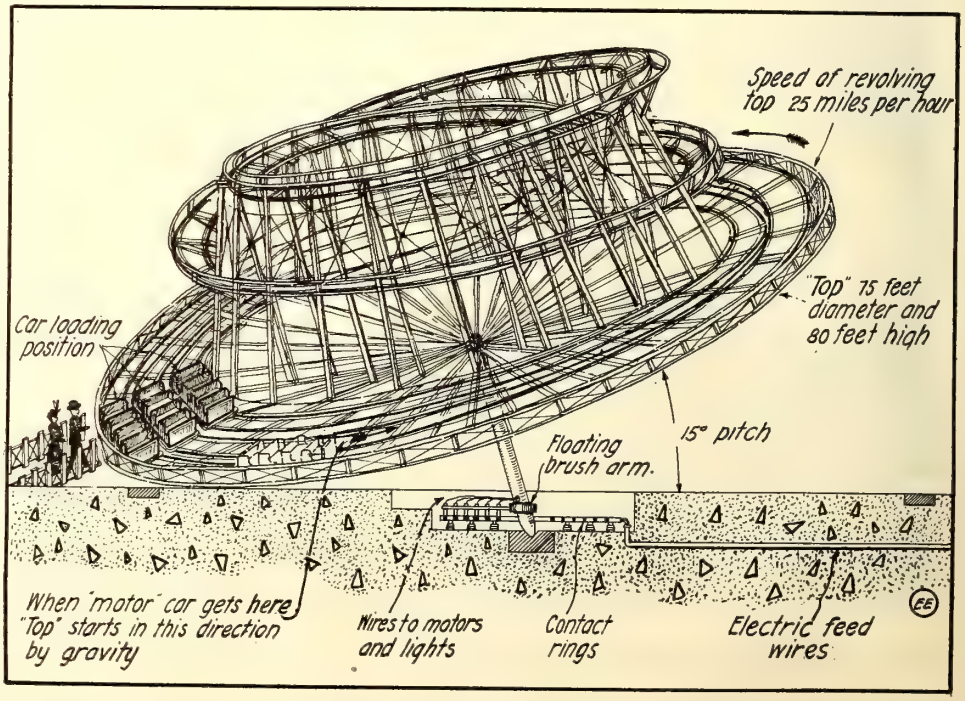
It is an electrical achievement which has been accomplisht after several years of study and experimenting. One of the greatest problems that has been solved is the transmission of current to the wheel which is revolving on a shaft resting in a pivot socket, as shown in the drawing, while the shaft is at all times resting at an angle of about 15 degrees from the horizontal. The lighting and operating current is transmitted from the socket pit by means of stationary contact rings and a floating brush arm carried on the shaft. The necessary electric current for the motor car and lamps (night illumination) is thus conveyed thru the revolving brush arm and brushes.

No great electrical driving force is required, as the shifting weight of the motor cars on the outside rim drives forward, by gravity, the cars (without motors) on the inner rim up an incline to a height of thirty feet.

Four motors, each of seven and one-half horse power, are used in the operating. These are fitted to the motor car running on the outer rim. In loading position the "top" is so designed that all three passenger cars are on the lowest level of each of the three independent tracks, and all in line before the gate. Passengers may thus pass thru the first car to the second and third cars. The two inner cars are always slightly behind the (outer) motor car when the "top" is running.

The passengers in the inner cars enjoy the most sensations, rising and falling as the "top" whirls around. The outer motor car keeps at an average elevation of 15 feet above the ground, but owing to the track (and "top") continually rolling, the motor and other cars eventually swing around a complete circle. The "top" has to make fifteen complete revolutions for a "ride", so as to bring all the cars back to the lowest track levels and in line before the gate.

Luna Park has augmented its brilliancy by the addition of thirty-two posts, each with five three hundred watt lamps. Placed at equal distances apart and in the center of the main concourse, they have brightened the entire park. The concourse is now known as Luna's White Way.



Illustrating In Detail How Luna's Wonderful Electric "Top" Is Operated. Its Central Shaft Rests On a Cone Bearing and the Climbing Movement of the Outer Motor-Car Causes the Whole Structure to "Roll" Around, Propelling the Inner Cars By Gravity Alone.

EXTENSION TO C., M. & ST. PAUL RAILWAY ELECTRIFICATION PROGRESSING.

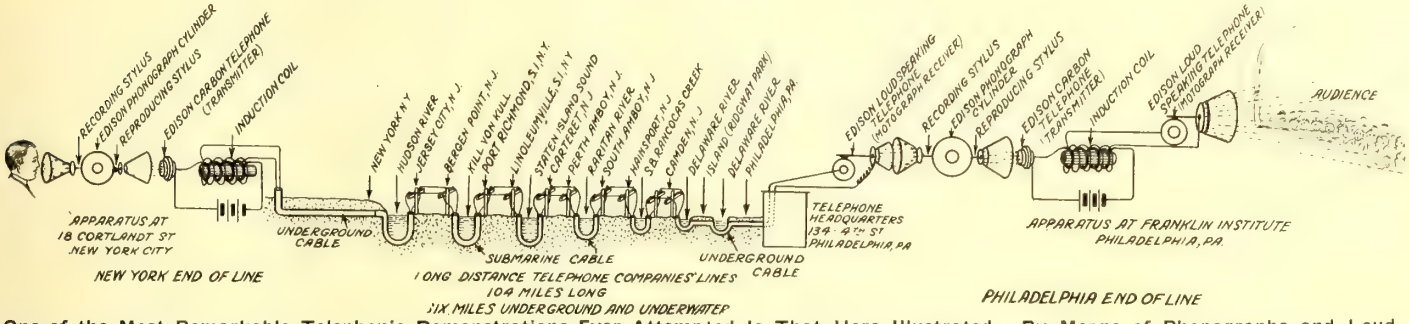
That part of the Chicago, Milwaukee & St. Paul Railroad between Harlowton, Mont., and Avery, Idaho, a distance of 437 miles, is now being operated as an electric line. Electric power is supplied by various plants of the Montana Power Company, the largest two of these being at Great Falls, Mont., and Thompson Falls, Idaho. The first electric train was moved in December, 1915, and the last steam-operated train was taken off the Missoula division in February, 1917. On that division is the St. Paul Pass tunnel, which cuts thru the summit of the Bitter Root mountain range near the Montana-Idaho line, and has a length of 8,000 ft.

The work of electrifying another division, of 217 miles, began about May 16, 1917. The starting point is at Othello, 100 miles east of Cle Elum, and electrification will proceed westerly to Seattle and Tacoma. Power will be furnished by the Intermountain Power Company. It is figured that the work will be completed between Cle Elum and Seattle and Tacoma before the close of 1918.

JACK BINNS ENLISTS IN BRITISH ARMY.

Prominent among the applicants answering the call for British recruits in America, was Jack Binns, the wireless operator, whose messages from the liner Republic on Jan. 23, 1909, brought rescue ships after she had been rammed by a freighter. Jack gave up the sea soon after the sinking of the Republic and took up newspaper work. Binns is thirty-two, married and has two children. He was injured in a train wreck and could claim exemption, but would not.

Transmitting Sound by Phonograph and Telephone 104 Miles, Thru 48 Physical Changes



One of the Most Remarkable Telephonic Demonstrations Ever Attempted Is That Here Illustrated. By Means of Phonographs and Loud-speaking Telephones the Human Voice Was Transmitted Thru a Series of 48 Physical Changes, 15 Different Mediums and Thru the Air 5 Times, Between New York and Philadelphia. Mr. Hammer, Who Engineered This Stunt, Was Awarded the "Franklin Medal" in Honor of the Occasion.

SOME years ago when telephony was still quite a youngster, one of the most interesting and remarkable scientific demonstrations involving several of Thomas A. Edison's great inventions, including the phonograph, were demonstrated by a New York Electrical Engineer, Mr. William J. Hammer.

Mr. Edison was very highly pleased with this really beautiful piece of engineering and scientific technique, which not only seemed impossible of accomplishment by the leading telephone engineers of the day, but which also retained and involved the demonstration of several Edison inventions.

This remarkable experiment in the phonographic and telephonic transmission of sound took place between New York and Philadelphia, over 104 miles of telephone cables, six miles of which were under ground and under water, as the illustration here shown clearly indicates. This novel experiment was shown by Mr. Hammer in his lecture on "Edison and His Inventions," delivered before the Franklin Institute at Philadelphia. It employed two Edison phonographs, two Edison carbon transmitting telephones, two Edison motograph receivers or loud-speaking telephones, two sets of induction coils and batteries and 104 miles of long-distance telephone circuit as before mentioned; 98 miles of this circuit consisting of wire strung on poles.

In this experiment in which three of Mr. Edison's wonderful inventions were shown working in juxtaposition, it will be observed that the sounds, which consisted of talking, singing and cornet playing, were transmitted thru the air *five times* and were transmitted thru no less than *fifteen distinct mediums,* from the speaker and musician in New York to the audience in the Franklin Institute in Philadelphia.

These mediums included vocal chords, cornet, air, glass, iron and mica diaframs, carbon buttons, styli of steel, palladium-faced pens or springs, hydrogen gas, distilled water, wax and chalk cylinders, copper wire and the mechanism of the ear.

The physical characteristics of the sound waves were changed during transmission no less than 48 *times,* as follows: (1) Air waves produced by vibration of the vocal chords in the speaker's throat or by the cornet. (2) Vibration of the glass diafram of the phonograph recorder, producing variations in curvature of the diafram. (3) Variation in longitudinal stress of the steel stylus attached to glass recording diafram. (4) Undulations in the wax cylinder of the phonograph. (5) Variation in the longitudinal stress of the steel stylus attached to diafram of phonograph reproducer. (6) Vibration of the glass diafram of the phonograph reproducer producing variations in curvature of diafram. (7) Sound waves thru the air. (8) Vibrations of the iron diafram of the carbon transmitter producing variations in curvature of the diafram. (9) Varying pressures on the carbon button, varying the resistance of the carbon exactly in accordance with the number and amplitude of the vibrations of the diafram. (10) Pulsatory current produced in the primary winding of the induction coil. (11) Undulating magnetic force produced in the iron core of the coil. (12) Alternating electric currents in secondary winding of the coil. (13) Minute Eddy currents appearing in copper wires of the primary and secondary windings of coil and in the iron core of the coil. (14) Heat produced by Eddy currents. (15) Magnetic hysteresis in iron core formed in overcoming molecular friction in the iron caused by reversals of polarity. (16) Heat produced by hysteresis in iron. (17) Infinitesimal variation in length of iron core due to magnetizing currents. (18) Moving electro-static flux on the line accompanied by or producing electromagnetic flux around the wire. (19) Heat produced by passage of electric current thru the wire. (20) Variation of the coefficient of friction between the surface of chalk cylinder and palladium-faced pen or spring of the motograph receiver. (21) Electrolytic action, causing evolution of hydrogen and oxygen between the chalk cylinder and palladium-faced spring of the motograph receiver. (22) Electro-capillary action, forcing moisture to the surface of the chalk cylinder of motograph receiver. (23) Variation in longitudinal stress of bar or spring attached to mica diafram of the motograph receiver. (24) Vibration of the diafram of motograph receiver producing variations in curvature of the diafram. (25) Sound waves thru the air. (26) Vibrations of glass diafram of phonograph transmitter producing variations in curvature of diafram. (27) Variation in longitudinal stress of steel stylus attached to glass transmitting diafram. (28) Undulations in wax cylinder of the phonograph. (29) Variations in longitudinal stress of steel stylus attached to glass reproducing diafram. (30) Sound waves thru the air. (31) Vibrations of iron diafram of carbon transmitter, producing variation of curvature of iron diafram. (32) Varying pressure on carbon button, varying the resistance of the carbon exactly in accordance with the number and amplitude of the vibrations of the diafram. (33) Pulsatory current produced in the primary winding of the induction coil. (34) Undulating magnetic force in the iron core of the coil. (35) Alternating electric current in secondary winding of the coil. (36) Minute Eddy currents, appearing in copper wires of the primary and secondary windings of coil and in the iron core of the coil. (37) Heat produced by Eddy currents. (38) Magnetic hysteresis in iron core formed in overcoming molecular friction in the iron by reversal of polarity. (39) Heat produced by hysteresis. (40) Infinitesimal variation in length of iron core due to magnetizing currents. (41) Moving electrostatic flux on the line accompanied by or producing electromagnetic flux around the wire. (42) Variation of the coefficient of friction between the surfaces of chalk cylinder and palladium-faced pen or spring of the motograph receiver. (43) Electrolytic action causing evolution of hydrogen and oxygen between the chalk cylinder and palladium-faced spring of the motograph receiver. (44) Electro-capillary action forcing moisture to the surface of the chalk cylinder of the motograph receiver. (45) Variation in longitudinal stress of bar or spring attached to mica diafram of the motograph receiver. (46) Vibration of the diafram of the motograph receiver producing variations in curvature of the diafram. (47) Sound waves thru the air. (48) Translation of sound waves into words by the auditory nerves and other mechanism of the ears of the audience at Philadelphia. By means of transmitters placed upon the stage, the lecture was listened to by audiences in fourteen different cities.

THE FRANKLIN MEDAL AWARDS.

The Franklin Medal, which is awarded annually by the Franklin Institute, Philadelphia, Pa., to "those workers in physical science or technology, without regard to country, whose efforts, in the opinion of the Institute, have done most to advance a knowledge of physical science or its applications," were awarded May 16 to Hendrik Antoon Lorentz, president of Royal Academy of Science, Amsterdam, and professor of mathematical physics, University of Leyden, in recognition of his "researches which have so largely contributed to laying on a new foundation our knowledge of the nature of light and in developing our ideas concerning the ultimate constitution of matter"; also to David Watson Taylor, chief constructor and chief of Bureau of Construction and Repair, United States Navy, in recognition of his "fundamental contributions to the theory of ship resistance and screw propulsion, and of his signal success in the application of current theory to the practical design of varied types of war vessels in the United States Navy."

Electric "Bloodhounds" to Find and Destroy U-Boats

By H. GERNSBACK and H. W. SECOR

NO one will deny the fact that the modern U-boat owes its deadliness to its invisibility. The submarine operates upon the time-old principle of waylaying its quarry, hidden in the dark from the view of its victim. The victim, unsuspecting of the waylayer is stabbed in the back, at the opportune moment when the bandit feels himself safe from counter attack.

Were the U-boat to operate in a perfectly transparent medium—such as the air for instance—we would not have much trouble in hunting it down soon. It is plain that we could then go after it with our own submarines, or on the other hand, merchant steamers would see the U-boat long before it could fire a torpedo, and in such a case the ship could be maneuvered quickly, making a torpedo hit unlikely.

Unfortunately water is far from transparent. To all practical purposes it is as opaque as a brick wall. Therefore, inventors who are apt to fight submarines — on paper—by means of powerful submerged searchlights should do well to remember that even the strongest light rays do not penetrate the ocean more than 300 feet at a depth of 25 feet below sea level.

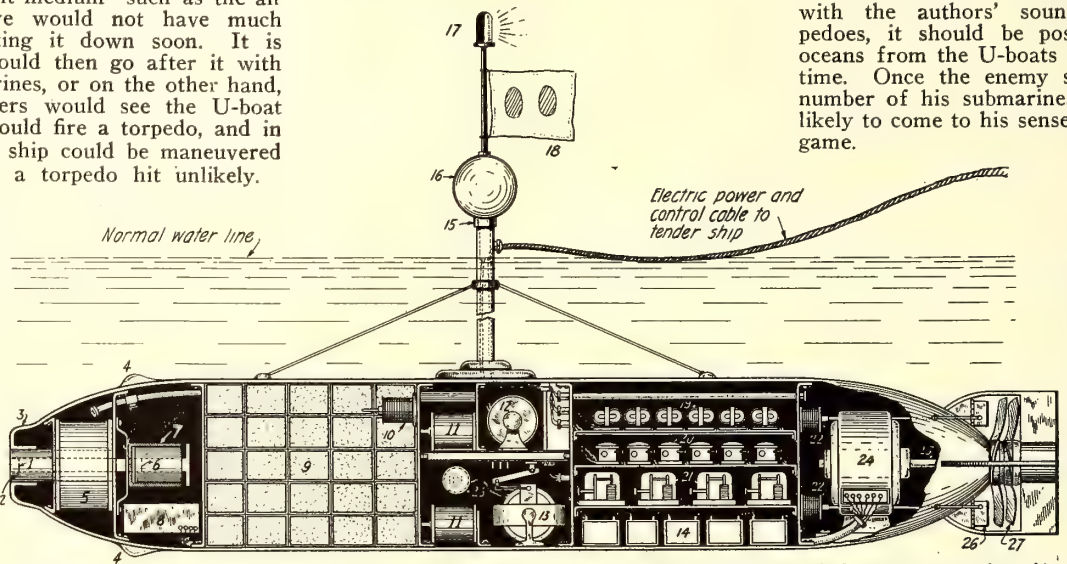
Coming back to our analogy of the bandit, everyone knows that while our own senses are more or less imperfect, this is not the case of the senses of certain animals. Thus if you fear an attack on a lonely road, you probably would take along a good dog if you owned one, reasoning that the dog would smell and hear the bandit in time and thus warn you. Also the dog would probably show you the direction in which the waylayer is located, and if you were armed, you could "go for the bandit." All this irrespective if it was in bright sunlight or on a dark night.

Applying this reasoning to the present submarine war, we find that if we can design the mechanical counterpart of a real bloodhound, the invulnerability of the U-boat, *i.e.*, its invisibility, will be wiped out.

With this in mind the authors have devised an electro-mechanical "bloodhound" which functions upon the same principle as his live brother on land. While the live bloodhound is mainly guided by his hearing and by his smell, the authors' machine operates only by "hearing."

Briefly, the idea consists of equipping a standard torpedo with a number of supersensitive microphones, which are provided with certain *tone-filters*, well known to electrical engineers. Now, a submarine must run its electric motors when running under water, and these motors of necessity make quite a good deal of noise. In fact, the sound of submarines has been detected with *microphone-audion* units for over 20 miles. This is a well established fact.

While on the other hand we have it on good authority that of late German U-boats mount their motors on felt and other sound deadening substances, the fact remains that the sound of a 600 horsepower electrical motor of a submarine cannot be deadened entirely. Then too—and this will be a surprise to the layman—sound travels much better and farther in water than in the air. (If you don't think so, next time you are in your bath tub, submerge both ears in the water and slightly rub two fingers together, under the water, of course. You will be surprised how well you can hear the slightest noises.) Therefore, even if the enemy submarine muffles its motors, we will still be able to hear the U-boat machinery over a distance of several miles.



1-Brass rod. 2-Iron. 3-Bronze or gun-metal shell tip. 4-Microphone. 5-Powerful holding magnet. 6-Iron core. 7-Telegraphing magnet. 8-Induction balance apparatus. 9-Explosive chamber. 10-Electric detonator. 11-Diving plane control solenoids. 12-Cable drum. 13-Electric Gyroscope. 14-Batteries. 15-Auto. release. 16-Ball float. 17-Pilot lamp. 18-Position flag. 19-Solenoid control relays etc. 20-H. Res. sensitive relays. 21-Amplifiers. 22-Rudder control solenoid. 23-Microphone. 24-Motor. 25-Shaft. 26-Rudders. 27-Propellers.

Fig. 1

Hunting the submarine in its own lair by an electro-mechanical "bloodhound" is proposed in this interesting article. The idea is to steer a torpedo by the sound of the submarine propellers. Certain sensitive microphones on the torpedo cause the latter to "go for" the U-boat and blow it up.

And that is all we require.

Our electro-mechanical "bloodhound" then, thanks to his electric brain and his electric motors, will start at once in the direction of the U-boat, as soon as he picks up its noise. Just as his live brother, he will then guide us to the invisible enemy as certain as fate.

And like the flesh and blood dog, the electric "bloodhound" guides us by a rope. In this case the rope is an electrical cable thru which the current passes to drive its propelling motors. The cable contains other wires, too, as will become apparent later. The cable itself runs to the fast motor boat chaser, which we own already, but which are rather ineffective today, due to their blindness; i. e., they can neither see nor smell submerged U-boats. Given a hundred submarine motor boat chasers equipt with the authors' sound-controlled torpedoes, it should be possible to rid the oceans from the U-boats in a few months' time. Once the enemy sees that a large number of his submarines are sunk, he is likely to come to his senses and give up the game.

Now, the authors, who have carefully gone into all of the details, find that the idea is entirely practical and feasible. For obvious reasons, not all of the details and refinements are made public at this time, and this article is published with a view of setting other able workers to think along similar lines.

It is thought that even if the enemy should become aware of the plan, no harm would be done, because there does not seem to be a defense against the proposed scheme. Also by publishing the idea thousands of people will become interested in it with the very great possibility that the device will be greatly improved upon in a short time.

It should be remembered that the electric "bloodhound" contains no startling new apparatus or machines, nor is it based upon mere theories or untried ideas. It makes use of certain well-known apparatus and devices, the only new thing being in their application and disposition. Any factory turning out torpedoes now will be able to construct the new "U-Boat Killer" in short order.

It should also be borne in mind that this idea does not depend entirely upon the principle of the microphones "hearing" the hum of the motors alone. The Germans might in time make their motors entirely noiseless — altho the authors very much doubt that it can be done. There remains the very loud sound of the propellers churning the water. And this cannot be suppressed by any possible means, unless the U-boat lies perfectly still, and a U-boat can't always lie perfectly still; it must move some time. Then, too, during the night it is forced to come up to the surface, running its Diesel oil engines in order to charge the storage batteries. And it is

(*Continued on page* 347)

The Sob of the Sub.

By Ed. Schultz.

Ten ambitious submarines
Splashing through the brine;
One, alas, went out of gas,
Which left together nine.

Nine aspiring submarines
Thrust themselves to fate;
One dove steep, in fact too deep;
Their number then was eight.

Eight aggressive submarines
Seeking for a haven;
One, take note, refused to float,
Which made their total seven.

Seven alert submarines
The enemy went to "fix";
They all went fine, till a floating mine
Reduced the fleet to six.

Six defying submarines
Ready for the strife;
They then took count, but quickly found
That really they were five.

Five evading submarines
Skilled in ocean lore;
All went well, till an en'my shell
Diminished them to four.

Four determined submarines
Terrorized the sea;
Their reign was brief, for a hidden reef
Curtailed the group to three.

Three desperate submarines
Beneath the ocean blue;
While there, a net made them regret,
Because it left but two.

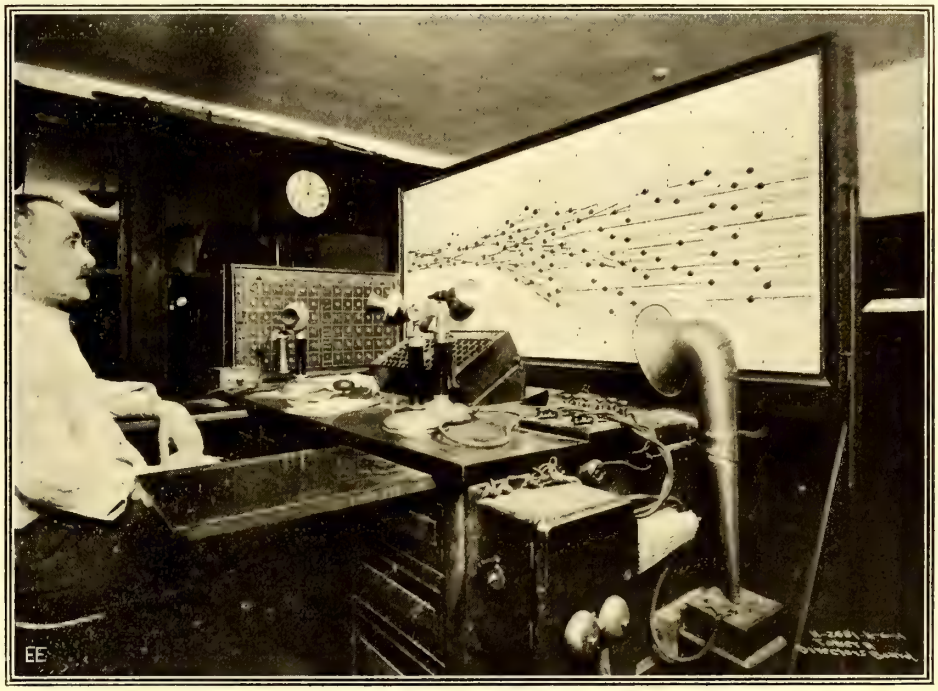
Two dejected submarines
Their voyage nearly done;
One 'tis plain was rammed in twain,
For now remained but one.

One remorseful submarine
To a neutral port came near;
It there sojourned till 'twas interned,
Which left the high seas clear.

Electric Tally-Board Shows Positions of Trains Constantly

Do you ever stop to think, as you go speeding over the clicking rails, of the large forces of men and the numerous devices and appliances that watch your trip day and night that you may reach your destination safely? Perhaps few of us give much thought to this all-important matter. We are either engrost in business, or watching the scenery, and seldom give a second's consideration to the large corps of men located in many isolated towers along our journey watching the speeding trains with a guiding hand, always with the watchword "safety first" in mind.

Practically all of the large roads have within the last few years greatly increased the number of appliances which tend to safeguard the public and at the same time eliminate the human factor as a figure in accidents, making every mile of the road always visible to the dispatchers. In the accompanying photographs may be seen views of the large electric tally-boards in the dispatchers' offices on a great eastern road. These boards show the position of all trains over the section covered by that particular office, by means of little lights which automatically flash, and go out as the train advances from one *block* section to another. In addition to this new device, the dispatcher has also the telegraph and telephone to aid him. In this way it is indeed rare that collisions occur, as the man in the tower or dispatcher's office knows just where every train is located constantly.



A Tower Director at the "Grand Central" Terminal, New York City, with His Elaborate Electrical Aide-de-Camp. The Various Lamps Show the Progress of Trains, Confirmed by Telegraph, Telephone and Telautograph.



© Photo by American Press Association

The Twentieth Century Railroad Tower Director Is a Very Important Personage Indeed. To Facilitate the Accurate Handling of Trains in Complicated Terminal Yards, Electrical Tally-boards Are Provided Which Show the Exact Position of Every Train by Means of Lamps.

STEEL FOR ELECTRICAL TRANSMISSION.

In a recent paper, read at a joint meeting of the American Institute of Electrical Engineers and the Association of Iron and Steel Engineers, Mr. H. B. Dwight emphasises the utility of steel cables for transmission purposes on branch lines, especially in cases where the size of copper strictly required to meet the load would be too small for use in practise. For alternating currents the resistance of a steel cable is considerably greater than for direct current, owing to the skin effect. In copper or aluminum conductors the latter is negligible, increasing the resistance by at most 1 to 2 per cent., but at high frequencies the apparent resistance of steel conductors may be increased by 100 per cent. or more. The losses may be kept within moderate limits by using fine strands to act as laminations, and by winding the spirals of alternate layers of wire in reverse directions.

Spy Aerials

"SPY wireless" is one of the all-absorbing topics of interest thruout the country at the present time, and quite naturally it would be, for some of the reasons which are illustrated and described herewith.

The average law-abiding citizen will probably consider that some of the devices mentioned would not serve at all for the reception or transmission of wireless messages, even over short distances of five to ten miles, but such is the case as experts well know from many experiments and tests which have been conducted in the past few years.

A simple and extremely innocent-looking flag-pole aerial might be constructed by a clever spy as shown in Fig. 1. This is nothing else but the well-known concentrated aerial of which much has been publisht in the past three years. In France the concentrated antenna consisting of a small rod or tube, a few meters in length and wound with a layer of insulated wire, has proved capable of picking up wireless messages at quite considerable distances from the Eiffel Tower Radio Station at Paris. In this country several very satisfactory experiments have been carried out with similar aerials consisting of a large number of turns of wire concentrated in a small space, notably at Union College, Schenectady, N. Y., and Atlantic City, N. J.

In preparing this article we have endeavored to show the unsuspecting public how an enemy agent may either send or receive radio messages by means of the most innocent appearing objects.

The Editors thought it best to give the article wide publicity, in order that patriotic citizens may the better apprehend possible spies, who might be using secret aerials of the types illustrated.

The article is intended for public enlightenment, as well as for the country's safety.

It is a matter of actual fact that these small concentrated aerials, which however possess considerable inductance, tho of very small dimensions, have picked up messages five hundred to one thousand miles away. In fact, it is believed that the Union College aerial, which did not measure over ten feet square, actually picked up messages from Nauen, Germany, a distance of nearly four thousand miles. Several modifications of the flag-pole antenna are possible; the layer of wire might be covered with a fiber or other sheath painted to imitate wood, etc.

Metal roofs may often be used to advantage in receiving wireless messages, and also for transmitting them over short distances as indicated by Fig. 2. If the roof is grounded by a continuous leader pipe running down into a cistern or sewer, then this pipe would have to be cut or patched up in some way, so that the metal roof would be insulated by the framework of the building, and a lead wire run from the roof or leader into the house.

Electric light wiring is one of the simplest indoor aerials which could be used by a Spy. It would usually be necessary to open the service switch so as to isolate the house wiring system, and as every electrician knows, these wires are very highly insulated and form really a very good radio aerial, in view of this excellent insulation.

Fig. 3 also shows another form of secret aerial which might be employed for carrying on nefarious radio intercourse by the Kaiser's able spies. Many houses are fitted with *metal* instead of wood lath, and the perforated steel lath plates usually overlap, presenting quite an appreciable capacity, especially when large rooms or corridors are considered.

Another interesting and possible aerial which might be imprest for service in emergency is the ordinary *gas pipe* system as illustrated in Fig. 4. It would be an easy matter for an enemy radio expert to disconnect the gas pipe at the meter in the cellar of the building, so as to isolate it, and in this way the building gas pipe system would be fairly well insulated by the wooden framework, and would serve as an antenna for the reception of messages or even for transmitting them.

Little does the washerwoman hanging up clothes on an *iron-wire clothes-line* stop to think that that very clothes-line might be serving as a medium for secret radio-communication. Such may be the case very easily (see Fig. 5), and there have been several instances already where wires very much resembling clothes-lines have been discovered on roofs of buildings which have proven to be disguised wireless antennae. One of these aerials in a large eastern city extended for several blocks, and was easily capable of picking up messages from such powerful stations as that at Nauen, Germany. If you live in the city (or even in the country) and have occasion to use a metal clothes-line of any appreciable size, it might pay you to closely scrutinize the supporting framework to see whether or not some alien enemy has been at work in an effort to use it for wireless communication purposes.

Fig. 6 illustrates two devices which the enemy might employ to carry on wireless service for quite a considerable distance. The first of these involves the use of a hidden aerial supported inside of a brick *smoke-stack*. Such an aerial might easily be quite a pretentious affair, comprising a large number of wire strands. Consider for the moment also that there are thousands of brick chimneys in various parts of the country in the neighborhood of factories and other plants, such as have been closed down, and who would want to gamble for one moment that such a stack—which might have a height of two hundred feet, as many of them have—is not harboring a secret radio aerial. City houses too can easily harbor good aerials in their chimneys and these will work irrespective of the fact that much heat goes up the flue.

Another substitute antenna which is often available on factory chimneys, as well as on private houses, is the *lightning rod*, which you and I would most probably pass by unthinkingly a thousand times, and yet that very lightning rod might be serving as a valuable link in the Teuton's espionage system. Of course the lightning rod would have to be cut at the earth so as to insulate it and the trick is done; and come to think of it, we have seen lightning rod installations which rambled over considerable areas, especially on large factories, not to mention 200 foot and 250 foot brick chimneys. Even a one-hundred-foot aerial for instance is a mighty good one, as any radio experimenter will tell you.

The *open well* could easily be used especially in the country to contain a radio aerial in a similar manner to that described in connection with chimneys. A clever Spy might even bury his lead-in wire from the apparatus in the house, and simply connect it at the well to a small wire cable, which could be substituted for the usual innocent-looking well rope, fastening a bucket to the lower end of the cable in the regular manner. When in use of course the bucket would have to be out of the water so as not to "ground" the steel cable. When this is cleverly done, we would like to know indeed of a more innocent-looking radio antenna.

Have you examined your *shade trees* closely this summer? Don't be surprised if you find a wire cleverly painted to match the bark on the tree and leading up to the various branches. It is readily possible for a persistent member of the enemy espionage squad to thus rig up a tree aerial, and it is not necessary to travel very far to find a sufficiently large tree, which would serve as a framework for several hundred feet of insulated wire.

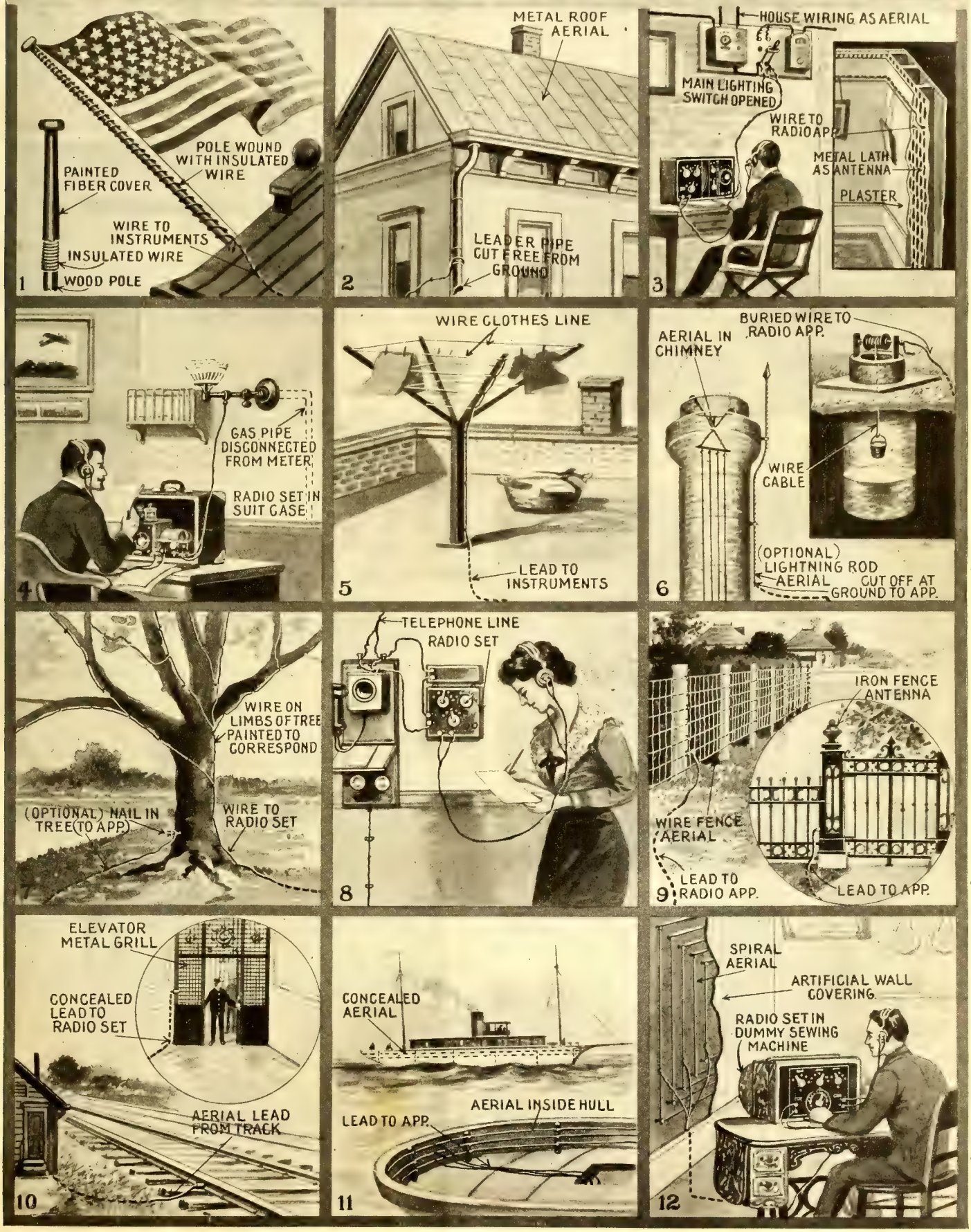
Fig. 7 illustrates this very ingenious antenna. In many instances success could be attained using the same tree as an aerial for wireless communications, but placing no wire in the tree whatever. General G. O. Squier, Chief Signal Officer, U. S. A., found in some tests made several years ago that it is readily possible to receive wireless messages over fair distances by simply driving a nail in the trunk of a tree, and thus utilizing the tree itself and its foliage as the antenna. This works surprisingly well.

Not to be outdone by all of the foregoing more or less efficient emergency aerials, wireless experts have for some time known that radio messages could be picked up over remarkable distances by properly connecting a radio receiver to existing *telegraph or telephone lines* as illustrated at Fig. 8. A Spy could readily use a pocket wireless set in this case, and chances are, he would thrive many months and even years before being detected, as naturally he would not endeavor to carry out this important experiment in the front parlor with the shades up and the lights turned on. Quite the contrary.

In Fig. 9, we see two other forms of aerials, which may be used to cover quite respectable distances, either transmitting or receiving. One of these is the ordinary *wire fence*, which may be found most anywhere and some of which are very well insulated, due to the particular construction employed, and the other possible aerial here shown is the ordinary *iron fence*, which very often is mounted on stone basepillars, so that it would be quite well insulated. These suggestions may sound a little out of place to a great many persons, but it is well to remember that several years ago, a number of tests carried out in New York City, proved that wireless messages, even from out of town stations could be picked up very easily by connecting a wireless receiving set to an ordinary *iron fire-escape* located not higher than the

(*Continued on page* 342)

"SECRET RADIO AERIALS"



(See descriptive text on opposite page.)

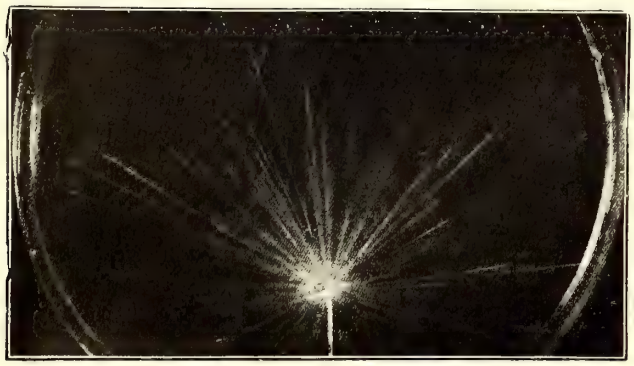
The Marvels of Radio-Activity

By JEROME S. MARCUS, B.Sc. (Ch. E.)

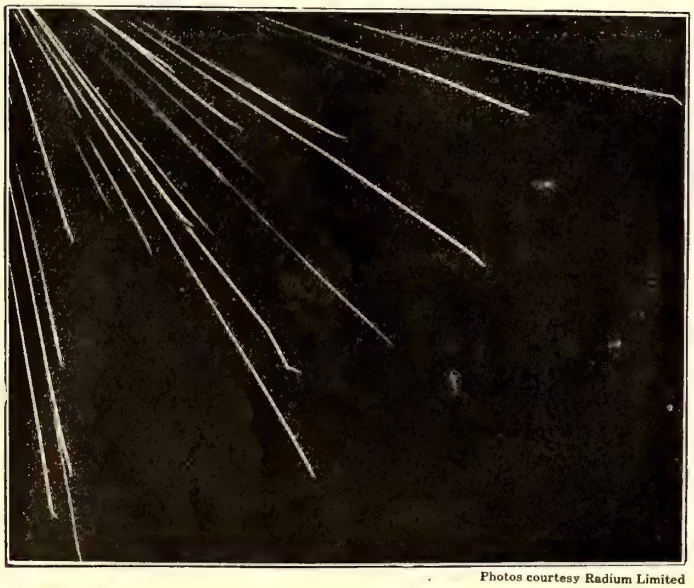
PART II.

Properties of Radium Rays

THE radiations emitted from Radium are of three distinct types known as the *alpha, beta* and *gamma* rays. Rutherford showed, in 1899, that the radiation from *uranium* was complex and consisted of (1) an easily absorbed radiation stopt by a sheet of paper or a few centimeters of air, the alpha rays, and (2) a far-more penetrating radiation capable of passing thru several centimeters of aluminum, the beta rays. Later Villard found that radium emitted a very penetrating type, the gamma ray, capable of passing thru twenty centimeters of iron and several of lead.



Formation of the Electrons of the "Alpha" Rays from a Particle of Radium. Photographic Picture by C. T. R. Wilson. Magnified 1:2, 18.



Photos courtesy Radium Limited

"Alpha" Rays of a Radium Particle as Above. Highly Magnified. The Fracture of the Rays Is Remarkable. It Is Produced by Collision of the A-corpuscles with Another Atom. The Ingenious Method of Wilson Is Based Upon the Electronic Property of the Radium Rays. In Water Vapor the Electrons Generate Condensation Droplets of Aqueous Vapor.

The Alpha Rays

The alpha rays are the most characteristic and important of the three forms of radiation. They are slightly deflected by an intense magnetic field. Some idea of the intensity may be gathered from the fact that a field which will deflect cathode rays (from a vacuum tube) in a circle of 0.1 cm. radius will turn alpha rays only in a circle of 39 cm. radius.

Before going on with our discussion of the types of rays, it would be well to interpolate an experiment on their ability to affect a photographic plate, that this phenomenon may be used later. (Experiment—A plate is well wrapt in black paper in a dark-room, and a small amount of the salt secured—as explained in the last article—placed on top. A key or other bit of metal may be placed between the salt and the paper. After about forty-eight hours the plate is developed. In all these experiments the salt used may be kept in a glass tube if care is taken to secure lead-free glass, as the Jena variety. The lead in ordinary glass will absorb a considerable number of the rays. The author took the radiograph shown in thirty hours, using two grams of *uranyl chlorid* in the bottom of a Jena beaker.)

Becquerel demonstrated the magnetic properties of the alpha rays by placing a plate with radioactive salt a short distance away in a magnetic field. The plate showed a distinct band where the rays had moved. The deflection is greatly magnified in a partial vacuum.

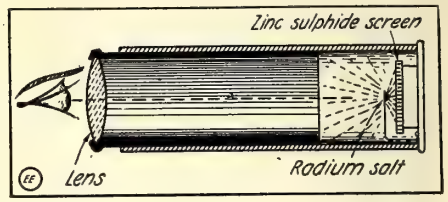
By means of the magnetic field it has been determined that the alpha ray consists of a stream of *positively* electrified particles. Hence, they will be deflected also by an *electrostatic* field.

Observations of the mass and velocity of these particles have been made by Rutherford, from the data secured by deflection. The velocity of an alpha particle is 2.5×10^9 cms. per second, or approximately 15,000 miles per second. The mass is calculated from physical chemistry as twice that of the hydrogen atom.

The alpha radiation is intense, but the power of penetration by the rays is independent of the intensity. A thickness of medium sufficient to stop any one particle will stop the whole discharge—regardless of its strength. That the penetration is small is due to the fact that the mass of an alpha particle is large.

Due to the large mass, the alpha particle possesses a considerable kinetic energy (6×10^{-6} ergs). Owing to this fact the particle has a great power of ionizing gases. The range of ionization depends on the element emitting the ray, the nature and pressure of the gas. The maximum is about seven centimeters of air at atmospheric pressure.

The alpha rays do not possess much power of affecting a photographic plate, the greater part of the effect being produced by the beta and gamma rays. They do, however, exhibit a remarkable power of causing *fluorescence* in many substances. A little instrument devised by Sir William Crookes, known as the *spinthariscope,* shows this phenomenon in a very pretty and visual manner. A short brass tube has a screen coated with crystalline zinc sulfid at one end, and a lens that can be focused at the other. A small pointed brass needle, having an extremely small amount of radium salt mounted on the end, is fixt a few millimeters from the screen. The screen will be seen to scintillate at points where the alpha rays strike, the beautiful effects having been likened to "moonlight on rippling water." (These instruments can be purchased very cheaply.) Each flash corresponds to the impact of an alpha particle against the screen. This is possibly the only direct evidence of the action of one individual atom known to science.



The Marvels of Radio-activity Are Happily Available to Everyone Interested, in the Instrument Known as the "Spintharlscope." The Eye Perceives the Radium Particles Bombarding the Zinc Sulfid Screen, the Action Being Magnified by a Strong Lens.

It is known that a given mass of radium maintains itself at a temperature higher than that of the surrounding air. This is due to the changing of the kinetic energy of the alpha particles into heat. Professor Curie reached the conclusion that one gram of pure radium would emit a quantity of heat equal to 100 gram-calories per hour.



Photo Radium Limited

Radium-therapy Is the Newest Agent for Treating Various Ills. This Is a Practical Apparatus for the Generation of Radium Emanation Water. The Inner Porcelain Cell Contains An Insoluble Radium Salt, Which Activates the Whole Volume of Water Daily.

The Beta Rays

The beta rays are composed of *negatively* charged particles. They are considered by many as electrons with an exceptionally high velocity, 1.6×10^{10} cms. per second. Beta particles are deflected by magnetic and electrostatic fields with much greater ease than the alpha particles. The deviation reduces the ionizing power.

The ionizing caused by the beta radiation is considerable, but not as marked as that caused by the alpha type. However, the range is very much longer.

Owing to the exceptionally high velocity of the beta particles, they have a considerable power of penetration. The absorption effected by matter is approximately proportional to the density of the medium. Thus lead is a far better absorbent than aluminum. (Experiment—A charged electroscope is placed on one side of a thin sheet of lead and the salt on the other. The rate of collapse of the leaves is noted. A sheet of aluminum of the same thickness is then substituted for the lead and the rate of collapse again noted, and a comparison made.)

The photographic action of the beta rays is intense, as proved by deviating them away from the other types, and allowing them to act on a plate. A brilliant fluorescence is caused in many substances, but not the scintillation of the alpha rays.

The mechanical disintegration caused in many substances, appears largely due to beta rays. Paper and rubber, after having been wrapt around relatively large quantities of highly active compounds, become quite rotten. Chemical changes are also produced, or induced, in many stable compounds. The harmful physiological effects, as the Becquerel burns, are attributable to these electronic rays.

The Gamma Rays

The third type of radiation has an almost incredible power to penetrate matter. The gamma rays appear to be similar to X-rays, being *ether pulses,* but are endowed with very considerably greater power of penetration than even the most penetrating variety of X-rays.

The gamma rays can be investigated by the electrical method as they ionize gases they pass thru. Rutherford states that the gamma radiation from 30 milli-grams of radium bromid could be detected by the electroscope after passing thru *30 centimeters* of solid iron!

The photographic action of the rays is also very intense, and most of the action produced by any radioactive substance seems to be due to the gamma radiation emitted. Fluorescent effects are produced by the gamma rays to a marked extent in a wide variety of materials, altho there are cases where the action differs from that of X-rays.

Experiment shows that the absorption of gamma rays depends on the density of the medium, as in the case of the beta radiation. But assuming the gamma rays to be a variety of *ether disturbance,* it seems impossible to assign a limit to their theoretical penetration. Yet a certain thickness of a medium will serve to absorb them.

Gamma rays are not affected by a magnetic field and so cannot be charged particles, as are the other two types.

Occurrence

The alpha rays are found in the radiation of all radio-active bodies. Beta rays are emitted by radium, uranium, thorium and actinium, but not by polonium. Gamma rays being, according to some theories, a consequence of beta rays, are given out by actinium, thorium, uranium and radium. In all cases, the radiation from radium is stronger than the others.

Secondary Rays

The three types of ray all set up secondary radiation on passing thru matter. A pencil of beta rays falling on matter is widely scattered in all directions, the scattered radiation being known as the secondary beta rays. The gamma rays give rise to secondary rays which consist in part of scattered gamma rays, and in part of electrons moving with a high velocity. These secondary rays produce *tertiary* rays, and so on.

The impact of the alpha rays on matter sets free a number of slow-moving electrons which are very easily affected by a magnetic or electro-static field. This type of radiation was first observed by Thomson, and has been called by him the δ rays.

The angle of incidence of the primary rays affects the intensity of the secondary radiation. The most effective angle appears to be about 45°.

(*Continued on page* 355)

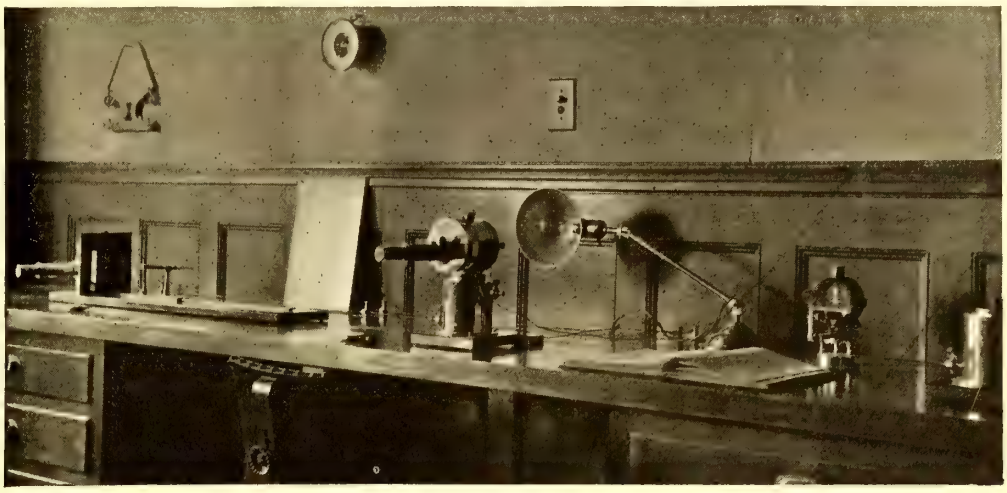
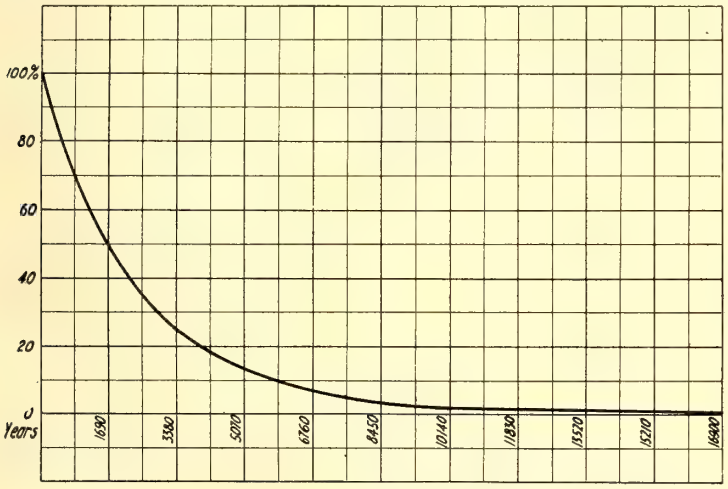


Photo Courtesy Cold Light Mfg. Co

Here the Radium Is Measured by Means of An Electroscope; Employees from Other Parts of the Laboratory Are Excluded at All Times, as the Electroscope Is So Sensitive That Even the Radium Infection in Their Clothing Impairs Its Accuracy. (Electroscope in the Middle Foreground.)



Prepared specially for the "E. E." by Radium Chemical Ltd.

Curve Showing the Decay of Radium. Each Radio-active Element Transmutes at a Constant Rate That Is Characteristic for That Element. Radium Is Disintegrating at Such a Rate That Half of Any Quantity Will Have Transformed in 1,690 Years. After a Second Interval of 1,690 Years Half of the Remaining Radium Will Be Gone, and So On Until After Ten Times the Half-decay Time Has Elapsed, 16,900 Years, There Will Be Remaining Only 0.1% of the Original Amount of Radium. The Curve Shows This Graphically. By Substituting the Half-decay Time of Any Other Radio-Element, the Curve Can Serve to Show Its Rate of Decay. Thus for Radium Emanation 3.85 Days Is the Half-decay Period, and So In 38.5 Days, Any Quantity of This Substance Falls to 0.1% of the Initial Amount.

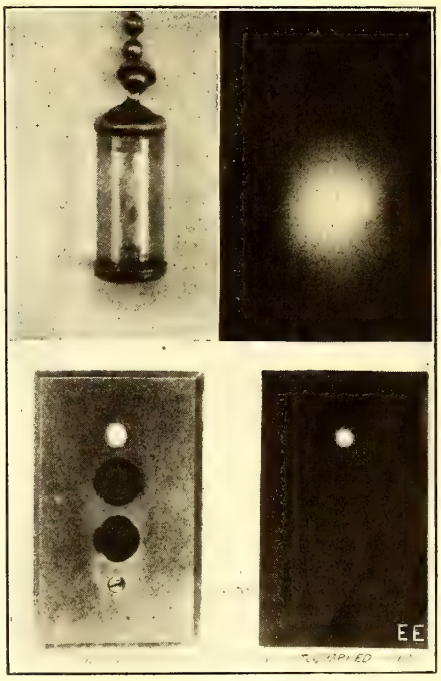
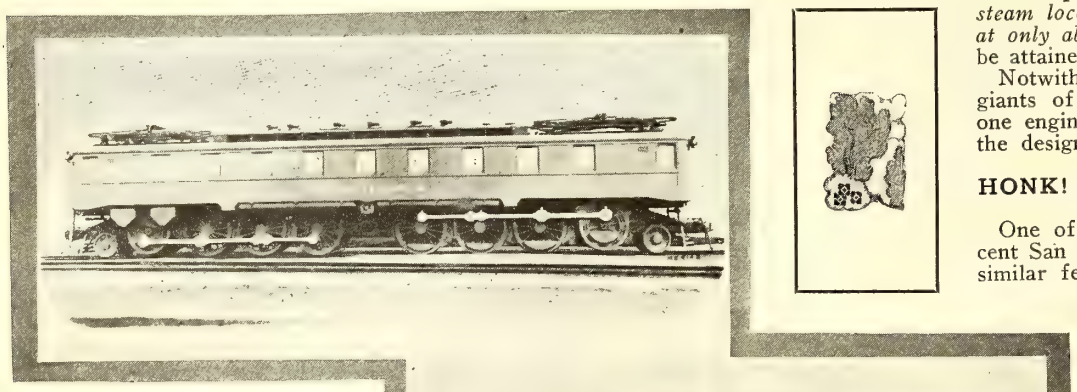


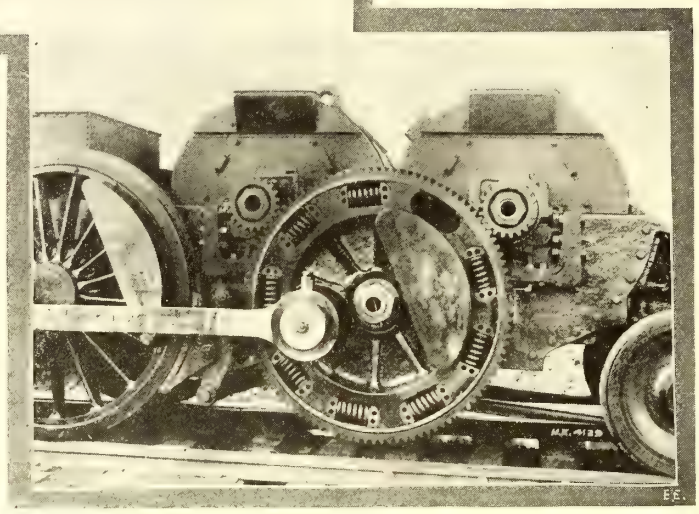
Photo Courtesy Cold Light Mfg. Co.

Luminous Radium Paint Is Being Widely Applied Now to Switch Buttons, Lamp Pendants, Dials, Etc. At Right, Appearance In Dark of Radium Coated Pendant and Switch; Left, Daytime Appearance. The First Radium Luminous Mixtures Were Made In 1902 by Wm. J. Hammer, the Eminent American Electrical Engineer, Which Fact Is Proved In His Letters Patent.

LARGEST ELECTRIC LOCOMOTIVE DEVELOPS 7,000 H. P.

A new era in railroad practise is dawning. The problem now confronting the railroads is that of increasing their efficiency, of getting more out of their existing equipment of trackage. Their product, namely transportation, is restricted by congestion and made more expensive by increased costs of fuel, materials and labor.





This Electric Locomotive Is "King of the Rail," Measures 76 Feet in Length and Develops 7000 Horsepower. Equal to Two Giant Steam "Locos" It Will Haul Freight Trains Over the Allegheny Mountains At Twice the Speed of Its Predecessors.

Accordingly they have turned to electrification as a solution of the problem thru the application of higher powered engines to their trains. Greater saving is also secured thru the more efficient use of coal in the great steam turbine plants, and also from the huge water power plants.

Pursuing a far-seeing policy, which was clearly exemplified some years ago when it built the first steel passenger car, the Pennsylvania Railroad has recently had built the electric freight locomotive shown, which is the first of what will be a standard type of high-powered units to be used by the railroad for moving its freight traffic. This locomotive, which is the most powerful ever built, weighs 260 tons, is 76 feet long, and is capable of developing a maximum of 7,000 *horsepower!*

This monster of the rails, capable of exerting as much power as a string of trolley cars over a half-mile long, draws its current from a wire no bigger than a lead pencil. This is made possible by the use of the high voltage, single phase, alternating-current distribution system. Current is supplied from a single trolley wire at 11,000 volts and the track is used for the return circuit just as in the case of the ordinary city trolley car. This current is changed by means of suitable auxiliary devices on the locomotive to a form suitable for application to the four three-phase induction motors, two of which are mounted on each of the locomotive trucks. These motors possess characteristics which particularly adapt them to this work, namely, ruggedness, constant speed and powerful starting effort.

The locomotive is built in one unit consisting of a cab, and trucks each having six driving wheels, six feet in diameter. On each truck there are mounted two powerful motors, geared to a *spring gear* jackshaft, which in turn is connected to the driving wheels by side rods in a manner very similar in construction and appearance to a regulation steam locomotive.

The engine may be operated from either end, and the control system has been designed so that the application of power is so gradual that a long train may be started without a jerk.

A maximum speed of slightly over 20 miles an hour can be obtained by this locomotive with a heavy train on grade, a speed that is deemed sufficient in view of the heavy traffic, sharp curves and steep grades to be encountered. A speed of 10 miles an hour can also be obtained when desired for slow movements, such as switching and running about the yards.

This engine is primarily intended for use in hauling the tremendously heavy traffic on the Pennsylvania Railroad over the Alleghenies Mountains between Altoona and Johnstown, Pa., including the famous Horseshoe Curve, a distance of about forty miles. The freight traffic over this section is unusually heavy, amounting to as much as 300,000 tons a day. The grades are unusually steep, and electrification will greatly facilitate the movement over this grade section. Trains of maximum tonnage will be handled by two of these engines, one pulling and one pushing, at a speed of over twenty miles an hour, that now require *three and sometimes four steam locomotives of the largest size, and at only about one-half the speed* that will be attained by the electrics.

Notwithstanding the power of these giants of the rail, they are operated by one engineer with perfect ease, owing to the design of the control apparatus.

HONK! HONK! HERE COMES THE MOTOR CHAIR.

One of the chief attractions at the recent San Francisco Exposition and at other similar fetes thruout the country, as well as at the seaside resorts, is the electric motor chair, one of which is here illustrated.

An electric-motor chair furnished with either 150 amp.-hr. or 200 amp.-hr. batteries is the latest luxury. The 150-amp.-hr. battery when fully charged will give five hours of continuous running service, it is said, and the 200-ampere-hour battery will give seven hours. The batteries are of the 12-volt type and the motor is designed to develop 0.5 hp. to 2 hp., according to load. The motor is geared directly to the axle of the front wheel with a triple worm which permits the motor to propel the car up a 15 per cent grade when loaded with two adults. Extending in front of the car is a guard which breaks the circuit between the batteries and motor and applies the brake when it comes in contact with any obstacle.

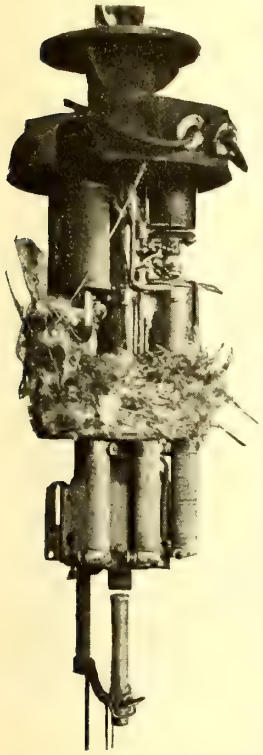
Electrically illuminated signs to be carried on the roofs to show whether taxicabs are vacant or occupied have been patented in England. Why not invent an electric sign giving the rates to various points? We never could savvy taximeter jargon.



Honk! Honk! Watch Your Step. Here Comes the Motor Chair. It Is Particularly Adapted to Ladies' Use and Will Not Bite, Balk or Rear. Can Be Stopt Instantly and Is Both Clean and Noiseless.

BIRD'S NEST IN ARC LAMP.

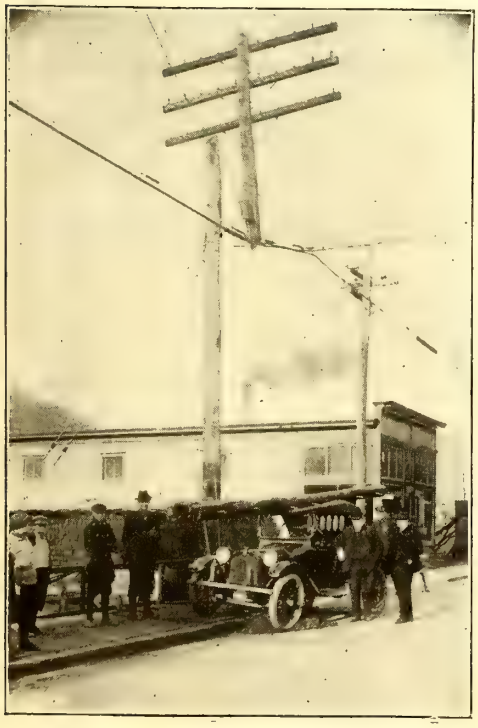
Recently an employee of the Cincinnati, Ohio, Electric Company, found that English sparrows had built a nest in an arc lamp. The top of the lamp had been broken so that the birds found a warm place for a home. Evidently the nest which they built was occupied thru most of the winter. The birds picked the wires and this interfered with, but did not stop the illumination. Attention was thus called to the lamp, and investigation showed the presence of the nest, which had been built so as to fill part of the interior. The birds had not been harmed by their experience. Photo courtesy C. G. Stander.



The Birds in Cincinnati Are Strictly Up-to-date. This Nest In An Arc Lamp Proves It.

AUTO CUTS OFF TELEPHONE POLE.

At Logan, W. Va., recently an automobile crashed into a telephone pole carrying a heavy load. The car struck the pole with such force that a 20-foot section was broken out of the pole just above the ground line. This part of the pole fell across the top of the car and remained securely balanced there, as the illustration shows. The upper 10-foot section of the pole, relieved of its former support, dropt down and alighted squarely upon a steel messenger wire which was strung above the street at a less height. There the piece of pole remained in an upright position. Photograph courtesy C. W. de Forest.



A Peculiar Accident In Which a Telephone Pole Was Severed By An Auto Crashing Into It. The Pole Remained Suspended by Its Own Wires.

FREES JUNGLES OF TERRORS FOR EXPLORER.

Radio-telegraphy has shattered the silence and terror of the jungle for explorers, and it is possible to penetrate vast wildernesses now without once losing touch with civilization. This is the message that Dr. Alexander Hamilton Rice, the explorer, brought with him from his perilous journey 2,100 miles up the Amazon River. He was accompanied on his journey by his courageous wife and a party of scientists.

In speaking of his explorations, Doctor Rice said:

"We took the Alberto, a yacht drawing seventeen feet, up the Amazon to Iquitos, a distance of 2,100 miles. Commodore Benedict last year took the Oneida up to Manaos, but we went 1,000 miles further, and I think the Alberta is the first yacht that ever went as far as Iquitos.

"It was while we were off Iquitos that we realized the possibilities of the wireless. At that remote point we had no difficulty in picking up the signals sent out from the Arlington Station at Washington. They came to us sharp and crisp, and it made us feel sort of homelike to think that we were in touch with the outside world in spite of the fact that we had penetrated thousands of miles of this vast country.

"We, of course, were not the first explorers of the Rio Negro, which we reached. Others, notably Dr. Russell Wallace, in 1851, went up the river, but Doctor Wallace did not succeed in making the latitude and longitude observations on the north bank, which we accomplisht.

"Another purpose was the further testing of the portable wireless which had been especially made for this journey, and a third object was the study of the diseases of the Rio Negro Valley.

"As its name indicates, the Rio Negro is a black water river, and it is unusually free from the logs, driftwood and debris. White water rivers like the Amazon, in this region, are just the reverse, being full of floating matter. Then again the white water rivers have the usual vegetation extending back from their banks into the forest, but with the Rio Negro the vegetation varies and has no set law of consistency.

"After you leave Santa Isabel you come to the Caoxeiras rapids and cataracts, which are formed by ledges and rocks."

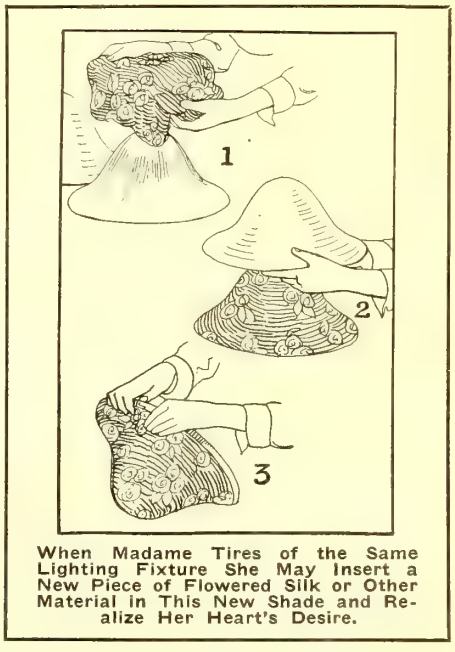


On a Recent 2,100-Mile Journey Up the Amazon River in South America, a Noted Explorer Found His Radio Apparatus of Wonderful Value. The Arlington "Time Signals" Were Received Daily As Well As Other News.

A CHANGEABLE DECORATIVE LIGHT SHADE.

The increasing desire of the modern housewife for artistic decorative effects in her home is bringing about the development of home furnishings of all kinds that readily adapt themselves to varied tastes and designs of home decorations. The most striking feature about these fixtures is that their design can readily be changed from time to time to suit an entirely new type of interior decoration, any special party or other social function, or even to satisfy a passing mood of the housewife. This has never been possible heretofore in metal and glassware fixtures than have been installed permanently.

The secret of the changeability of these new fixtures consists in their unique construction, which embodies two separate glass bowls held together by means of a metal ring and so arranged that between them can be inserted a piece of colored silk or cretonne. By changing this insert it is thus readily possible to change the entire decorative effect of the fixture. These fixtures are made in some half dozen different sizes and shapes, some having shallow, others deep bowls and some urn-shaped bowls. A pattern is furnished with each size and type of fixture. This permits cutting the fabric to exactly the right shape and size. The fixture is very easily assembled and any housewife can readily take it apart and change it as she wishes.

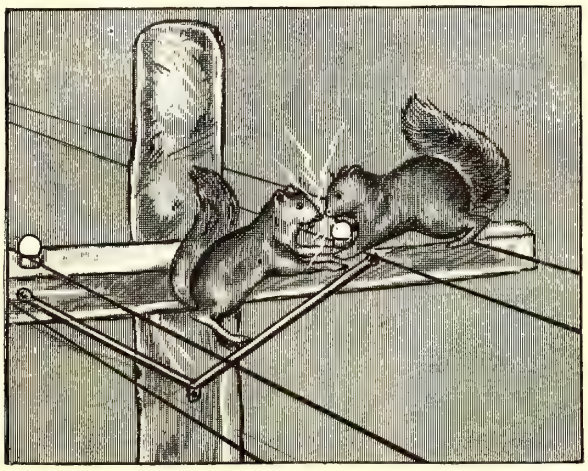


When Madame Tires of the Same Lighting Fixture She May Insert a New Piece of Flowered Silk or Other Material in This New Shade and Realize Her Heart's Desire.

The fabric is first placed over the inner bowl, after the latter is inverted on a table. This bowl has prismatic ribs upon it which serve to reflect most of the light upward toward the ceiling, thus making the fixture a purely semi-indirect type.

THE KISS OF DEATH.

Contrary to expectation, this is not the title of a new film thriller, but the story of a short-circuit on a 13,800-volt line. On a recent Sunday, trouble showed on the Fayville line between Hopkinton and the Sudbury dam in England. On patrolling the line thru the woods Charlie Marshall, Hopkinton trouble man, found one of the lines on the ground with a squirrel lying dead beside the wire. Another squirrel was wedged in the cross-arm brace on the pole, and was also dead. On examination it was found that the bodies and noses of both animals were burned. The nature of the burns disclosed the fact that one squirrel was on the line and the other was on the brace, which is grounded. When the little animals touched noses a flash-over from line to arm was caused, which burned off the wire and resulted fatally for the unfortunate lovers. Which goes to show that the top of a pole carrying 13,800 volts is a bad place for spooning.

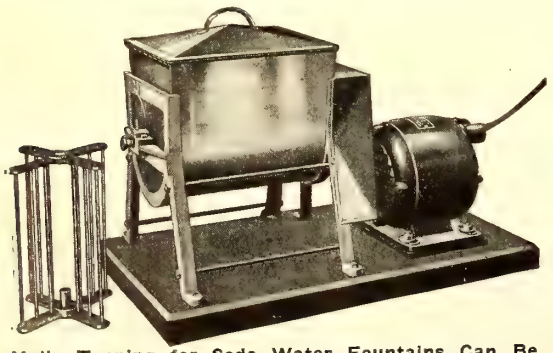


When These Squirrels Touched Noses There Was a Flash of Sparks and Two Red-skins Bit the Dust.

MAKING "MALLO TOPPING" BY MOTOR.

Mallo topping—that delicacy which we all enjoy so much at soda fountains—is now made by motor.

Place one-half gallon of Mallo Topping in the whipper, and add four ounces of hot water, says the recipe. Start the machine and whip two or three minutes. Then add four ounces more of hot water. Whip this until nice and light. The Mallo Topping when finished will be about the consistency of whipt cream. By whipping the Mallo Topping with this amount of water, it will double in volume. If you wish to re-flavor or re-color it, place the flavor or color desired in the mallo when it is being whipt up.



Mallo Topping for Soda Water Fountains Can Be Made in a Jiffy with this Motor-driven Whipper.

The Destruction of Steel and Concrete by Electrolysis.

By K. M. COGGESHALL

QUITE often, while walking down a city street, we will notice a little squad of workmen digging in the roadway to unearth a burst water main. Perhaps we will see a piece of the old pipe after it has been removed and will be surprised to note how it is pitted and eaten away. If a pocket knife is used to dig into the sides of the pipe, it will be found to be soft and easily cut. A chemist would tell us that this destruction of the steel or cast iron pipe was caused by electrolysis—a decomposition by an electric current.

A further explanation might make this action more lucid if we consider the electro-chemistry of the plating bath. Here we have the current entering the bath thru the copper, silver, or nickel metal, passing thru the bath, and leaving by the metal article being plated. A chemical reaction then takes place; the copper, silver, or nickel, as the case may be, is decomposed and a deposit of this same metal is formed on the object being plated. The voltage necessary to create this action may be quite small altho the decomposition will increase materially with a larger difference of potential.

Dry soil does not easily lend itself to the passage of an electric current altho, especially in large cities, it contains a great deal of mineral matter and salts. When the earth is wet, however, these salts dissolve, thus changing the soil into an electrolytic conductor. It can easily be seen, then, that if there is a difference of potential between two points on the earth's surface, a current of electricity will flow from one to the other.

Most cities operate a street railway system which uses the rails as a return circuit. As it is impossible to insulate the rails from the ground, the current will stray from them and flow back to the power house thru the soil. If a water main is in the near vicinity of these currents it will serve as a conductor for part of the distance until a path of less resistance presents itself. Here, then, is where a problem must be solved by the municipal and railway engineers. At every point along the water main, where the electric current leaves the pipe, decomposition by electrolysis will occur.

Eventually this decomposition will destroy the walls of the pipe and bursting may take place at a critical moment when an excess pressure is put upon it during a fire.

The sketch shows the condition contributing to electrolysis. The current flows along the trolley, thru the car motors, to the rails, and back to the power house. Suppose that a water main runs parallel to the track. Some of the current will stray from the track, as indicated by the arrows, and use the water main as a conductor. At the point of exit near the power house electrolysis will occur.

Quite often there will be a high resistance joint in the water pipe caused by a coating of asphalt or other compound. In such instances the electric current will shunt around this joint thru the soil. Here, again, we find electrolytic action where the current leaves the pipe. This disintegration, as a rule, causes pittings close to the lead filler, which softens, resulting in a leak.

It is interesting to note the effect electrolysis has on different metals. The cast iron pipe does not show the destructive action on its surface while in the ground. If a section of the pipe is removed, however, and exposed to the sun's rays until thoroly dry, the graphite and other impurities with which the pittings are filled, become hard and drop out or may be easily removed with a pen knife. In wrought iron and steel pipes the iron oxid resulting from the chemical action is diffused thru the soil. As a rule in wrought iron pipes the action will concentrate at one point, thus causing rapid deteriorization. White and yellow salts are formed when electrolysis takes place in lead pipes. This is especially noticeable where lead-sheathed cables are used in underground wiring.

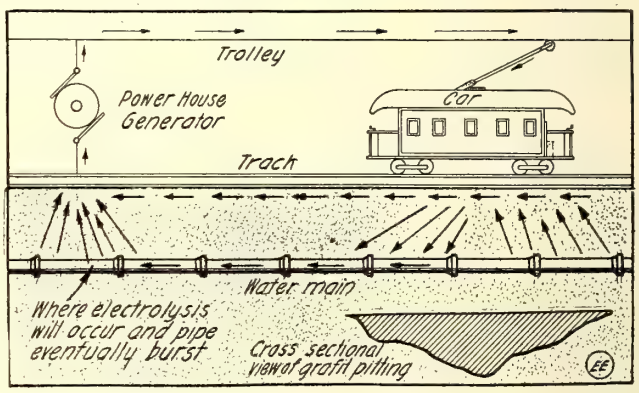


Diagram Showing How the Street Railway Current Often Strays from the Rails to a Water Pipe, Eventually Causing a Ruptured Main Where the Current Leaves the Pipe Line.

Many experiments have shown that concrete when damp is a good conductor of electricity. The majority of the concrete structures of to-day are reinforced with steel bars. It has been found that when currents of electricity pass from these bars into the concrete, the latter will crack. The oxids of iron formed occupy a space greater than the original bar and a terrific outward pressure is produced. It has also been found that when currents pass from the concrete into the iron, the former will soften and eventually the rigid bond between the two will be broken. Electrolysis in concrete is often found in bridges and where steel foundations are imbedded in concrete.

All of the foregoing discussion refers only to the action of direct currents such as used for street railway power. The damage caused by alternating current is so slight as to be negligible. The only difference is that while with direct current electrolytic decomposition occurs only at the positive electrode, with alternating current this corrosion is present at both electrodes.

NEW LIFE BELT HAS ELECTRIC LIGHT.

The illustration herewith shows a new wrinkle in life belts, and one which should be conducive to the saving of many lives annually. It often happens that persons washed overboard, even tho provided with a life belt, are lost nevertheless, particularly when this occurs in the night time.



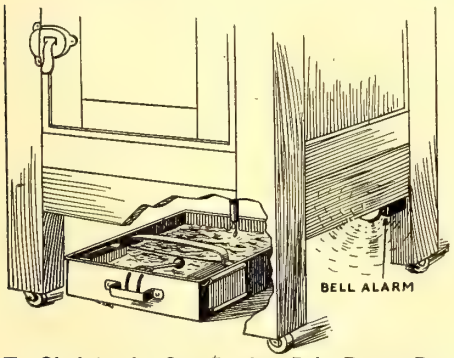
A Yankee Genius Has Come Forward With An Electric Light Attachment for Life Belts, Which If Adopted, Should Help to Save Many Lives Annually.

To increase the chances of being rescued of the person so situated, a New York inventor, Mr. A. M. McGiff, has patented a *luminous life belt.*

As soon as the person dons this life belt a switch is closed which illuminates the electric light or lights, and thus the shipwrecked soul has every chance of being seen by another vessel in the dark. The lamps may be supplied with current from a dry or storage battery placed within one of the belt compartments.

ELECTRIC DRIP PAN.

How many times have you heard mother say, "Johnny, empty that drip pan," and when you undertook to carry out the assigned task found that the pan was filled to overflowing, and possibly had flooded several square yards of carpet about the ice box. To obviate this household catastrophe which has occurred and will most probably occur many thousand times, a New York inventor, Mr. M. Jacobson, has recently obtained a patent on an electric drip pan alarm here featured. When the water reaches a certain predetermined level in the pan, the float arm rises, causing the electric



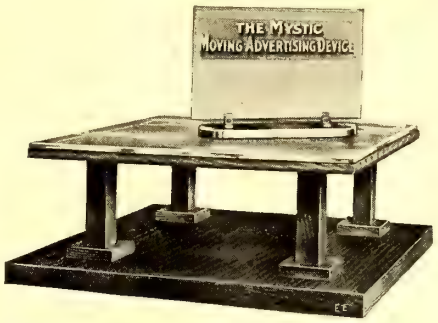
To Obviate the Overflowing Drip Pan a Recent Patent Provides for a Simple Electric Alarm Bell and Float Switch, Which Act When the Pan Is Nearly Full.

bell circuit to be closed. This should prove a God-send to the busy housewife, not to mention the perpetually busy servant girl or cook who, when she is not busy frying potatoes or baking cakes, or perusing one of Laura Lean Jibby's famous works, is highly preoccupied with the fatuous and propitious duty of entertaining the iceman.

MOVING MAGNET OPERATES MYSTIC WINDOW DISPLAY.

Possibly you have found yourself among a hundred others standing before an attractive show window, and patiently stretching your neck in an effort to see what held the interest of the crowd. Mysticism is the key to nearly all of the best window attractions that have been evolved in the past several years. The one shown herewith is no exception, and undoubtedly you have come face to face with it more than once without being able to figure out just what caused the ever shuffling advertisement to move about in such an uncanny manner.

The display in question is generally designed with a heavy plate glass top supported on four well-spaced columns. When you see this device in operation, it is really very puzzling, for it is hard for one to conceive that a magnet could be made powerful enough to move the advertisement card and its attached base about on the glass plate, which latter stalls most of the "electrical experts" in the crowd, as glass is known to be a good electrical insulator. A magnet is really in back of or rather under



Magic and Black Art Still Exercise Their Charm Upon the Public. If You Don't Believe It Watch the Crowd This Magnetic Window Novelty Attracts.

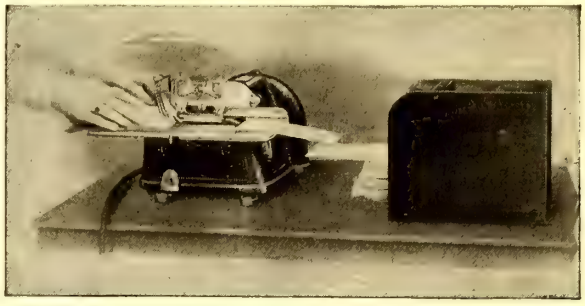
the whole device, and it is repeatedly changed in position by means of proper gearing, and an electric motor hidden in the base.

The pedestal supporting the advertisement card is of iron so that the magnet can act upon it.

OPENING 50 LETTERS AT ONCE BY MOTOR.

Anyone who has ever had to open a thousand letters by hand or by hand-operated letter openers, knows the enormity of the task involved and the amount of time necessary to complete the operation. In addition, the greatest care has to be exercised in the opening process in order that enclosures be not mutilated. This can all be eliminated, and the time required reduced to a minimum by the use of the motor-operated opener shown. This device opens the letters in a continuous stream, cutting only a thread from the edge of the envelopes, and in a seemingly uncanny way missing the enclosures. One of these letter openers in actual operation has opened 73,000 letters in a working day of 8 hours!

In operation, the unopened letters are placed on a feed-table back of a guard, which has a capacity of 50 letters at a time. They are fed thru one at a time by means of two rubber rollers, which pass them along past two cutting wheels. The guard eliminates all possibility of the operator's fingers coming into contact with the cutters. The depth of the cut may be varied and set at will. After the letters



73,000 Letters Opened in 8 Hours, Is the Record of This New Electric Letter Opener.

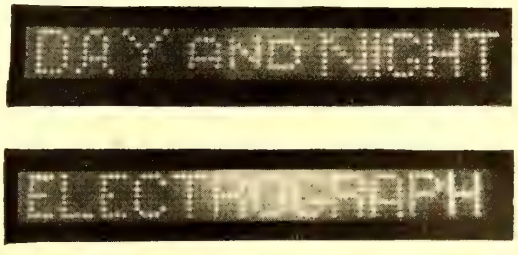
are opened they are automatically thrown out and stacked up in the case of the machine, as shown in the illustration. A 1/20 h.p. electric motor operates it.

NEW TRAVELING ELECTRIC TALKING SIGN.

Recent improvements in the talking electric sign have made it possible to either flash the message in consecutive distinct flashes or continuously traveling, the story moving across the lamp field from right to left. The sign can be supplied in any size, either for outdoor display or for store or show window use. One of its greatest features is that it can flash an advertisment of any desired length. The system consists of only three essential parts, the lamp letter field, the flash controller for the operating stencil, and the connecting cable which joins the two.

How does it do it? The words are spelled out on a bank of very closely spaced electric lamps. The lamp bank may be of a size to flash a six-foot or six-inch letter.

The word-flashes are operated by means of a motor-driven stencil ribbon, perforated with the message. This ribbon may be practically any length. It may be continuous so as to repeat the message. Sections of message-ribbon may be added at any time or removed—all in a few minutes. The story may thus be kept up to the minute.



The Latest Electric Talking Sign Enables the Advertiser to Flash a Continuously Changing Message to the Public. The Letters Move From Right to Left.

Vocation of the Engineer

By PROF. A. E. WATSON
Instructor in Electrical Engineering, Brown University

WHAT is an engineer, and what does he do? The trade definition is obvious and simple, but the professional application is meant, and to that the answer is not so easy; at least it cannot be short. New extensions and applications of the name are constantly being found, suggesting wide differences in the definition.

The name was early used in a military sense, for to the "engineer corps" of an army was assigned the detail of designing and constructing fortifications, roads, bridges, etc. For the arts of peace the building of canals and railroads demanded similarly skilled men, but in civil life. It was in the decade of 1865-1875 when the first great transcontinental railroads were building that these "civil" engineers, as distinguished from the military engineers, were recognized as forming a separate professional body. To equip railroads and ships with their motive power, great factories with their machinery and tools, required men trained along quite other lines, and the mechanical engineers became a second professional class. Hand-in-hand with these latter, at first perhaps a step behind, but now with the slogan "Do it electrically," quite in line with his elder brother, the electrical engineer has found his functions both a demonstration and a challenge.

Like that of other professions, the work of engineers is constantly becoming more diverse and specialized. With the multiplication of proofs that their work is ordinarily done in an economical and reliable manner, more and more matters, not at first regarded as properly within the scope of engineering, have been entrusted to their advice, judgment, and execution. Thus in addition to the older designation of "city engineer" we find "public service engineer," "efficiency engineer," "illuminating engineer," "heating engineer," etc. It is from these actual instances rather than from a dictionary that the present usage of the word is to be derived.

It is fortunate that all of us are not vitally interested in the same things, for a certain sort of life-work that is a source of the highest inspiration to some would be of most depressing drudgery to others. While a normal man is sufficiently resourceful and energetic to adapt himself to circumstances, and to derive a sufficient and tolerable subsistence from any one of a variety of employments, he should be given free choice in the matter of selection of that work which above all others appeals to his whole heart and mind. Once entered upon this course he will bode no stint or limitation. Some have heard that call in engineering, have followed, and not been deceived. As judged by their own admissions and by the testimony of word and deed, they have done the work for which they have seemed specially fitted.

What shall we reply then to the young man who says, "Engineering is just what I want. How can I get into it?" If possible, even from the first, the value of the personal element should be recognized. Tell him that if he knows of an engineer with whom he can get acquainted, let him do it. Try to visit him at his work, or even at his play. If engineers or engineering societies in the neighborhood have meetings for discussion, let him attend such as appear to furnish subjects of interest. Ordinarily the public is cordially invited to such gatherings. Altho many of the topics may be over the young visitor's head, he will be sure to become interested in certain of the attendants, and some of the members will become interested in him.



Prof. A. E. Watson, Instructor in Electrical Engineering, Brown University, Is to Our Mind An Ideal Educator and Scholar. He Holds Degrees of B. Sc., and Ph. D., and Is a Member of the A. I. E. E. Besides His Tutorial Duties He Finds Time to Write Technical Books and Papers, and We Are Pleased to Present His Message to Embryo Engineers Herewith.

IN THE OCTOBER "E.E."

"Research in High Frequency, High Potential Currents," by Dr. Nikola Tesla.

An automatic electric "zig-zagger," to prevent torpedoing of ships.

The marvels of Radio-activity—Part III—by Jerome S. Marcus, B.Sc.

Electricity in the manufacture of Ammunition and Guns.

"A new electrical war scheme"—by H. Gernsback.

The American inventor of Radio who antedated Marconi.

The earliest electrical apparatus—an article of historic and technical interest, by H. Winfield Secor.

Chemical action of storage batteries—of interest to all electrical and radio students, by Albert W. Wilsdon.

New and startling experiments with High Frequency Currents—Lighting a bank of 110 volt lamps thru the body, and a host of other extremely interesting and mystical experiments.

Radio-dynamics—the control of torpedoes, boats, et cetera, by wireless waves. Some recent developments in this field.

The How and Why of Radio Apparatus—Part 5. Helices and Oscillation Transformers.

The "October issue" will be of particular interest to all classes of readers. It will mark the official opening of the "working" season. We will all be back from vacations then and ready to study up on the latest advances in electricity, radio and science—which "THE ELECTRICAL EXPERIMENTER" knows just how to serve. Don't miss it, Friends!

This association should quicken his intellect and unfold to him some of the problems of the engineers and their tentative or final solutions. Let him subscribe for an engineering magazine, and read such others as may be available. Without interfering with regular school or other work, such an enquiry extending over a couple of years will demonstrate if the interest in engineering matters is merely transient or is likely to be permanent. Once in the life-work the competition between one's fellows is altogether too real to permit trifling with the original selection.

To have any reasonable chance of getting into the first rank of engineers or even of good standing in the profession, the aspirant should have a college or technical school degree. Of course numerous instances can be quoted of successful engineers who have not received such formal education, but they will be found to consist mostly of the older generation whose schooling came before the present numerous and comparatively easy opportunities for education were afforded. Immediately after graduation, two-year training courses are ordinarily available in some consulting, designing, erecting, operating or manufacturing concern. During such a coarse the "student-engineer" receives a living wage, say $60.00 to $75.00 per month, and is frequently transferred from one department to another, whereby he acquires a working familiarity with a great variety of subjects or apparatus. During such a course or at its completion, the embryo-engineer is supposed to have made a sufficient impression upon his employers as to merit an appointment to their permanent staff, or to secure a recommendation to some allied interest, or to warrant his getting into business more of his own making. He can now properly call himself an engineer, but to secure that recognition from his fellows he should make application for membership in one of the national engineering societies. Its publications and associations should prove of lifelong interest.

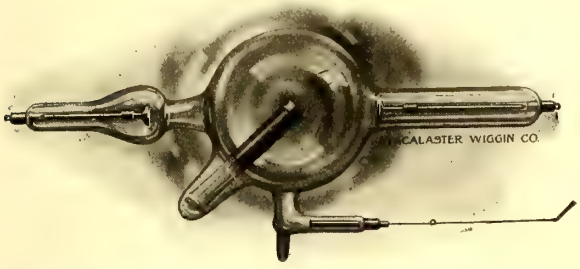
Thus scheduled it would appear that the engineer has to a considerable degree been the product of artificial methods, that he has been machine-made, without the recognition of the inventive and creative attributes usually ascribed to one of his profession. Perhaps this criticism may occasionally be heightened by hearing a seasoned veteran maintain that engineering consists simply of good common sense. In reality, however, such a statement hardly puts the case strongly enough, for successful engineering will be found to consist of uncommonly good sense. In this last expression is to be summed the whole school education of the man, then tempered and supplemented with years of experience. The weight of increasing responsibilities in connection with important and even stupendous enterprises may dim the recollection of college and apprentice days, but that early training is indispensable.

The expectant engineer may well consider that his life-work will bring him in touch with city councils, with legislative committees and assemblies, with courts of law, with financial interests, and undertakings. He may be called upon to give public addresses and to prepare papers for publication. His word and action will be critically watched, for the engineer must make no mistakes. Life and property are too valuable to serve as subjects for snap-judgments and ill-considered experiments.

X-Ray Tubes for High Frequency Coils

By Dr. FREDERICK FINCH STRONG
Lecturer on Electro-therapeutics, Tufts Medical School, Boston

IN all the history of scientific achievement there has been perhaps no discovery of such a startling and revolutionary character as that of the X-Ray. The *Electron theory,* which forms the basis of the chemistry and physics of our New Age has been formulated almost entirely from deduction made possible by the work of Roentgen and the Curies.



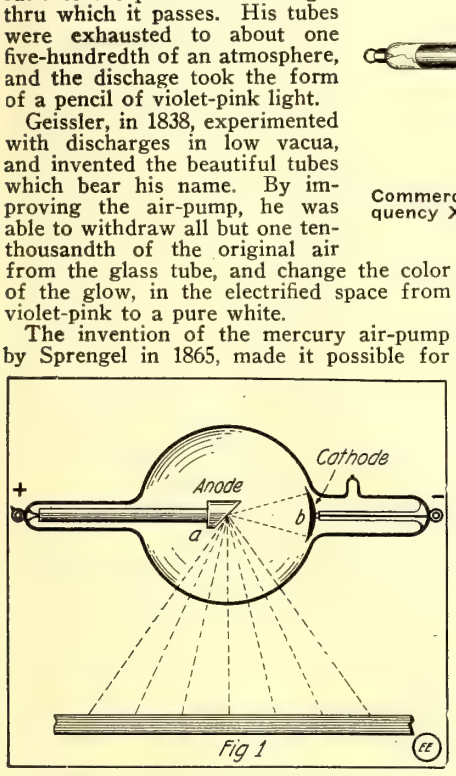
Standard Form of Single-Focus High Frequency X-Ray Tube. The First Powerful X-Ray Tubes Were Excited By a High Frequency Oscillator.

If we review the history of these discoveries we find that they have resulted from long series of researches dealing with the phenomena of electrical discharges in partial vacua.

The air pump was invented in 1650 by Otto von Guericke; by its use Sir W. Snow Harris, in 1834 was able to show that the spark-length of a given electrical machine increases in inverse ratio to the pressure of the gas thru which it passes. His tubes were exhausted to about one five-hundredth of an atmosphere, and the dischage took the form of a pencil of violet-pink light.

Geissler, in 1838, experimented with discharges in low vacua, and invented the beautiful tubes which bear his name. By improving the air-pump, he was able to withdraw all but one ten-thousandth of the original air from the glass tube, and change the color of the glow, in the electrified space from violet-pink to a pure white.

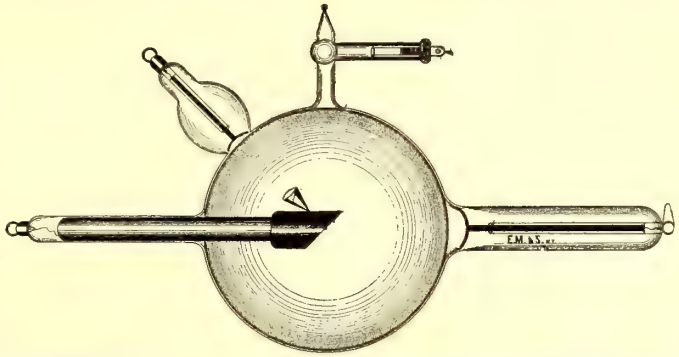
The invention of the mercury air-pump by Sprengel in 1865, made it possible for Sir William Crookes in 1878, to study electrical discharges in rarefied gases with pressures as low as *one one-millionth* of an atmosphere. He gave to the world the "Crookes tube," with which Lenard in 1894, proved the existence of the "Cathode rays," and from which in 1895, Roentgen accidentally discovered a new form of emitted energy which he tentatively called the "X-Ray."



The Simple X-Ray Tube Contains an Anode or Target "a" and an Aluminum Cathode "b." The Cathodic Electron Bombardment of Target "a" Causes X-Rays to be Produced At Right Angles or Downward As Shown.

We all recall the circumstances of this discovery. Roentgen was experimenting with a Crookes tube enveloped in an opaque cover, when he noticed a bright glow on a nearby card, coated with Platinum-Barium-Cyanid. The glow continued even when the uncoated surface of the card was presented to the tube, and further experiment showed that the interposition of the experimenter's hand between the covered tube and the fluorescent screen would cause a shadow-picture of the bones to appear upon the glowing surface.

The publication of Roentgen's discovery led investigators in all parts of the world to study the new phenomena. Static machines and Ruhmkorff induction coils were at first employed to excite the Crookes tubes; but the intensity of the resulting X-rays was not very great. In those days an induction coil giving a four-inch spark was regarded as exceedingly powerful. We know now that such an apparatus is entirely inadequate to the production of X-rays for any practical purpose.



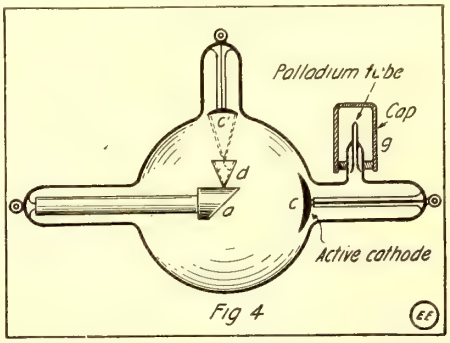
Commercial Form of a Second Type of Single-Focus High Frequency X-Ray Tube Shown Sectionally in Fig. 4. These Tubes Are Adapted to High Power Tesla or Oudin Coils.

Tesla and Elihu Thompson advocated high-frequency currents for X-ray generation, and in 1896 the Knott Apparatus Company of Boston designed the first practical commercial X-ray machine. It consisted of an open-core transformer, glass-plate condenser and Tesla coil, immersed in oil, and a rotary spark-gap not unlike those now used in Radio-telegraphy.

A few months later, the writer made the first practical high-frequency apparatus having solid insulation instead of oil, and suitable for therapeutic as well as X-ray work. The many types of high-frequency machines that are now made for physicians' use are but variations and improvements of this original apparatus.

At the present time the professional Roentgenologist uses almost exclusively powerful apparatus of the high-tension transformer type; the high-voltage, low-frequency, alternating current being rectified by a high-tension commutator operated by a synchronous motor. With such an apparatus and suitable X-ray tubes, a skiagram of the adult thorax or abdomen may be made in the *fraction of a second.*

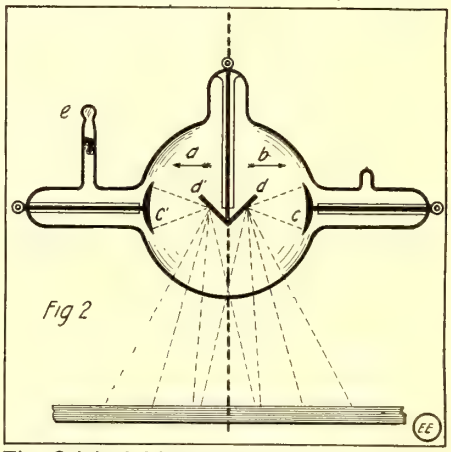
For the general practitioner, the dentist and the amateur experimenter, however, the high-frequency apparatus is still the most convenient and inexpensive device for exciting X-ray tubes, and produces results quite adequate to their respective needs.



Special Form of X-Ray Tube of the Single-Focus Type, Fitted With Palladium Vacuum Regulator and Focussing Mirror "C'", Also Copper Cone "d," for Dissipating Auxiliary Cathode Stream.

The construction of an X-ray tube is familiar to all:—in its simplest form it consists of a Crookes tube (as shown in Fig. 1), containing an anode or target (a), faced with platinum or tungsten, and a concave aluminum cathode (b). A high-voltage, unidirectional current flowing thru the tube causes streams of electrons to pass from the cathode to the target, which is set at an angle of forty-five degrees to the axis of the tube. The electronic stream ("Cathode rays"), is reflected at right angles and part of the energy is transformed into X-rays, which emerge from the glass in a divergent cone, as shown. Such a tube is not suited for use with alternating or oscillating currents, as a double set of rays would be produced; this would tend to melt the aluminum cathode and cause the absorption of the residual gas in the tube so that it would soon be too "hard" to use.

This led Elihu Thompson, in 1896, to invent his "double-focus tube"; the construction and operation of the Thompson double-focus tube is shown in Fig. 2.

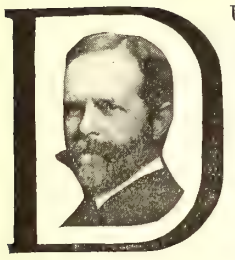


The Original Thompson Double-Focus High Frequency X-Ray Tube Which Really Comprised Two Distinct Bulb Elements.

(*Continued on page* 328)

The Franklin Experimental Club

By WILLIAM J. HAMMER
Consulting Electrical Engineer



DUE to the exigencies of the World's War, our Government has deemed it advisable to dismantle the many Wireless Plants about the country which might be used to convey messages to the enemy, and strict regulations are at present in force. Doubtless there are thousands of enterprising and ambitious boys all over the country who have constructed and operated wireless plants at their homes whose ardor for scientific knowledge and experimentation has been somewhat cooled by their inability to operate their stations.



The Electrical Side of the "Franklin Experimental Club's" Laboratory and Work-Shop. Every Member Had His Own Tool Drawer and Prizes Were Given Monthly for the Best Original Piece of Work Or Experiment.

The writer has noted with great interest the illustrations of wireless installations, many of them elaborately equipt for both sending and receiving wireless messages; which have been designed and built by amateurs all over the country who have sent in photographs and data regarding their installations for reproduction in the columns of THE ELECTRICAL EXPERIMENTER, and he has a fellow feeling for these young men, as he has dabbled somewhat in this field himself and believes that he was the first person in the world to use wireless for domestic purposes in 1894. (See *Elec. Review*, Feb. 25, 1905). Therefore, he would like to make a suggestion to the host of "Electrical" and "Radio Bugs" about the country which might further stimulate their interest in scientific matters, for which their work in wireless has already given them a keen taste.

The writer's suggestion is that in various communities boys interested in wireless and other branches of electrical science, physics, chemistry, etc., get together and form a scientific club where they can study, experiment, build apparatus and models, where they can gradually collect tools, instruments and supplies such as batteries, wire, chemicals, etc., as well as a library of technical books and papers, and where each boy will be enabled to avail himself at small expense of the club's facilities and secure the benefit of the criticism and help of the other members and perhaps the valuable advice and co-operation of older men in the community who have had experience in scientific matters. Such men, for instance, as the teachers of science in the local public schools, whom he feels confident would be glad to assist the boys in organizing and conducting the club, for they realize the great benefits which come from doing things with one's hands and believe that boys should be encouraged to do useful work of this character and they also realize that there are few things out of which boys can derive as much pleasure.

Perhaps the "Electrical" and "Radio Bugs" to whom this article is addrest and who may consider forming such a scientific club may secure some useful suggestions if the writer tells them of such a club which he took the initiative in forming and in which he was greatly interested for several years until a serious fire, which started in an adjoining alleyway, destroyed the club's headquarters, causing him a personal loss of several thousand dollars in apparatus, books, tools, etc., which he had loaned the organization, and unfortunately putting a quietus upon the club's activities.

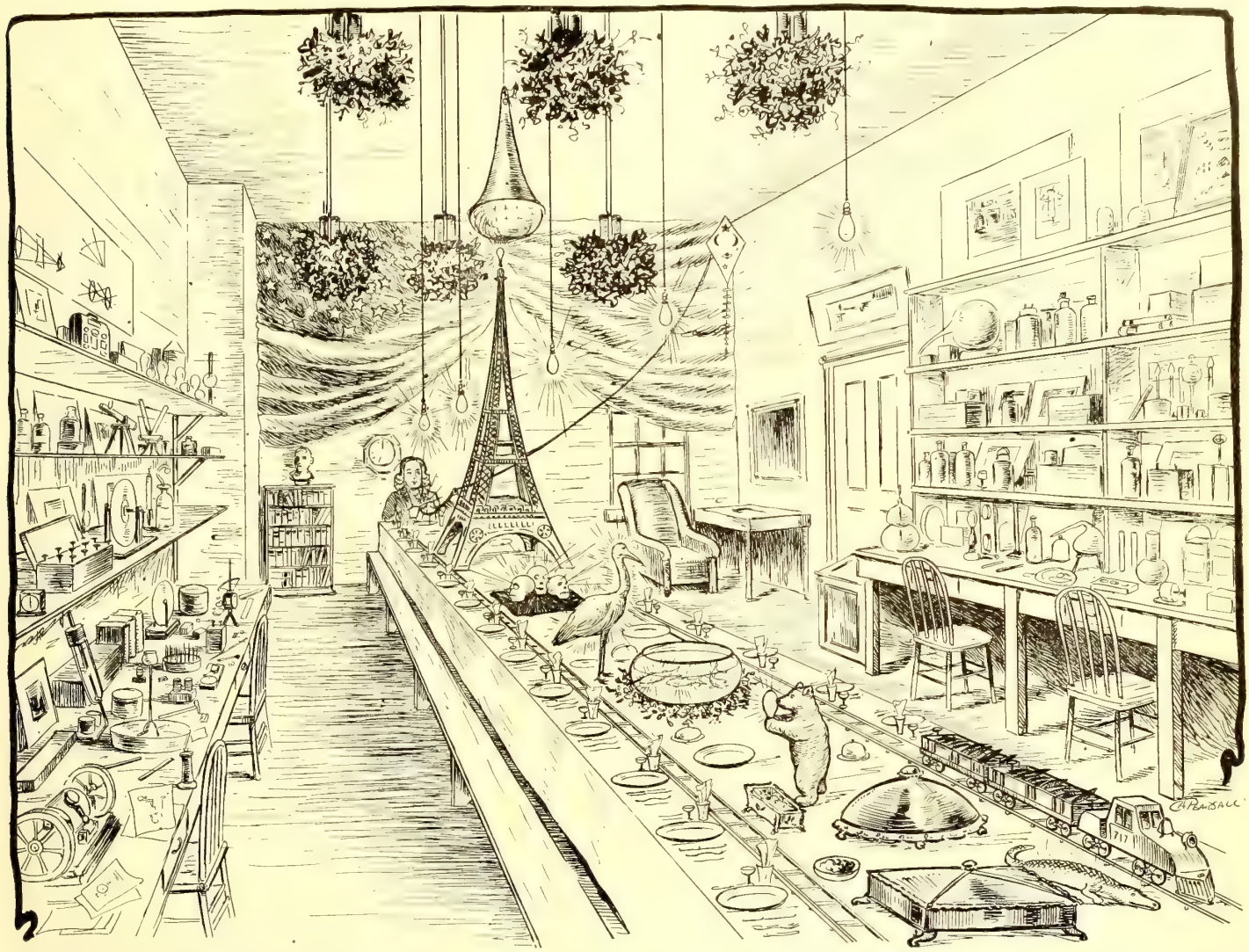
The *Franklin Experimental Club* of Newark, N. J., was organized January 31st, 1890. The object of the club as stated in its constitution was *"the advancement of its members in scientific knowledge by study and experimental research thru the helpful influence of united effort."*

This modest little club was really the result of the writer's previous unsuccessful efforts made years before to interest certain prominent men in the formation of an Institution in New York City where Popular Scientific Lectures would be given, where there would be a scientific museum of models of historical value, and also containing many working models and instruments, each demonstrating some scientific principle, and each accompanied by an appropriate explanatory card. Keys, push-buttons and switches for operating the apparatus would be supplied and instead of the usual notice everywhere, *"Please do not handle,"* the visitor would be requested to *"handle everything"* and more than this, the proposed lyceum was to have experimental laboratories and workshops where young men without means who showed an aptitude for scientific investigation and were properly fitted and desirous of availing themselves of such opportunities, would be supplied without cost to them with instruments, tools and appurtenances for such work, and could prosecute their studies and experiments under qualified instructors. However, such a plan did not



Another View of the Well-equipt Laboratory, Showing Part of the Chemical Apparatus At Extreme Left. Such a Club Is a Real Asset to Any City Or Town. There Ought to Be 50,000 of Them Right Now.

receive the necessary encouragement. Some years later (1889) while visiting Berlin, Germany, with Mr. and Mrs. Edison, we were shown thru the New "Urania" lection of flags of all nations which the writer had collected in his various trips to Europe. A case containing a collection of butterflies, bugs and insects, which he had monthlies, several quarterlies, and a number of weeklies were on file, and it is well to note that publishing and supply houses not only gave the club special rates, but



The Wonderful Electrical Dinner Given by the "Franklin Experimental Club" And Which Was Attended By Many Notable Guests. Franklin (Thanks to a Concealed Phonograph) Repeated His Proverbs. The Electric Railway Hustled Cigars Around the Table, the Skulls Flashed and Howled, Oysters Sizzled In An Electric Cooker, While Bennie Franklin Drew Lightning Now and Then From the Kite String. It Was "Some" Dinner, Fellow "Muckers," Take It From Your Uncle William.

Museum by the chief director and originator, Dr. Werner Siemens, and the writer saw that here was a small model of the very institution which he had tried previously to establish in New York and he decided upon his return to America to start a scientific club in a small way hoping that its earnest work and actual accomplishments would cause public spirited men to extend it into the original plan he had conceived.

The accompanying illustrations, Fig. 1, 2, and 3, give a fair idea of the exterior and interior of the club headquarters, which the members facetiously dubbed the "Chinese Laboratory" by reason of its occupancy of the premises over Mr. Sing Lee's laundry. The club and Mr. Sing Lee were soon on speaking terms, due among other things to the "high periodicity" of the upset battery jars and chemicals in the club rooms.

The bare beams and walls were covered with heavy paper and hung with many photographs, pictures, diagrams, etc., and later draped with a fine collection of flags of all nations which the writer had collected in his various trips to Europe. A case containing a collection of butterflies, bugs and insects, which he had caught and mounted while an assistant at Mr. Edison's laboratory at Menlo Park, N. J., 1880-1, may be noted in one of the accompanying photos.

One side of the Club room was devoted to electrical and physical apparatus and the other side to chemical apparatus, while work tables and benches ran around the walls and down the center of the room.

The club possest quite a fine library of technical books and some twelve scientific monthlies, several quarterlies, and a number of weeklies were on file, and it is well to note that publishing and supply houses not only gave the club special rates, but frequently sent us things with their compliments, and certain publications put the club on their free list. The various members also loaned books, instruments, tools, etc. Professor George C. Sonn of the Newark Public High School and the Club's Curator and Historian, was one of the club's most valued supporters.

Each member received a handsome certificate of membership bearing Franklin's portrait.

The initiation fee was $5, and the dues $1 per month. The dues were expended for rent and the purchase of apparatus and supplies. Each member was supplied with keys to the club and access could be had at all times, night and day, and each had a special drawer for his tools, apparatus, etc., and a section of the work bench. All apparatus, tools, books, etc., whether the property of the club or of individual members, were at the disposal of all members and were under the guardianship of the Club Curator.

Lectures and informal talks and demonstrations were frequently given.



Obverse and Reverse of Souvenir Medallion of Benjamin Franklin Which Each Guest At the "Franklin Experimental Club" Electrical Dinner Received. A Pleasing Memento.

Experimental Physics

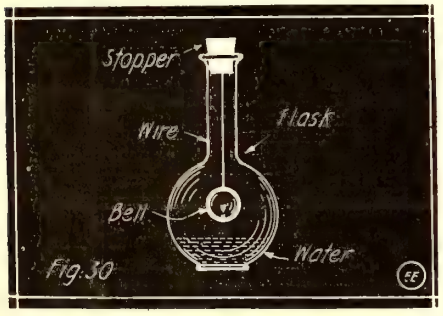
By JOHN J. FURIA, A. B., M. A.
Instructor in Physics and Science Master, Riverdale Country School

LESSON 7.
Sound.

WE all pity the unfortunate person who is born deaf and has to go thru life without hearing a sound. He never has the opportunity of hearing the exquisite music of people eating soup, of the baby next door yowling twenty-four hours a day, of the rollicking ragtime rattle of the square piano downstairs, of the straining of the vocal cords of Miss Nightingale upstairs while she sings the "ahs" and "ohs" and "ees" preliminary to allowing the impresarios fight each other as to who shall have her services at $5,000 per, for the next season's opera. Never does our poor unfortunate hear the strains of Heine's little German Band playing in the back-yard, nor does he hear the harmony of the cat quintet.

The question arises, "if we were all deaf, would there be no sound?" Believing that the world could not possibly get along without the above enumerated soothing sounds, we are gratified that in so far as "Physics" is concerned, the sound really does exist, whether anyone hears it or not. When *we* hear the sound it simply means that the Physical sound is causing a Physiological sensation in us. In everyday life sounds are usually disturbances. Therefore the grouch will be gratified to learn that Physics teaches us that *all sounds are* always *disturbances* (of the air).

EXPERIMENT 40—Place about half a cup-ful of water in a large Florence flask

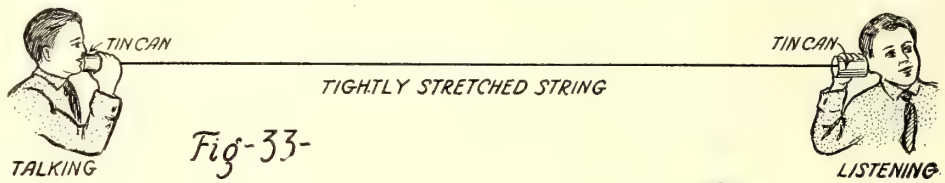


To Demonstrate That Sound Is Conducted Thru the Air and Not Thru the Ether, Try to Make a Bell Ring in a Vacuum.

(or thin bottle which can be heated without breaking). Stick a heavy wire thru a rubber stopper which fits the flask tightly, and attach a small bell (such as hangs on pussy's neck to warn the mice that she is approaching) to the end of the wire as in Fig. 30. If now with the stopper tightly in place the flask is shaken, the bell is heard distinctly. Remove the stopper with bell attached and place the flask on a Bunsen flame or stove and allow the water to boil several minutes. Then replace the stopper tightly; allow the flask to cool and when sufficiently cool run cold water over it. If now the flask is shaken the bell will not be heard and if the stopper is not airtight it will be heard only indistinctly. This leads us to the first important consideration that sound will not travel in a vacuum. The clapper hit the sides of the bell in both cases; and if now the stopper is removed and the air allowed to pass into the flask, on shaking, the bell will again ring.

The question naturally arises, "What caused the vacuum?" When the water was heated the steam from the water displaced the air in the flask and caused the air to leave. As the flask was cooled the steam condensed to water again and if the stopper was airtight since no air could enter to replace the steam, a vacuum was left above the water in the flask. The fact that sound will not travel thru a vacuum and that when a sound is made the surrounding air moves violently, as for example when the automobilist has a blow-out, or when an explosion occurs, etc., leads us to the next important consideration, namely, that sound is a disturbance of some medium—usually the air.

As far as Physics is concerned the sound occurs if the air is disturbed, whether there is anyone present to hear the sound or not. On careful consideration one will grant that this is the logical way to look at it, just as one grants that the Sun shines at night even tho *we* do not happen to see it. Light exists while we are in a dark cellar, but we do not happen to be getting the *physiological sensation.* In other words, the question of whether or not a sound exists if no one is around to hear it is identical with the question of whether light exists if we shall all become blind suddenly. The actual *physical* phenomena exist in both cases, and it is the *Physical* phenomena of sound that the Physicist deals with. The Physiologist and Psychologist deal with the sensations which the human being interprets as light or sound.



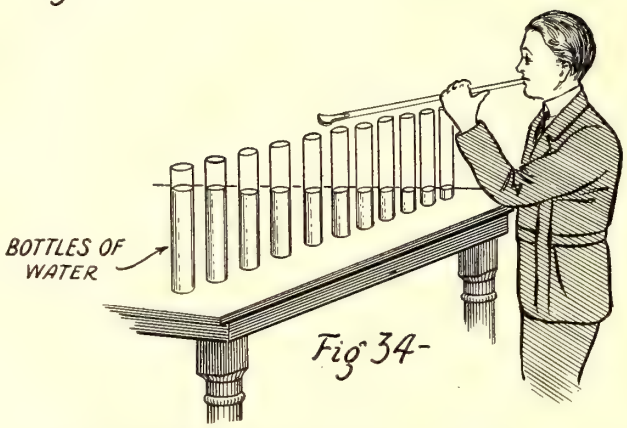
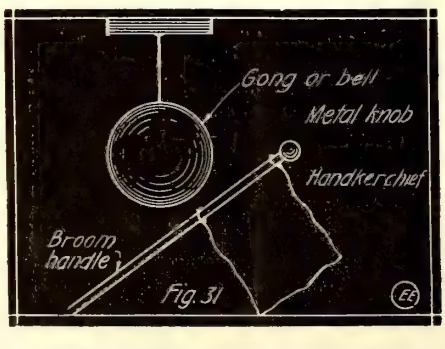
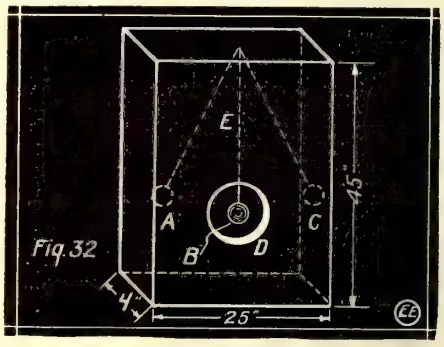


Fig. 33 Illustrates the Well-Known Tin-can Telephone, Which Shows the Principle of Sound Conduction by Means of a Vibrating String. Fig. 34 Shows the Principle of the Organ Pipe. The Air Columns Are Set in Vibration by Blowing Over Them.

EXPERIMENT 41—Everyone has noticed that the lightning flash is seen before the thunderclap is heard. Anyone who has been present when a cannon is fired at a distance from him has noticed that the sound of the cannon is not heard until after the flash is seen. On the other hand if one is close to the cannon the flash and sound appear to occur at the same time. It is evident that sound travels more slowly than light (for all practical purposes light can be taken to travel instantaneously) and it is interesting to measure just how fast sound does travel. Two persons are necessary to perform this experiment, but it is by no means complicated and does not require any elaborate apparatus except a stop-watch, which may be borrowed for the occasion. A piece of metal is attached to the end of a broom handle or other stick and a handkerchief



A Simple Experiment in Measuring the Velocity of Sound by Means of a Flag, a Gong, and a Stop-watch.



Another Scheme for Checking Up the Velocity of Sound by Means of the "Seconds Pendulum." Sound Travels at 1,100 Feet Per Second.

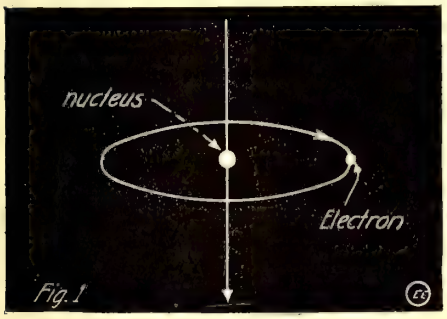
is tied as in Fig. 31. A gong or old bell or a large cow bell such as is used on New Year's Eve, is suspended so as to hang freely. Thirty-three hundred feet is measured out from the gong by use of a tape, or string of known length, or by taking 1,100 paces if your pace is three feet. Your partner stands there with a stop-watch and watches the gong. Standing below the gong you wave the improvised flag from the horizontal position slowly to and past the gong. At the given signal you wave slowly past the gong three times at an even rate of speed; at

(*Continued on page* 345)

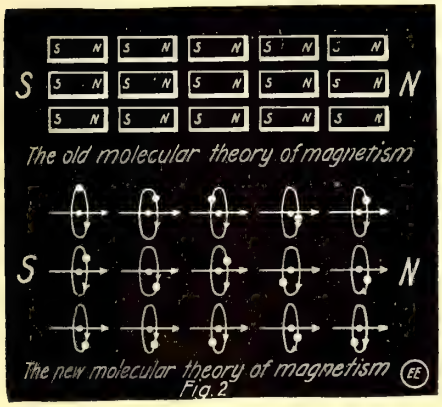
Manufacturing Magnetism

By ROGERS D. RUSK, B. Sc.

MAGNETISM is such a common force today that we hardly ever stop to think how it is made or why we do not make more of it, why we do not use it to sweep the submarines from the sea, or why we do not use it to put out of commission the delicate machinery of some distant enemy. In the first place it has never been possible to direct a magnetic field or concentrate it at a distant point. Then iron, our most magnetic element, can only be magnetized to a certain intensity known as the *saturation* value. Further than that man has been producing magnetism in the same old way ever since its discovery by stroking a piece of steel with the pole of another magnet or by placing an iron core in a coil of wire thru which a current is flowing. This latter is the same process by which the magnetism of the motor, the dynamo, the transformer, or the electro-magnet, is produced. A current flows in a solenoid about a core of iron when lo and behold, the iron becomes a magnet. Until lately there has never been another method by which magnetism could be produced except by placing the body to be magnetized in such a magnetic field, either that due to a solenoid or to a permanent magnet.



The Old Theory of Magnetism Has Undergone a Revolutionary Change in the Science of To-day. Each Atom Is Now Believed to Comprise a Positive Nucleus or Center, About Which the Negative Particles (Electrons) Rotate At High Velocity.

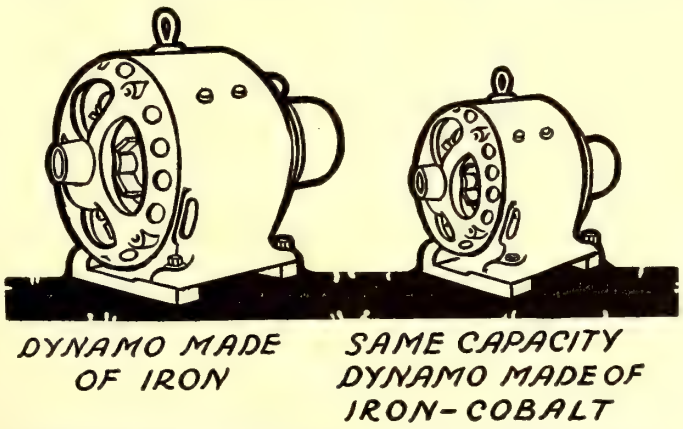


Representation of the Old and New Molecular Theories of Magnetism.

Recently, however, strange things have been found out about magnetism. Several magnetic alloys have been found which are composed of metals *not* magnetic in themselves. Iron, which was long supposed to be the most permeable substance known, has now been surpast by one of its alloys, and Dr. S. J. Barnett, of Ohio State University, has discovered a totally new method of producing magnetization not dependent on the ordinary electro-magnetic processes, but one the theory of which reaches back to the fundamental constitution of matter itself, and is based upon simple laws of mechanics.

Mother Nature herself has always been the greatest manufacturer of magnetism, for in some strange and mysterious way she keeps a supply permeating the earth all of the time. If the earth's magnetism, weak as it is, could be concentrated at a single point it would be over a trillion times stronger than the strongest field ever produced, and it would pull the largest dreadnaught afloat right out of the water and over the land!

If we could manufacture magnetism in the same way that the earth's magnetism is being continually generated, or if we could find some element or compound vastly more magnetic than iron, industry would be revolutionized, fortunes would be won, science would advance years at a single bound, inventions would multiply, and warring nations might be at once subdued.

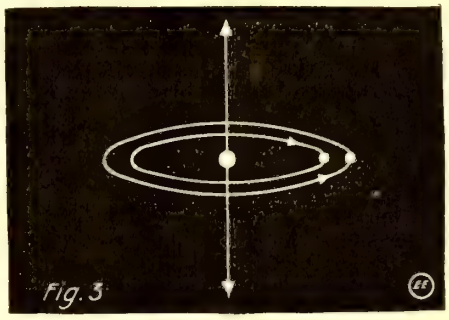


Comparative Size of Two Dynamos, Each of Equal Output, One Made of the Usual Iron and the Smaller One of the New Iron-Cobalt Alloy, Whose Permeability Is 25 Per Cent Higher Than That of Pure Iron.

Many attempts have been made to solve the problem of the earth's magnetism and for the most part these have failed because they presented nothing new. In fact, only the most vague and unsatisfactory guesses have been possible concerning its origin, such as that it is due to static charges carried about by the rotation of the earth, and thereby acting as a magnetizing current; or that it was induced by some heavenly body.

The earliest method of producing magnetism was, of course, by rubbing with the lodestone or natural magnet. This was a slow way at best, and magnets of great strength were not made until after Oersted had discovered the magnetic effects of an electric current. Up to this time it has scarcely been suggested that there was any close relation between electricity and magnetism, but shortly after Oersted's discovery electro-magnets of huge size were constructed, and we read of one constructed by Henry in America which was capable of lifting a ton weight. Nowadays commercial lifting-magnets are made much more powerful still.

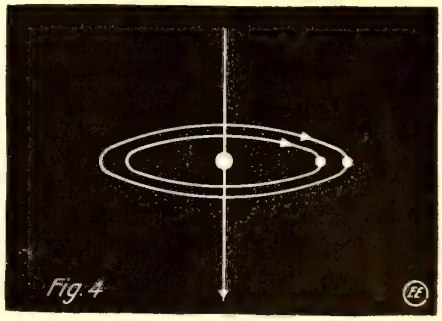
The intimate relation between electricity and magnetism is now well known, and it was upon a further study of this intimate relation that Dr. Barnett was led to conclude that a bar of iron could be magnetized by simply rotating it. His results show his assumptions to be true and these give us many new ideas concerning the nature of magnetism and even suggests a totally new theory concerning the magnetism of the earth itself.



Showing How the Electrons Revolve About the Nucleus In Opposite Directions In the "Non-Magnetic" Atom.

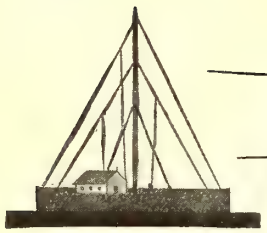
The theory of magnetization by rotation, tho of deep scientific interest and one which reaches back to the very structure of matter itself, is not at all hard to understand.

Everyone knows that a spinning top stands upright without visible support, due to its motion. In the same way a gyroscope, which is nothing more than a wheel revolving about an axle, will retain its horizontal position and if displaced will return to it. Now if a bushel basket full of gyroscopes all of them running, was suddenly started revolving, all the gyroscopes would line up with their axes parallel to the axis of rotation of the basket, and all would point in the same direction. That is the secret of Magnetization by rotation, only in the case of a rotating piece of iron, the gyroscopes are the atoms themselves, and because each atom acts as a little elemental magnet; when they line up the bar is magnetized. The only



Structure of the "Magnetic" Atom, Wherein the Electrons Act Together.

(*Continued on page* 355)



RADIO DEPARTMENT



A Remarkable Amateur Radio Station with a Record

By A. F. PENDLETON

Notice to All Radio Readers

As most of our radio readers are undoubtedly aware, the U. S. Government has decided that all Amateur Wireless Stations, whether licensed or unlicensed, or equipt for receiving or transmitting, shall be closed.

This is a very important consideration, especially to those who are readers of THE ELECTRICAL EXPERIMENTER, *for the reason that we desire to continue to publish valuable articles on the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have published in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools thruout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment. Remember! that you must not connect up radio apparatus to any form of antenna.—The Editors.*

THE accompanying photographs show radio station 2PM, owned and operated by Messrs. Faraon and Grinan of New York City.

This station has (prior to the war) repeatedly establisht new records for long-distance work. In February they succeeded in communicating directly with station 9ZF, in Denver, Colo., and a few weeks later they were reported being heard in Los Angeles, Calif., by Mr. J. B. Farrington of that city. To our mind this is wonderful work, since at no time did they use more than 450 *watts input.* Their wave length was 200 meters and decrement .09, as tuned by the radio inspector.

During March they handled 400 messages, most of which averaged over 1,000 miles. This also included a message sent from Seattle, Wash., to them *via* but one relay station, 9GC in Grand Forks, N. D.

The author recently made a trip as operator on the S. S. *Manchuria* and heard 2PM's signals six days out. We were then 2,100 miles East of Nantucket. The author was using a single vacuum valve detector.

Mr. Lebowitz, senior operator on the S. S. *Ancon,* has reported that he heard 2PM's signals while lying at anchor in Colon, Panama, on a galena detector.

Operator Grace of the S. S. *El Sol* and Frank Attwater of the S. S. *Pastores* have both heard 2PM while in Havana harbor.

The author visited their station a number of times and noticed that the way in which they handled traffic, even thru the worst kind of interference, was remarkable. The efficiency of their installation should be a goal for all other amateurs.

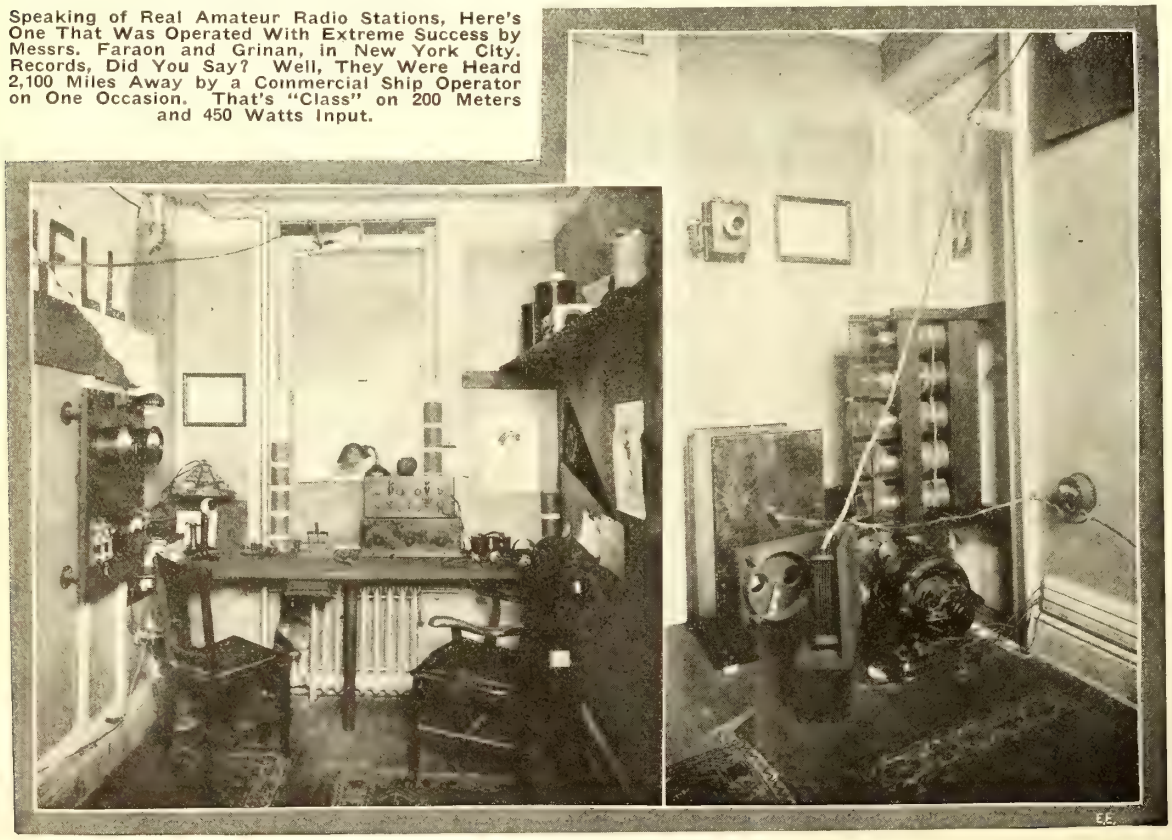
Mr. Grinan operated old "N. Y.", 42 Broadway, and was also at the Sayville trans-Atlantic station during 1914. Mr. Faraon on a recent trip to France operated the Eiffel Tower station in Paris for seven months.

On February 6th last, they were the starting point of the epoch-making trans-continental message. It took exactly one hour and twenty minutes for them to receive an answer to their message addrest to 6EA of Los Angeles, Calif.

We know of many commercial stations that are envious of the records made by these men during the past year.

Herewith is a list of stations with which 2PM has worked before the war:

Stations Worked by 2PM.		
8AAK	9AAB	9WG
8AEZ	9AAR	9GC
8AFO	9ABD	9WO
8AHN	9ALM	9XM
8ALE	9AU	9ZL
8AMG	9BJ	9ZN
8AOF	9CF	9ZF
8ARH	9DB	
8ASG	9DC	1ASE
8CO	9DK	1ASR
8CS	9EG	1DK
8ED	9GJ	1IZ
8EG	9GY	1SJ
8JA	9HQ	1VN
8JX	9IC	
8JZ	9JI	3AEP
8LE	9KR	3AFA
8NH	9AFG	3AK
8PA	9LR	3ATR
8OB	9NN	3NB
8OK	9NW	3NG
8VP	9ON	3PC
8VX	9PC	3UF
8XE	9PF	3XJ
8YI	9PI	3ZS
8YO	9QR	3WM
8ZP	9RW	
	9VY	2AGJ



Speaking of Real Amateur Radio Stations, Here's One That Was Operated With Extreme Success by Messrs. Faraon and Grinan, in New York City. Records, Did You Say? Well, They Were Heard 2,100 Miles Away by a Commercial Ship Operator on One Occasion. That's "Class" on 200 Meters and 450 Watts Input.

U. S. SEIZES POWERFUL RADIO.

A powerful wireless outfit, valued at $10,000, was confiscated recently and a man, said to be Edward Clay, was arrested by United States secret service agents about four miles west of Greenfield, O.

The secret service agents found the apparatus strung from two big oak trees.

SOUTH AMERICAN INDIANS HAD RADIO IN 1898.

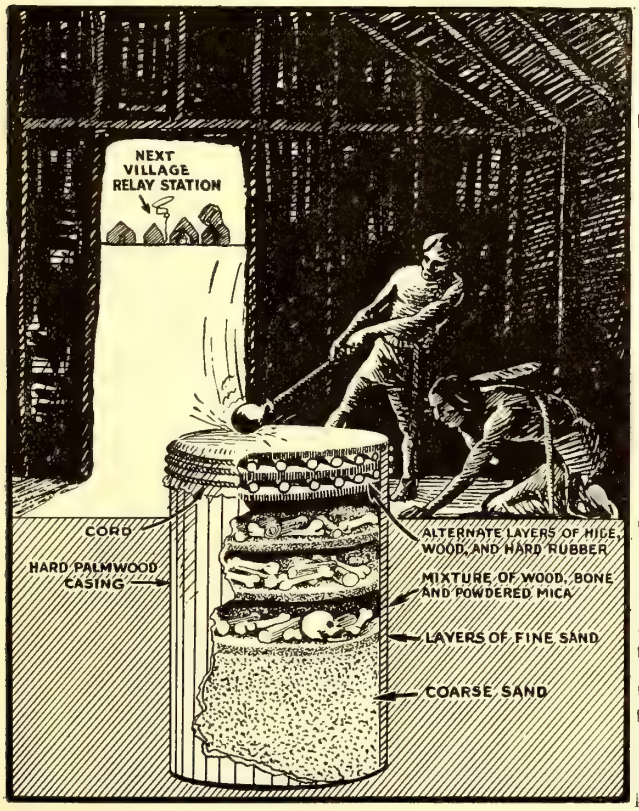
In these days of wireless telegraphy it may be interesting to learn that as long ago as July, 1898, there was recorded the discovery of a wireless telegraphic apparatus in use among the Catuquinaru, an Indian tribe of the Amazon valley in South America, says a writer in the *Geographical Journal.*

The apparatus, called *cambarysu,* consists of a hole in the ground about half filled with coarse sand; above this layers of fine sand, fragments of wood and bone, and powdered mica fill it almost to the surface of the ground. These materials are surrounded by a case of hard palm wood, which extends above the surface. The upper part of the apparatus consists of layers of hide, wood and hard rubber, arranged in the manner shown in the accompanying illustration below.

Between the upper layers and the lower layers there is a hollow space. With a club, much like the stick used to play the bass drum, the native strikes the layer of rubber that forms the top of the instrument.

One of these instruments is concealed in each hamlet of the tribe. The villages are not more than a mile apart, and are placed in a direct North-and-South line. Altho a person standing outside the building in which the apparatus is kept cannot hear a blow of the stick on the rubber top, it is quite distinct in a similar building a mile distant. When one of these instruments is struck, the neighboring ones to the North and South echo the blow. The Indian stationed at each one of the posts answers the signal, and by means of code messages a long conversation may be carried on.

An electrical process is being tried in Russia for the manufacture of gold leaf, heretofore made only by hand.



As Far Back As 1898, the South American Natives Had a System of "Wireless Communication" Working. It Employed Sound Waves Propagated Thru the Earth.

PUEBLO, COLO., NAVY STAFF STARTS RADIO SCHOOL.

Spurred by the need of the navy for several thousand radio operators, members of the Pueblo naval recruiting staff have, of their own initiative, arranged to start a school in wireless telegraphy. Classes will be held at the naval recruiting headquarters starting very soon. Charles T. Randall, head of the station, and H. T. Rainey, one of his assistants—both men graduates of the U. S. naval radio service course at Mare Island near San Francisco—will be the instructors.

The course will be free of charge. It will be open to young men between the ages of 18 and 25 years, tho in special cases men up to 30 years of age and approaching 18 will be accepted.

The navy is now in urgent need of wireless operators. Every ship which crosses the Atlantic now must be provided with them. The great merchant fleet of 1,000 ships being built by the United States Government to beat the German submarine blockade must be supplied with naval radio operators and gunners. In addition there are some 300 submarine chasers which will have to be supplied with operators by fall. Many ships of various other kinds are now in the service or will be placed in the service in the near future.

All of these must have naval radio operators.

The men who may be enrolled as landsmen for electrician (radio operators) must be able to receive at least ten words a minute in the continental code legibly, spell correctly at the rate of 25 words per minute and have a grammar school knowledge of arithmetic.

Randall and Rainey will give the instruction an applicant needs to qualify for enlistment as an operator. They estimate that the average man should master this end of it inside of three weeks. Then, if he qualifies for enlistment in other regards, he will be sent on to one of the three training schools for wireless operators—Harvard, Mare Island, or the New York school in the Brooklyn navy yard.

Three of four months' training should make a man able to handle an instrument in the naval service. Thus, inside of three or four months, a man should be able to get into actual service on some craft of the United States navy. He might be detailed to a submarine chaser and go thru with the tense excitement of hunting out the German sea sharks off the British Isles or the coast of France. Or he might be put on one of the great merchant fleet ships which will run the submarine gauntlet. Or again be assigned to one of the U. S. battleships.

In addition to affording a chance for all kinds of wild adventure in the radio service inside of a short time, it is one of the most desirable branches of the naval service, all of the grubby and disagreeable work which falls to the lot of an ordinary seaman being eliminated.

The radio operators, third class, will receive $32.60 per month and all expenses; second class, $52, and first $61.

SENATOR MARCONI ENCOURAGES WOMEN'S WIRELESS CLASS.

The accompanying photograph shows the women's wireless class of Hunter College, New York City, and Senator Marconi of the Italian Commission in a special pose at the Hotel Ritz-Carlton, where the Senator received the girls.



Photo © by Underwood & Underwood

Senator Guglielmo Marconi on His Recent Visit to New York and the Young Women Radio Students of Hunter College to Whom He Gave Important Advice as to the Future, as Well as the Military Advantages of Radio-Telegraphy.

The women are studying to become radio operators for the Government. The class was organized before the war was declared and now has one hundred and twenty-five women enrolled. The students are now taking the more intensive course at the Marconi School. Senator Marconi talked to the women on their work as an aid to the Government in war time.

U. S. SIGNAL CORPS WANTS ELECTRICAL AND RADIO MEN.

Still the cry comes for more men! You young fellows hanging on the outside of things in these stirring days don't seem to grasp the opportunities that are being offered you in the U. S. Signal Corps.



How the New York Division of the "Signal Corps" Exhibits Radio Apparatus to Drum Up Recruits.



At the Right We See a New York Street Exhibit Where the Omnigraph Clicks Off the Dots and Dashes to Future Soldiers.

The Signal Corps needs men and needs them badly, so if you are qualified in any branch of the work just step up and be one of the boys to "do your bit."

A large school has been opened at Pratt Institute, Brooklyn, to give training to young men in Radio work, and all men enlisting are immediately transferred there to receive a complete course in Radio Telegraphy.

The Corps is using many interesting and novel ways of street advertising and two illustrations are here reproduced showing some of these stunts. The field radio pack set is on exhibition at Times Square, New York City, and is drawing quite a number of worthy lads to the service. Recruiting offices have been opened all over the country for this branch of the service, including New York, Philadelphia, Rochester, Baltimore, Richmond, Ithaca (where aeronautics is taken up with this work) and Pittsburgh.

One of our illustrations depicts an omnigraph attached to a small electric lamp bulb. The telegraphic flashing off and on always draws a big crowd of men and boys, who gasp in astonishment at the unfamiliar signaling apparatus.

As soon as a bystander manifests the slightest interest and starts asking questions, one of Uncle Sam's smart khaki clad soldiers gets busy and explains the many advantages of the service to him.

The main offices for the Eastern Division are at 39 Whitehall street, New York, and all communications and inquiries should be address to Major Henry G. Opdycke, who is in charge of recruiting in New York City and vicinity.

It's up to you, so show your colors!

DeFOREST LOSES "AMPLIFIER" AND POSSIBLY "OSCILLION" PATENTS.

Judge Julius M. Mayer found the following on July 11, for the Marconi Company, plaintiff, against the de Forest Radio Telephone and Telegraph Company, defendant:

"This is the return of an order to show cause why the decree and injunction heretofore made and issued does not cover and include certain devices which defendant makes and sells and why the reports already filed *should not be extended to include such devices.*

"The devices in question are called 'amplifiers' and 'oscillions.'

"In the first place, this procedure is correct. It has frequently been followed in this court and, as I understand, approved by the Circuit Court of Appeals.

"The opinions of the Circuit Court of Appeals and of this court on the main controversy so fully discust the essential features of the patent and the infringing device that it must be assumed that the litigants are, by this time, fully informed of the views of the two courts. As in the original case, there is again the use of 'Audion' language, which is more or less meaningless from the standpoint of the patent law and certainly does not add to a clear understanding of what has now become reasonably simple, even in an abstruse art.

"1. An *amplifier* consists really of two or more detectors in tandem with a telephone transformer interposed between each element of the series. The primary element of such an amplifier may be either an Audion or any other form of detector. In some of the amplifier sets sold by defendant, the primary element is a part of the outfit. In other instances, the primary element is not part of the outfit.

"I fully agree with Waterman on his facts and explanation as to the 'amplifier'. In other words, an 'amplifier' is part of a detector. In any event, the case falls under the familiar rule of Roberts v. Ryer, 91 U. S. 150, 157, many times since reiterated and followed. I have no doubt whatever that the motion in this regard must be granted.

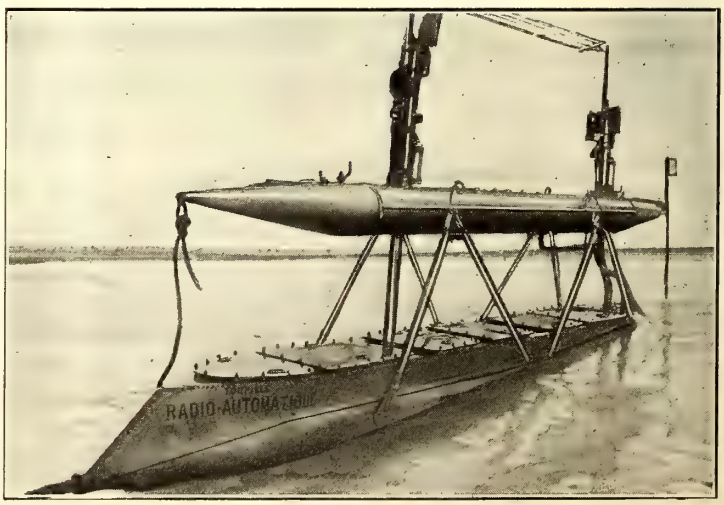
"2. I am not clearly convinced that the Fleming valve can perform the functions of an 'oscillion' so as to oscillate and generate radio waves. On this branch it will be necessary to give demonstrations or oral testimony or both and witnesses should be subject to cross-examination. This is really equivalent to a trial. My view is that where the court on an application of this kind is not clearly convinced that the motion should be granted, then the proceeding should be by bill and answer, because the inquiry necessarily develops into a trial, and, therefore, the issues should be clearly joined. There is usually little saving of time or labor in short cuts.

"The motion, therefore, as to 'oscillions' is denied."

A FRENCH RADIO CONTROLLED TORPEDO.

By Frank C. Perkins.

The accompanying illustration shows a remarkable French automatic wirelessly controlled torpedo on the River Seine. The control of this torpedo from a distance is accomplisht by a wireless operated valve supplying comprest air to the motor. To turn the torpedo one way or the other the rudder is moved by two solenoids controlling the air valve by means of different wave lengths. To steer the torpedo to the right one set of wave lengths are used, the coherer acting on the proper solenoid and operating the air valve turning the rudder in that direction. To turn the rudder so as to swing the torpedo to the left, another similar mechanism is used which works on another wave length. At the wireless controlling station there is checking and tally apparatus.



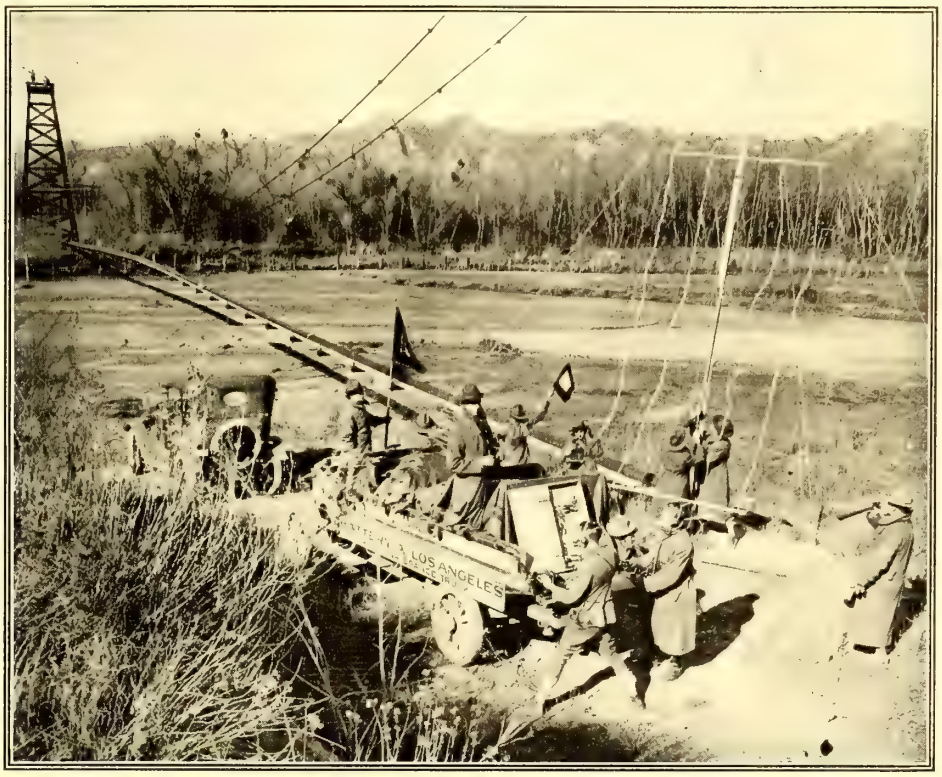
A French Radio-Controlled Torpedo. Such Devices as These, If Made to Resist Enemy Radio Interference, May Prove One of the Deciding Factors in the World War.

PORTABLE WIRELESS REPORTS CALIFORNIA "WASH-OUTS."

By Charles W. Geiger.

During the annual rainy season in Southern California, a wireless outfit is sent out in all directions to report the condition of the roads and various bridges that may have been washed out.

The wireless outfit is mounted on a 1½-ton motor truck. The equipment consists of field telephones, switchboards, relay coils, guys, metal pins, aerial and demountable poles, head sets, telegraph keys and other equipment. The truck made 30 miles an hour on good roads. It carried a company of 15 men. The following is a copy of a wireless report from the expedition: *"Roads open Bakersfield Castaic Wash quick sand dangerous cars sinking to frame passable towed county team Ridge route passable from end State highway to Castaic rough dangerous Bakersfield reached Bouquet canyon Elizabeth lake rough thruout deep ruts bogs Mint closed (Signed)."*



In California They Have Developed a New Use for the Radio. During the Rainy Season a Portable Radio Outfit Is Sent Out to Report the Road Conditions.

MISS SYDNEY SHIELDS, WIRELESS OPERATOR.

Miss Sydney Shields, the little leading woman who was recently seen in "The Case of Lady Camber," is the very first woman of the stage to have completed a wireless telegraphic course. She is now ready to enlist in the Signal Corps of the United States Navy. Wanting to be especially efficient in the field she has chosen to serve her country, Miss Shields has taken a post-graduate course in the various other ways of marine signaling—by means of flags and semaphores, Ardois lights and "blinkers." Just now she is intensely interested in the new means of communicating on the high seas with "smoke signals," which are electrically operated, according to the Morse code.

"Although it may seem wicked to say so," said Miss Shields, "I have never had such a good time as since war was declared. When I was a youngster my greatest regret was because I was a girl instead of a boy. I wanted to be a sailor."

A high barbed wire fence now surrounds the United States radio station at North Head, Wash., and the strands of wire are heavily charged with high-tension electricity.

The Present Status of the Audion

By Dr. LEE de FOREST

NOW that the U. S. Circuit Court of Appeals has refused to reverse the lower Court's finding that the Audion is an infringement of two claims of the Fleming Valve patent, a brief review of the facts brought out in the trial will be of interest to all radio men.

First of all it was shown that both Fleming and de Forest utilized the *Edison effect,* or the incandescent lamp with a cold electrode—Fleming as a rectifier simply and solely, connecting the cold electrode, always and invariably, to the negative of the filament battery; that this rectifier was inferior to any ordinary crystal rectifier, and has never been used in commercial wireless signaling; incidentally that Fleming claimed in his patent that he *had discovered* this rectification phenomenon, quite forgetful of Edison, Howell, Wehnelt, etc. Further, that de Forest was the first to disclose the use as a wireless detector of the heated electrode in gas—at atmospheric or rarefield pressure; that by the addition of the *B-battery* in the telephone circuit a genuine relay (as distinguished from the rectifier) effect was obtained, of much greater sensitiveness; that two years after de Forest's disclosure of the Edison lamp relay detector with *B-battery,* Fleming recognized the *new way* as he styled it, in which this incandescent lamp detector can be used, and patented a form of *B-battery* "valve" of which some 200 were used; that long prior to this "discovery" de Forest had introduced the third, or *grid* electrode, which at once placed the Audion in a class by itself; that this grid principle and numerous improvements which de Forest and other inventors had brought out from time to time had made possible the reliable trans-oceanic telegraphy, trans-continental telephony (wire and wireless), the Audion Amplifier of low and high-frequency currents, the Ultraudion, or self-heterodyning detector, the Oscillion or generator of undamped waves of any length; that tens of thousands of grid Audions have been, and are in use by every Government in the world; that the present state of our U. S. Navy Radio Service, and of the Radio Art itself, could not exist without the Audion; that the Fleming valve (as disclosed in his U. S. and Foreign patents), had contributed nothing whatever of utility to the art, and has evolved not at all; that the rectification effect on which the valve must absolutely depend (ceases) when both electrodes are heated; that the Audion effect on the other hand is unaffected whether *one, two or three electrodes are incandescent;* that any rectification effect, if existent at all, is wholly *parasitic* and of no effect in the genuine relay and extraordinarily sensitive actions which make the Audion so immensely practical.

However, and largely due to the clever and fact-defying feats of the Marconi expert, all the above considerations availed nothing to convince the Court that a very great injustice would be inflicted by granting to the inutile Fleming patent, domination over what all unbiased scientific minds the world over have come to regard as one of the most radical and practically valuable devices yet discovered in the art of signaling, by wire or wireless. Truly—"the Shadow dominates the Substance."

This Audion patent case is on all fours with that of the famous Selden automobile patent, but with this immense difference: the Court there, while finally sustaining the visionary and impractical Selden patent as *basic,* so limited its applications that its owners were no longer able to extort tribute from those who had actually developed the gasoline-engine-propelled vehicle of commerce.

Early in the Audion trial the Marconi Wireless Telegraph Company confest the validity and their infringement of the de Forest grid and amplifier Audion patents, and are now perpetually enjoined from these patents. They are at present endeavoring to avoid this hardship by developing an Audion with the grid member on the *outside* of the glass, in defiance of the de Forest Patent No. 841,386; but due to the present inferiority in sensitiveness of this to the *interior* grid Audion, they have not yet used the device in practise. They were also forced to file a disclaimer in the Patent Office, limiting their claims to *high-frequency* currents—as otherwise all their claims were invalid on their face, in view of Edison. For ten years those claims have thus stood obviously invalid and un-menacing to a rapidly developing Audion art.

To those familiar with U. S. Courts of Appeals in patent causes, the recent sustaining of the Lower Court's finding in so highly technical a case detracts nothing from the true merits of the Audion as against the "valve." It is the consensus of unbiased opinion of those acquainted with the facts that an opportunity to correct a grievous injustice has been regrettably lost by this court.

"Radio"-Communication Over Gas and Water Pipes—"Wired Wireless"

WE have been careful in studying the various phases embodied in this article, and it is our opinion that amateurs may now find a good as well as practical use for their outfits. Let it be understood that the ideas set forth in this article, do in no way violate the President's order, as no radio waves are either radiated in free space (ether), nor can outside radio messages be received with such outfits. From this it follows that "Wired Wireless" is nothing but a modified telegraph wire line. The "wire" in this instance being the gas or water mains.

By means of this system, amateurs should be enabled to cover modest distances by relaying messages from house to house or from block to block. This should keep them in trim until such time when we will be allowed to send and receive real radio messages.

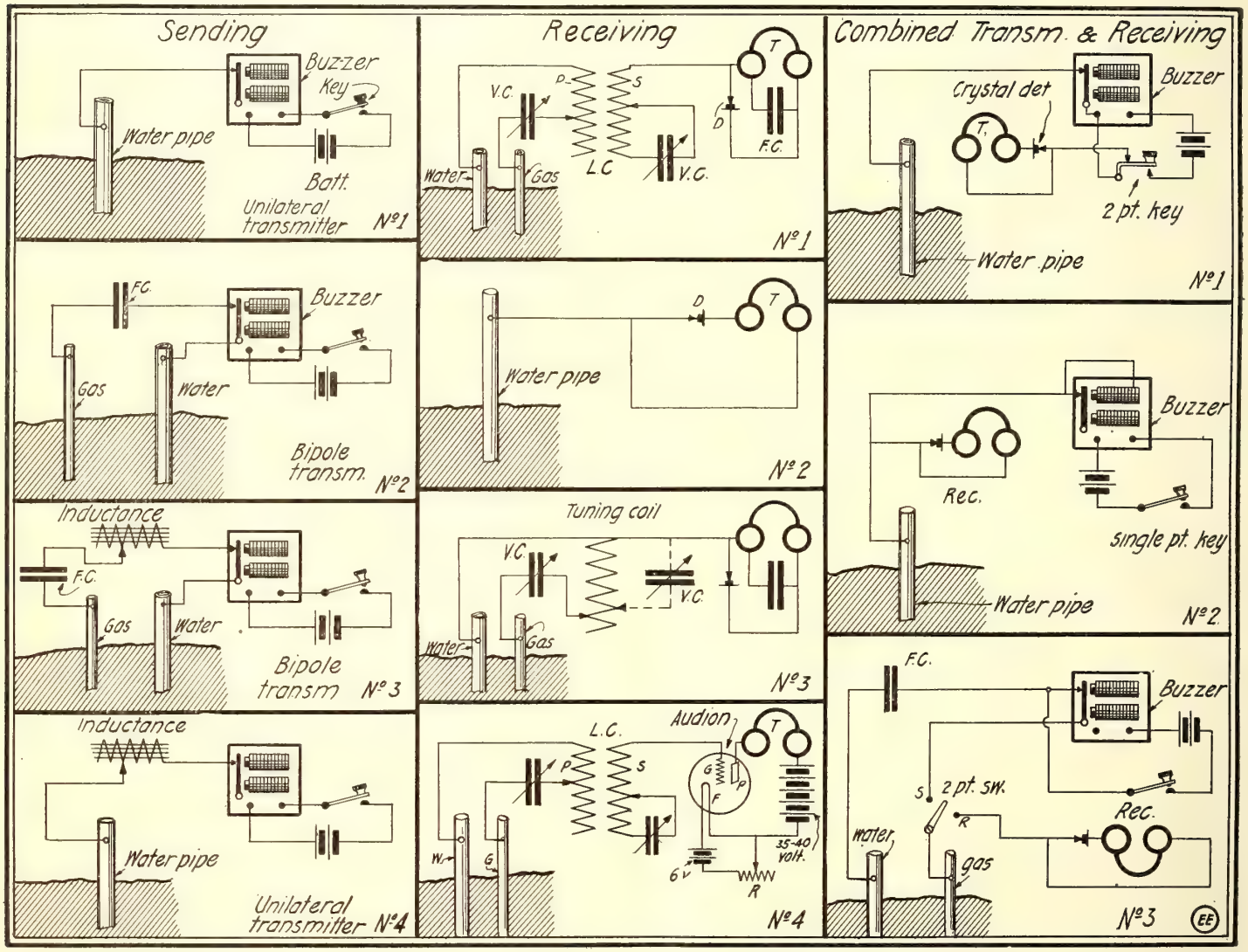
THE radio amateur has undoubtedly in many instances felt that all was lost after amateur and experimental radio stations thruout the country had been closed by order of the President. In the following paragraphs there are given a number of new ideas which it is believed the radio amateur will find of considerable interest under the present stringent conditions governing all such work.

The general scheme here outlined is to carry on *short-range communication* by means of radio apparatus of *extremely low power*, and with which it is not possible to transmit or receive messages over a distance exceeding a few city blocks or possibly one-quarter of a mile.

The circuits shown are presented in three different groups under "Transmitting," "Receiving," and "Combined Transmitting and Receiving Hook-ups." The idea in general is to utilize the ordinary buzzer, such as commonly used for signaling purposes in place of bells, etc., as the reader will perceive from the diagrams here given.

Referring first to the sending circuits, an ordinary buzzer is utilized thruout in Figs. 1 to 4. In Fig. 1, there is shown a low-power buzzer transmitter, a connection being establisht between the water pipe (or a piece of pipe or other metal driven into the damp earth) as indicated. This connection being known as *unilateral* excitation. It should be used wherever a short distance of a few hundred feet is to be covered, so as to not create any undue disturbance or interference with other stations which may be using a similar transmitter.

The buzzer transmitter shown in Fig. 2 represents a *bipolar* transmitter, connections being establisht between the gas and water pipes to the contact screw and armature terminals of the buzzer, interposing a small fixt condenser in series with one of these leads to prevent short-circuiting the buzzer coils. This is a more efficient type of transmitter than that shown in Fig. 1.



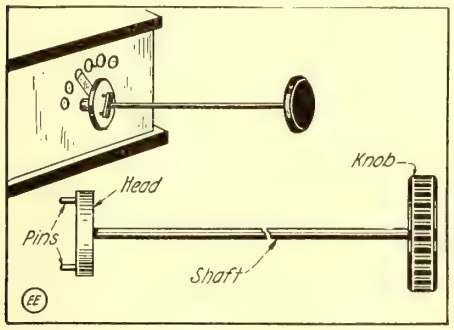
"Radio-bugs" Who Are Grieving Their Hearts Away Because They Cannot Use Their Radio Apparatus, Will Find This Group of Short-range "Wired Wireless" Hook-ups of Interest. A Buzzer Transmitter Is Employed and a "Unilateral" Receptor.

Diagram Fig. 3 shows a *bipolar* buzzer transmitter, connected to the gas and water pipes with a fixt condenser in series with one of the leads, and also utilizing an extra *kicking* inductance in one of the exciting leads. This inductance may consist of a soft iron wire core, about ¾ inch in diameter by 6 inches long, wound with several layers of No. 16 insulated magnet wire. The inductance coil tends to intensify the radiated current by the self-inductance action of the coil and iron core. Fig. 4 shows a *unilateral* connection of buzzer with inductance coil.

(*Continued on page* 332)

A CONTROL HANDLE FOR UNDAMPED WAVE TUNERS.

In the handling of super-sensitive undamped wave apparatus, the operator is put to a great deal of inconvenience by the fact that the proximity of his hand to the apparatus has a marked effect upon the operation.



To Prevent "Body" Capacity Interfering With Undamped Wave Audion Tuning Use May be Made of This Extension Handle.

To overcome this annoying and time consuming condition, there is a scheme whereby the knobs of the control are extended as far from the set as is necessary to keep the operation of the set stable. This plan, while effective, disfigures a neat appearing set, and takes up valuable room.

To secure the advantages of the above plan, at the same time doing away with the disadvantages, the author devised the controller shown in the sketch, which is self-explanatory. The entire device should be made of Bakelite, hard rubber or fiber, with the exception of the pins, which may be of brass. The knobs of the set have two small holes drilled in them to receive the pins. These holes need not be very deep, and will not mar the appearance of the apparatus in the least.

In operation the device is used for fine or close adjustments. The set is roughly tuned to the incoming wave in the usual manner. Upon removing the hand, the signals often die completely out. Then by using the controller, the signals are brought back to their original loudness.

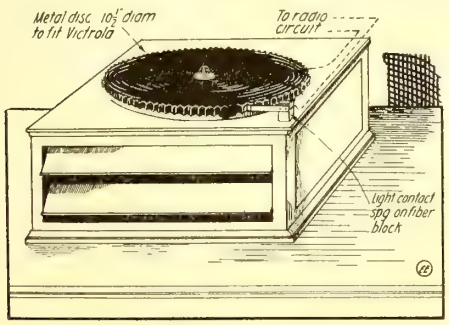
The hard rubber rod should be not less than twelve inches long. With some sets two feet may be necessary.

Contributed by C. S. ROBINSON.

TRY THIS ON YOUR "VICTROLA."

Most of "us amateurs" who are still without Audions can make use of their pet phonograph to receive undamped waves. Where no motor is available to drive the *tikker*, cut out a metal disc about 10½ inches in diameter, having nicks evenly spaced about the circumference, ⅛ inch apart. When the phonograph is not otherwise engaged, put on this new *record* and use it as a circuit-breaker in place of the ordinary crystal detector in the receiving circuit. Try it—it works!!

Contributed by F. C. HAMILTON.

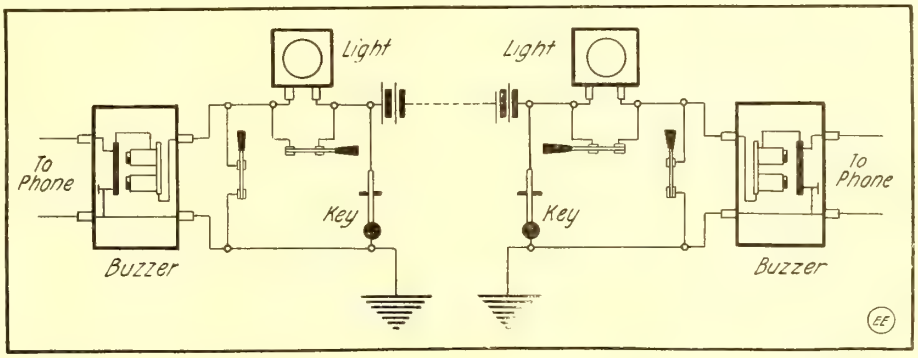


A Toothed Metal Disc Driven By a Phonograph Motor So As to Interrupt the Condenser Circuit Rapidly Provides a Serviceable "Tikker."

AN EFFICIENT SCHEME FOR LEARNING THE CODE.

To learn the code well, altho not difficult, requires considerable and attentive practise. Very often the beginner claims he knows the code well, giving as proof his ability to send. The proof, however, should be his ability to receive well and the impatient learner usually fails in this attempt. Confusion, the cause of this, is the result of the incoming signals not being imprest sufficiently upon his memory to respond quickly. His efforts should therefore be directed to methods more suitable than the ordinary sound signals.

Referring to the accompanying sketch, the lead wires lettered "to phone" are taken from the stationary contact and armature of the ordinary buzzer. In series with the buzzer is a small electric bulb of the flash-light type. By enclosing the light in a small box which supports in front of it a small transparent screen of a gray color, the persistence of vision on the retina of the eye will not be effective to such a degree as to interfere with the proper reception of signals. The buzzer should be adjusted to a high pitch and packed in a box with cotton. Four dry cells, two at each end of the line, will provide current enough for several hundred feet. The operation of the line is as follows:



With the Arrangement of Lamps and Buzzers Shown, the Telegraphic Signals Are Imprest on the Student's Mind Both Visually and Aurally.

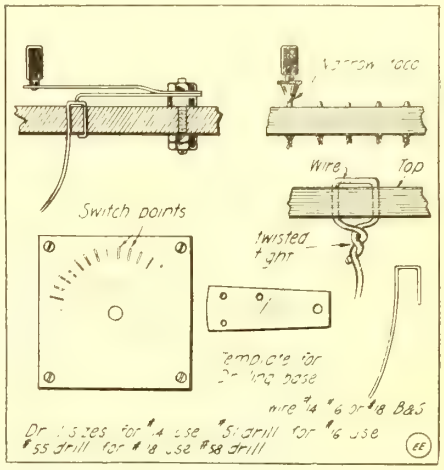
When receiving, the beginner should look attentively at the gray screen in front of the electric bulb. The receiver should be held on his ear by the customary head-band and may be of the seventy-five ohm type. When the key is deprest at the other end, he will not be confused, as the light and buzzer will act simultaneously in their action on his mind in the same manner that persons speaking naturally convey their meaning by facial expression and words, the two always acting in harmony. By means of the cut-out switches shown, any one of the instruments at either end of the line may be used.

Contributed by JOSEPH BRAFF.

PLACING LARGE NUMBER OF SWITCH POINTS IN SMALL SPACE.

For use where a large number of switch points are necessary in a small space, or where the regular switch points are geographically or financially out of reach, this switch is recommended. Forty-eight of these points can be put in a two-inch circle with as much or even greater separation between points than is usually allowed.

The template is a rather thick piece of metal. The stud for the center hole of the



This Scheme Proves That There Is a Way to Get an Unusually Large Number of Switch Contacts In a Small Space.

switch is soldered fast to it, and three holes, of the size given for the different sizes of wire, drilled in the outer end. In making a switch, the stud is inserted in the central hole of the base and the first hole drilled. Put a pin (a phonograph needle) through the template into the base in this hole and drill the next pair. Then move the template so that the pin will enter the outer hole of the pair just drilled, and drill the next pair; continuing in this manner until the required number have been finished.

This method insures a true, evenly spaced switch, without use of dividers, or laying out the switch base, marking it off, etc., and when carefully made the switch is a neat and very efficient article. Enameled wire may be used for the points, and cleaned off on top with sand or emery paper, after the switch is finished. The wire is best twisted several times on the back of the base or panel, so as to ensure its remaining in place permanently. Tap leads from coils may be soldered to the twisted wire stubs. The idea is very useful in building miniature loose couplers.

Contributed by C. E. P.

RADIO STATION CHART FOR TUNING DATA.

The chart here shown will prove useful in any wireless station for keeping a record of the setting of the instruments. It saves time and patience, as one can tune any station on the minute providing it is recorded

Station Chart

Station	Coil	Wv Lngth	Time	Prim	Sec	Cap	Gap	Loud	Remarks
Arlington	W.A.A	600-6000	Continuous	5 points	4 points	52°	150°	0	Very high note etc
Brooklyn	W.A.H	1000 etc	11.30	3 "	3 "	130°	30°	3 points	Loud sharp note
Yauen-G	P.O.Z	12000	10.30 P.M	10 "	6 "	20°	60°	45 "	Undamped

Radio Operators Will Find This Method of Keeping Station Data Very Efficient for Rapid Tuning.

on the chart. Such a chart will also show how far you can receive.

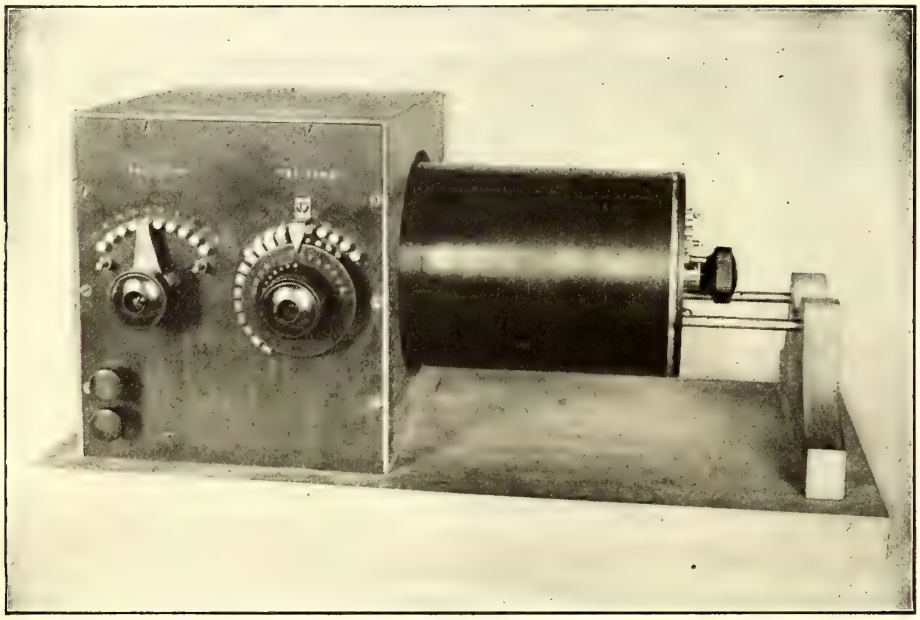
Contributed by MAURICE L. MUHLEMAN.

Calculation and Measurement of Inductance

By H. WINFIELD SECOR AND SAMUEL COHEN

PART 3 (*Conclusion*)*

HAVING thoroly discust the methods of both calculating and measuring the inductance of coils, we are now in a position to continue with the design of the most important type of inductance coils used in radio work. We will confine ourselves to the types of coil which are mostly used, namely—loading inductances, loose couplers, variometers and transmitting oscillation transformers.



A Modern Long Wave Loose Coupler Provided With Dead-end Switches. To Ensure Accurate Inductance Adjustments in Any Case, All Switch Connections Should be Mounted on Hard Rubber or Bakelite. A Large Loose Coupler Is Usually Superior To a Small One and a Loading Coil.

Before we delve into the actual design of these coils, let us first consider the first fundamental facts necessary for the design. Since the inductance is employed in building up the proper oscillating condition of the circuit and consequently the wave length, we can express this relation by the following formulæ:

We have first the formula expressing the wave length, *W.L.*, of the open (antenna) oscillatory circuit, thru the primary, L_o, of a loose coupler, loading or tuning coil.

$$W.L. = A \sqrt{L \times C} \; ; \qquad (1)$$

where:—

A = a variable, ranging from 38.15 to 59.6 for short wave lengths. (See curves for various values of "*A*" in article above cited, in February, 1917, issue.)

L = total inductance in centimeters of aerial, including lead-in and loose coupler, tuning coil or loading coil.

C = capacity in micro-farads of aerial, including lead-in.

Those interested in this subject should refer to the excellent article on "The Design of Large Radio Receiving Transformers," by C. S. Ballantine, in the February, 1917, issue of this journal, page 732. The variable factor, 59.6, appearing in the usual wave length formulæ was there discust at length, with a graph giving the different values of this function for various wave lengths and aerial inductance to localized inductance ratios.

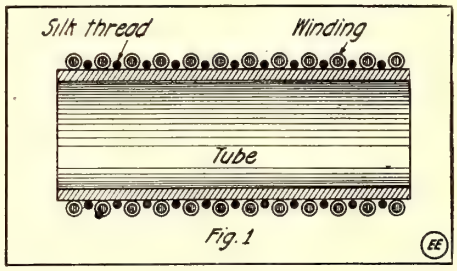
Considering long wave lengths (10,000 meters and higher) and the design of large loose couplers, we are safe in using the expression:

$$W.L. = 59.6 \sqrt{L \times C} \; ;$$

where:—

L = inductance of loose coupler primary and loading coil (if used); the inductance of the antenna being neglected, owing to its small value compared to the inductance of the loose coupler (or loading coil).

C = capacity of antenna, including lead-in.



One Method of Winding Radio Inductances Involves the Use of a Thread Spun on Between the Turns.

For designing short wave apparatus we shall call L_o, the value of the loose coupler (or tuning coil) primary inductance. Then we have:

$$L_o = \frac{\lambda^2}{3552 \times C} - L \; ; \qquad (2)$$

here:—

L_o = inductance of load (loose coupler, tuner, etc.), in centimeters.

λ = maximum wave length to be tuned to.

L = inductance of antenna and lead-in in centimeters.

C = capacity of antenna and lead-in in micro-farads. (See tables herewith for these values.)

For long wave apparatus, let L_o represent the loading coil inductance, plus the inductance of the loose coupler primary (or tuner, if used). Then we have the formula:

$$L_o = \frac{\lambda^2}{3552 \times C} \; ; \qquad (3)$$

with all values the same as in formula No. 2.

The following tables will be found useful in applying the above equations to the design of loose couplers, etc.

TABLE "A"

Cap. in M.F., Including Lead-in, of 4 Wire Inverted "L" Aerials. Wires Spaced 3 Ft. Apart

Height in Feet	Length of Flat-top in Feet 60	80	100	120
40....	.00033	.00042	.00051	.00060
50....	.00035	.00043	.00050	.00058
60....	.00036	.00044	.00051	.00059
70....	.00037	.00045	.00052	.00059
80....	.00039	.00046	.00053	.00060
90....	.00040	.00048	.00055	.00061
100....	.00042	.00049	.00056	.00062

TABLE "B"

Inductance in Cms., Including Lead-in, of 4 Wire Inverted "L" Aerials

Height in Feet	Length of Flat-top in Feet 60	80	100	120
40....	35,000	41,100	47,200	53,310
60....	48,800	55,460	62,090	68,700
80....	62,400	69,320	76,300	83,300
100....	76,260	83,500	90,750	98,020

It is possible to determine approximately the inductance required to produce a desired wave length when the capacity of the total oscillating system is known. When using any of the above formulas, it should be remembered that they include the total value of the unit. Thus, the capacity factor includes the antenna, and condenser capacity, each of which must be determined separately and the capacity of the antenna must be obtained by actual calculation, formula for deriving this quantity having been given on page 732 of the February, 1917, issue of this journal, as well as a table of the capacities of a four wire antennæ of different lengths and heights.

The first step in the design of an inductive tuner (having determined the wave length) is the actual size of the instrument, and from this to find the approximate dimensions of the winding tubes to be used. Having these on hand, and knowing the maximum inductance of the primary by equations (2 or 3), we can immediately determine the number of turns that the primary coil will require to obtain the wave length sought, by solving equation (3) of (Part 1, March, 1917, issue) for N;

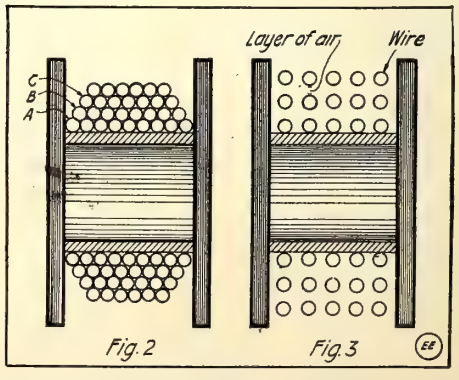


Fig. 2 Shows a "Staggered" Radio Inductance and Fig. 3 a Sectional View of the New "Morecroft" Multilayer Radio Winding, Designed to Have Minimum Distributed Capacity.

*Parts I and II of this series appeared in the March and April, 1917, issues of THE ELECTRICAL EXPERIMENTER.

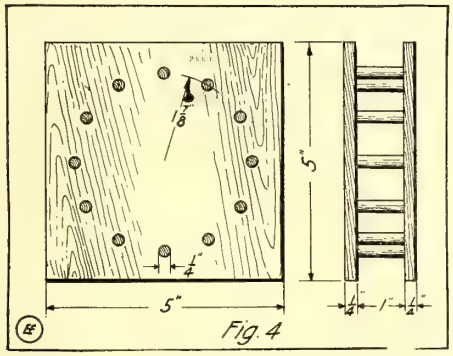
in terms of units we obtain the following relation:

$$N = \frac{1}{5d}\sqrt{\frac{L\ (3\ S + d)}{3}} \qquad (4)$$

Where:—
N = total required number of turns.
d = diameter of coil in inches.
S = length of coil in inches.
L = inductance required in centimeters.

The inductance of the secondary winding should be such that its wave length should correspond very nearly to the antenna circuit, and that of the primary. If this condition is to be obtained, then we have an ideal condition of maximum efficiency and great care must be exercised in bringing about this ideal condition. The value of the secondary inductance must therefore be in the neighborhood of the primary (unless it is to be shunted by a variable capacity), but in practise it is made somewhat larger than that of the primary. It is customary in coupler design to allow one-half inch difference in size of diameters between the primary and secondary tubes and therefore the diameter of the secondary can readily be determined. The number of turns required is deduced from equation (4).

The size of wire to be used on the secondary coil is a very important factor in efficient couplers, and the only factor controlling the diameter of the wire to be used is whether a crystal or Audion detector will be connected in the secondary circuit. Since the latter type is a potential operating device it is essential that the winding should consist of a smaller wire than if the same coil is to be connected to a crystal detector. The reason for this is that the energy received by the secondary winding is so infinitesimally small that any superfluous resistance in the secondary circuit due to small wire winding destroys the intensity of the rectified current in the telephone receiver; but this condition does not hold true for a potential operating detector where the superfluous resistance is overcome by applying a greater potential in the circuit by the variation of the "B" battery of the Audion circuit. It was found from actual experiments carried out by the authors that with an Audion detector, the secondary winding should be made with a gage wire ranging

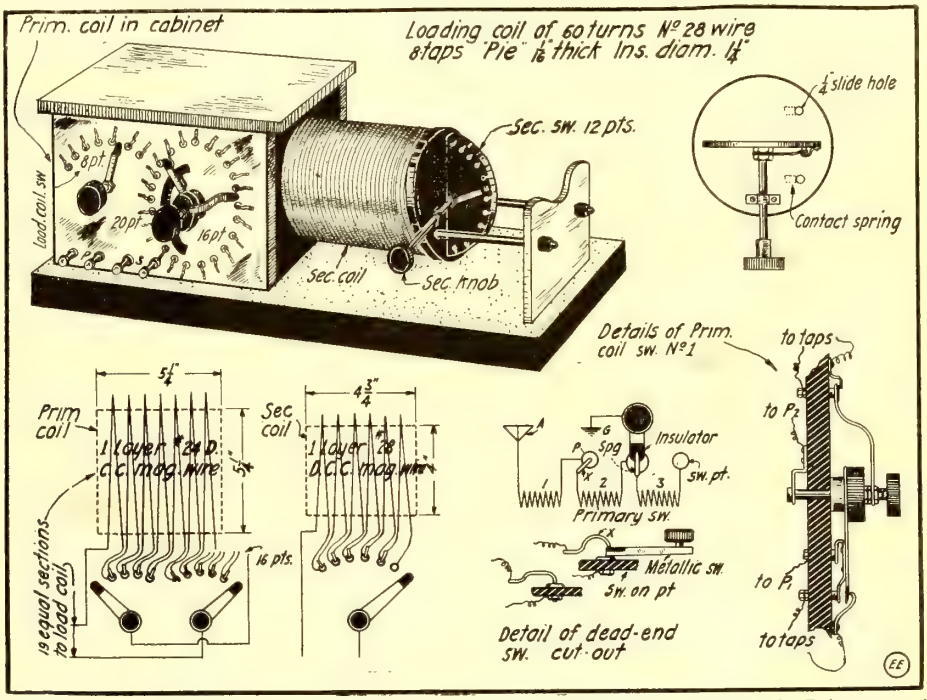


Details of a "Morecroft" Radio Inductance. In Winding the Coil, a Layer of Card-board is Placed Between the Layers to Give a Spacing Between All Turns as Shown Clearly in Fig. 3.

from No. 28 to 32 B&S, while with a crystal detector numbers 22 and 24 were found to give best results.

After the primary and secondary coil quantities have been obtained, the specified design is completed and the next step is to consider the general mechanical features of the tuning devices and the manner in which the coils are held in place; the latter will be left to the builder, since each one has his own idea of finishing up an instrument.

It is advisable at first in winding the coils, that no shellac or any kind of varnish be applied to the wire to keep it in place, as the capacity dielectric losses between adjacent turns are considerably increased, which naturally decreases the efficiency of the instrument. An ideal method of winding the wire is to cut a very fine thread on the surface of the tube in a lathe, and winding the wire in this thread. If a coil of this kind was going to be made, hard rubber or Bakelite should be used; the latter is preferable since it



Construction Details of 4,000 Meter Loose Coupler Having Dead-end Switches in Primary and Secondary Circuits. The Secondary Terminals Are Attached to the Slider Rods, Against Which Two Brushes Bear, These Brushes Being Placed Inside the Secondary Form.

does not warp during changes of weather conditions. The method of winding a wire on a threaded tube is also advantageous in reducing the distributed capacity of the winding.

Still another method of winding the wire on a coil upon which a thread can not be machined, is to wind a fine silk thread between adjacent turns. Fig. 1 shows how it is done. This method of winding has been used considerably in building high grade inductance coils and has proved of sufficient merit to warrant its use with inductive coupler windings.

The question of tap connections and switches is a very important one in designing inductive transformers, and the following points should be kept in mind by the designer: *i. e.,* that all connections from winding leads should be as short as possible; all connections are to be invariably soldered and if possible they should consist of *stranded cable* in order to reduce lead resistance. These terminal leads should be soldered to copper lugs which are connected to the switch point. The latter must be free from any lacquered plate coating as this increases the high frequency resistance due to an increase of metal surface. It has been found, however, that if the metal is silver-plated and its surface kept white (not lacquered), that the increase of surface resistance to high frequency currents is negligible. Care should be taken to keep the buttons and switch blade contact as clean as possible, in order to minimize the contact resistance. This also applies to the elimination of the use of lacquer or any other form of polish on switch contact surfaces.

It is advisable in building a coupler to always employ a *dead-end switch* in order to reduce losses due to the distributed capacity inherent in the coil. Both primary and secondary windings should be equipt with one of these switches, and a very excellent and easily constructed type was illustrated and described on page 33 of the May, 1917, issue of THE ELECTRICAL EXPERIMENTER.

A great deal of deficiency and loss of energy accrues to the use of wood, hard rubber and fiber for switch panels, as the former usually contains water, acid or other mineral substances, which cause a partially short-circuit on the taps; consequently not permitting the total energy to traverse the winding, which naturally does not permit the total flux induction to take place between the windings.

The fiber and hard rubber panels are not satisfactory for the simple reason that their surface deteriorates in time, and with the latter material, a film of sulfur is formed which collects dust, into which metallic particles lodge. These produce a short-circuit between contacts. Fiber, too, is rather hygroscopic. The best material for the construction of switch panels is Bakelite, which makes an ideal insulator for radio work. It is used on all receiving sets now built by the large commercial companies.

For the benefit of those who desire to build an excellent 4,000 meter loose coupler, we give herewith a complete working drawing of one.

There is still another type of inductance coil which has recently proven very satisfactory for tuning long waves, and this is the *multilayer coil.* During the last few years considerable criticism was made against the use of these coils, due to the untoward distributed capacity effect produced by adjacent layers. However, these criticisms lost themselves among certain radio engineers who have been working on this problem and notably the Telefunken experts, who have evolved the so-called *staggered winding* multilayer coils, which consists of tapering layers of wire on top of each other in the manner shown in Fig. 2. The first layer A was wound in the usual way; the second layer B was

(*Continued on page 322*)

"RELAY KEY" MADE FROM TELEGRAPH SOUNDER.

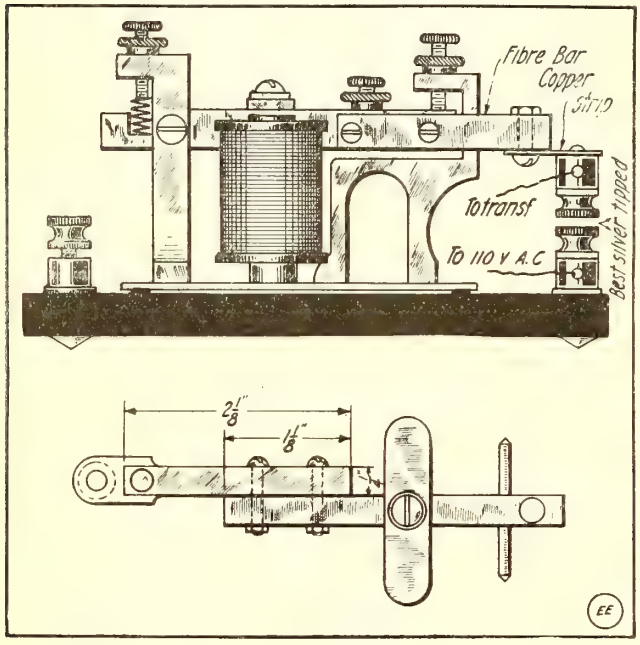
I give below description of an easily made relay key.

A good many amateurs are using the small (legless) type of telegraph key and are bothered with the points burning away —at least that was my trouble until I thought of this way of preventing it.

I don't think that this *key* has ever appeared in your magazine as I have been a reader of THE ELECTRICAL EXPERIMENTER for the past two years and have never run across it among the pages of your very useful magazine.

The relay key, which is nothing more than an old telegraph sounder, is easily made and I think that most amateurs have the necessary material lying in their junk heaps.

Cut a piece of fiber 2⅛"x⅜"x¼". Drill two ⅛" holes thru this and the bar of the sounder and fasten these together with bolts. Then drill a hole thru the outer end of the fibre bar and fasten on a piece of copper, to which an old binding post has been riveted. Another binding post serves as the bottom contact, it having been fastened to the base of the sounder, as shown in the drawing, when the key is ready to hook-up. Two dry cells will be sufficient to operate this key as it works similar to the telegraph sounder and the battery will not burn the points off the small key as will the A.C.



Substantial Design of Heavy Current Relay Key Which Can Be Made from a Discarded Telegraph Sounder.

Contributed by DON I. BAILEY.

CALCULATION AND MEASUREMENT OF INDUCTANCE.

(*Continued from page* 321)

started from the center of the first two turns as shown; the third between the first two of the second layer and so on until the last winding which consisted of a single turn.

Great precaution must be exercised in making the turn for the approaching next layer. This is done by making a sharp bend in the wire. This type of coil has been used with success for a number of years by the Telefunken concern, and they are still being used. They are excellent for building inductances for long wave lengths in a small space.

Something new in multilayer inductances is shown in Figs. 3 and 4. This design is due to Prof. J. H. Morecroft of Columbia University, who has done considerable research work in radio.

It was pointed out in an article on "Distributed Capacity and Its Effect" in the May, 1917, issue, that on the long single-layer coil the distributed capacity increased with an increase of coil length, and that the potential effect is greatest at the end of the coil. It naturally follows that with extremely long coils the voltage is extremely high at their ends, as compared with any of the apparatus used in the tuning circuit. It has usually been considered that multilayer coils had considerably greater distributed capacity than those of the single layer type, due to the proximity of the layers making up the coil, but it has recently been found that by properly constructing such coils, the inherent capacity is minimized. This fact was proved by constructing two multilayer coils where the layers of each winding were separated by a layer of air as indicated in Fig. 3. One of these coils has twenty layers, the other ten layers, yet the distributed capacity was found to be very low, or of the order of 25 centimeters and an inductance value of about 70 milli-henries.

The winding is made over a cagelike insulating reel, by eight wood pins past thru two end pieces. After one layer is wound a strip of cardboard is placed across the winding right over each wooden peg. The next layer is then wound on and the cardboard strips give an air space between the two layers. Each successive layer is wound in a similar manner, giving an air space between layers.

The inductance of multilayer coils of the Morecroft type is obtained from equation No. 10, Part 1 of this series. The notation of symbols is the same. The cross-sectional diagram, Fig. 2, of the first series shows a multilayer coil without an air space between layers, but the relation of the units holds true for the air space coils, since the dimension of the air space must be considered in the actual calculation.

In determining the capacity of multilayer coils the following equation has been found quite accurate:

$$C = \frac{a}{420}\left[\frac{b\,e}{c\,x} + 0.8\right] \qquad (5)$$

Where:—

C = capacity in milli-microfarads.
a = means radius of coil (inches).
b = axial length of coil (inches).
e = 2.718.
c = winding depth of coil (inches).
x = insulation thickness between layers in mils.

The first part of the equation represents the capacity due to the dielectric flux between layers, and this varies with the different parts of the coil as the variation of voltage is different at the various lengths of the winding. It also takes care of the dielectric losses due to the wire, and for air, which is used in the Morecroft coils, it is unity. Various other losses are encountered in these types of coil such as eddy current, hysteresis and skin effect, all of which losses are still under investigation.

The general construction and dimensions of the Morecroft multilayer coil is shown in Fig. 4. The ends are made from well-seasoned wood and the ¼" dowel pegs are glued into the holes made in the side pieces as indicated. The winding consists of ten layers of No. 30 silk covered wire. Each layer consists of 75 turns.

The great advantages of these coils are that long wave lengths can be tuned with a small size coil, and the capacity effect of the operator's body upon the coils is minimized, which eliminates the detuning effect on the oscillating Audion circuit when the operator stands near his apparatus. This effect is very noticeable when the long inductance coils are employed.

This completes this series, and it is the aim of the authors to have the information given herein accurate and concise so that it may prove of value to both the electrical and radio experimenter who reads these columns. The student who is endeavoring to master the various problems of the calculation, measurement and application of inductance coils in radio circuits will do well to procure copies of the March and April, 1917, numbers, the three articles forming a complete series. This is a subject which no prospective radio expert, whether operator or engineer, can afford to neglect.

AUDION EXPERT IS AWARDED RADIO ENGINEER'S HONOR MEDAL.

The first award of the medal of honor of the Institute of Radio Engineers which was described and illustrated in our July issue of THE ELECTRICAL EXPERIMENTER has been presented to Mr. Edwin H. Armstrong, E. E., of the Radio Research Department, Columbia University, New York City, in recognition of the valuable contribution to the art represented in his work in connection with receiving apparatus, and particularly to the efficiency of the well-known *Armstrong Circuit.*

It will come as a surprise to many of our wireless readers no doubt to learn that Mr. Armstrong's regenerative Audion circuit was developed and perfected in his amateur experimental days. This simply goes to prove that much is to be gained by experiment in the radio field, and this should prove a decided incentive to every radio amateur worth his salt. Certain it is, that little may be gained that is really worth while by simply owning a radio station, if one intends to simply sit at the apparatus and punch the key. In this, as in every other field of scientific endeavor, and wireless certainly is scientific if anything, it has always developed in practically every case on record that wherever a revolutionizing, original idea or invention has been evolved, that back of it all there was invariably a vast amount of hard work which required much study and experimental research. The present situation, when all experimental wireless stations have been closed by the Government, due to the war, should prove nothing less than a spur to urge the real radio amateur on to a higher goal. "After the War" days are surely coming, and with them will come a wonderful opportunity for radio experts, not to mention the present great opportunities in the Army and Navy signal divisions, besides many lucrative positions available with industrial concerns at the present time for first-class radio experts.

Due to the advent of the war, we are particularly desirous of obtaining manuscripts describing original and practical "Electrical Experiments." We shall continue to publish Radio articles, but what we need is snappy "Electrical" articles. Be on guard for the enemy—Repetition!

THE CONSTRUCTOR



How I Built A 2½ H.P. Flivverette

By CLEAGE FEILD

"NOTHING succeeds like success," would seem to be the beacon-light of one Master Cleage Feild, age fifteen years, who has patiently designed and built the racy looking motor car in miniature here shown. Like many other motor car makers of the day, Master Feild has assembled his parts around an engine that runs, preferring not to take chances on casting and machining the engine parts. The inventor deserves considerable credit for his ingenuity in building a little pleasure automobile that really gets there. It covers the ground at a speed of 20 miles per hour easily and 35 miles on a gallon of gas is regular work with Cleage. Fellow-bugs—electrical, mechanical and radio—Master Feild. Master Feild, etc. The introduction having been effected, let us read what this young mechanic and inventor has to say regarding the details of his 2½ H.P. flivver-ette.—Editor.

Construction Details

Frame—The frame is of red oak, one and three-fourth inches square. It is seventy-four inches long, fourteen inches wide and thirteen inches above the ground. It is bolted at the corners and braced by pine and oak strips.

Hood—The hood is of oak with poplar slats on it, 4 inch slope, 27 inches long, 14 inches wide, 15 inches high in front and 19 inches back. A screened hole in the front admits air. It has two hooks on each side to secure it to the frame.

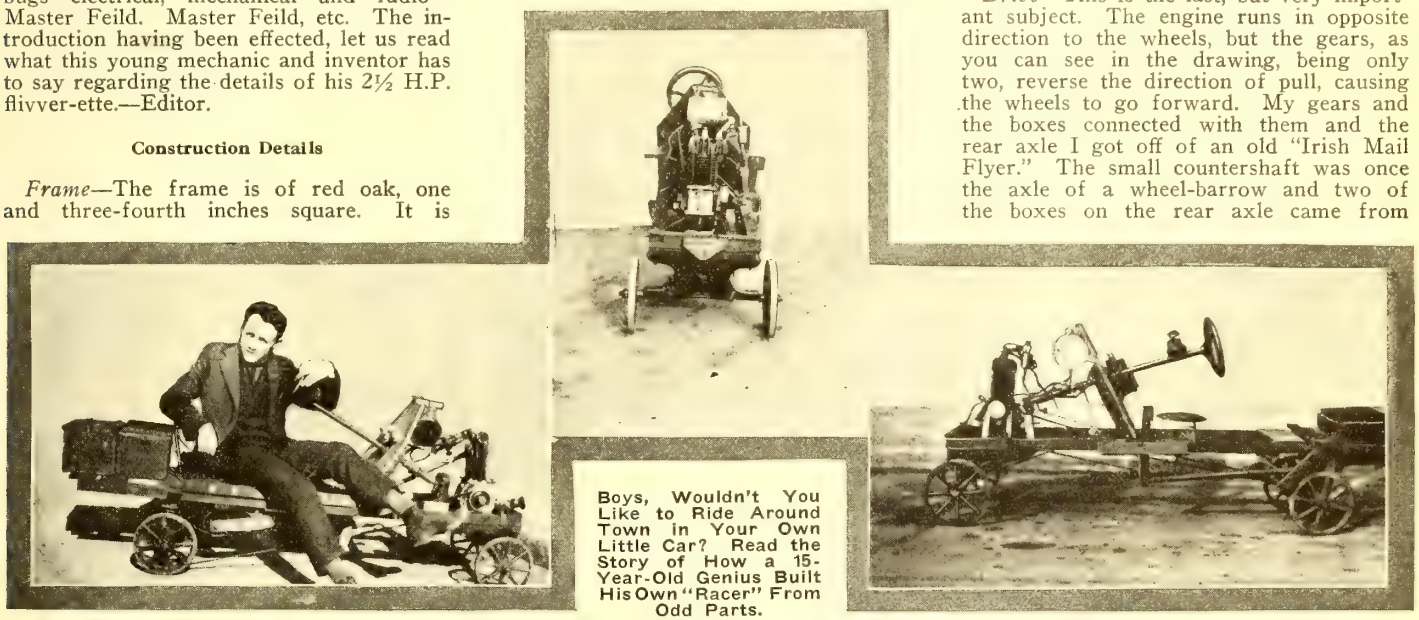
Dash Board—The dash is separate from the hood and is nailed to the bed. It is made of oak and has the same dimensions as the back of the hood.

Steering Gear—This runs thru the dash in an iron box; the rod is a piece of broom handle and the wheel came from a book press. The horn (hand Klaxon) is clamped to this rod. Ropes wrapt around the part of the rod under the hood, in opposite directions, run thru pulleys on the left of frame to the swivelled front axle block, as shown in drawing.

Wheels—These are No. 3, Auto wheel, coaster, size 10 inches high and use ½-inch axle. They are roller bearing and are held on by cotter pins. The wheel base is 58 inches. The front axle is riveted to the block, while the rear one revolves in four iron boxes.

Brake—I have only a foot brake. This pushes on the rear left wheel and the pedal for it is on the same side of frame.

Seat—I have three seats which may be changed to suit the occasion, a wooden one, which is my country and county seat, another one which came off of a girls' tricycle, which is my town seat. And a small leather auto seat which is my "Sunday best"!



Boys, Wouldn't You Like to Ride Around Town in Your Own Little Car? Read the Story of How a 15-Year-Old Genius Built His Own "Racer" From Odd Parts.

Engine—The engine is a 2½ horse power, Shaw bicycle attachment, air-cooled type. It is fastened to the frame by iron strips and bolts. I use a Cico spark plug and a contact timer equipt with a spring to keep it shut off. In the cylinder head is a priming cup which can be used as a compression release when starting.

Carburetor—The carburetor is a small one-half Acme Essex, of the float valve type.

Tank—The gas tank is made of a copper tank cut in two; it has a copper tube running from it to the carburetor. The tank is on the back of the dash board and has a capacity of one-half gallon. It has a screw cap on top of it.

Piston—This has three rings and is connected directly to the two fly wheels, which are enclosed in the crank case.

Oil System—The oil is poured into the oil case thru a plug.

Ignition—The ignition consists of the spark plug, four dry batteries (which are located in the box behind the seat), a vibrator coil (which will give about ¼-inch spark), a switch, the ground connector, the timer and wires connecting them all together properly.

Controls—The spark is the main controller of the speed of the engine. A wire runs from the timer to a small lever which works into a notched slot. This lever may be seen on left of frame. The gas feed is regulated by a string which opens and shuts the vaporizing chamber door. Since my drive was changed I have no need for an idler.

Drive—This is the last, but very important subject. The engine runs in opposite direction to the wheels, but the gears, as you can see in the drawing, being only two, reverse the direction of pull, causing the wheels to go forward. My gears and the boxes connected with them and the rear axle I got off of an old "Irish Mail Flyer." The small countershaft was once the axle of a wheel-barrow and two of the boxes on the rear axle came from the same outfit. The left rear wheel is equipt with bearings like the front two, but the right and *drive* wheel is different. I found the end of the axle cut almost square, or I would have done it myself. A piece of a flat iron strip with a square hole in it was fitted over the axle and bent thru the spokes. This clamps axle and wheel firmly together. The automatic idler I spoke of is very good. The pull of the belt, which is at the bottom of the rear pulley wheel, tends to raise the small gear, boxes, shaft and itself upward. This movement lengthens the distance between pulleys and tightens the belt. The smaller gear, as you can see, would naturally climb up the larger one and do the same as above.

A few facts—My car will make about 20 miles per hour. The wheels altho a little too small, possibly, are very good.

Seven Years of Wireless

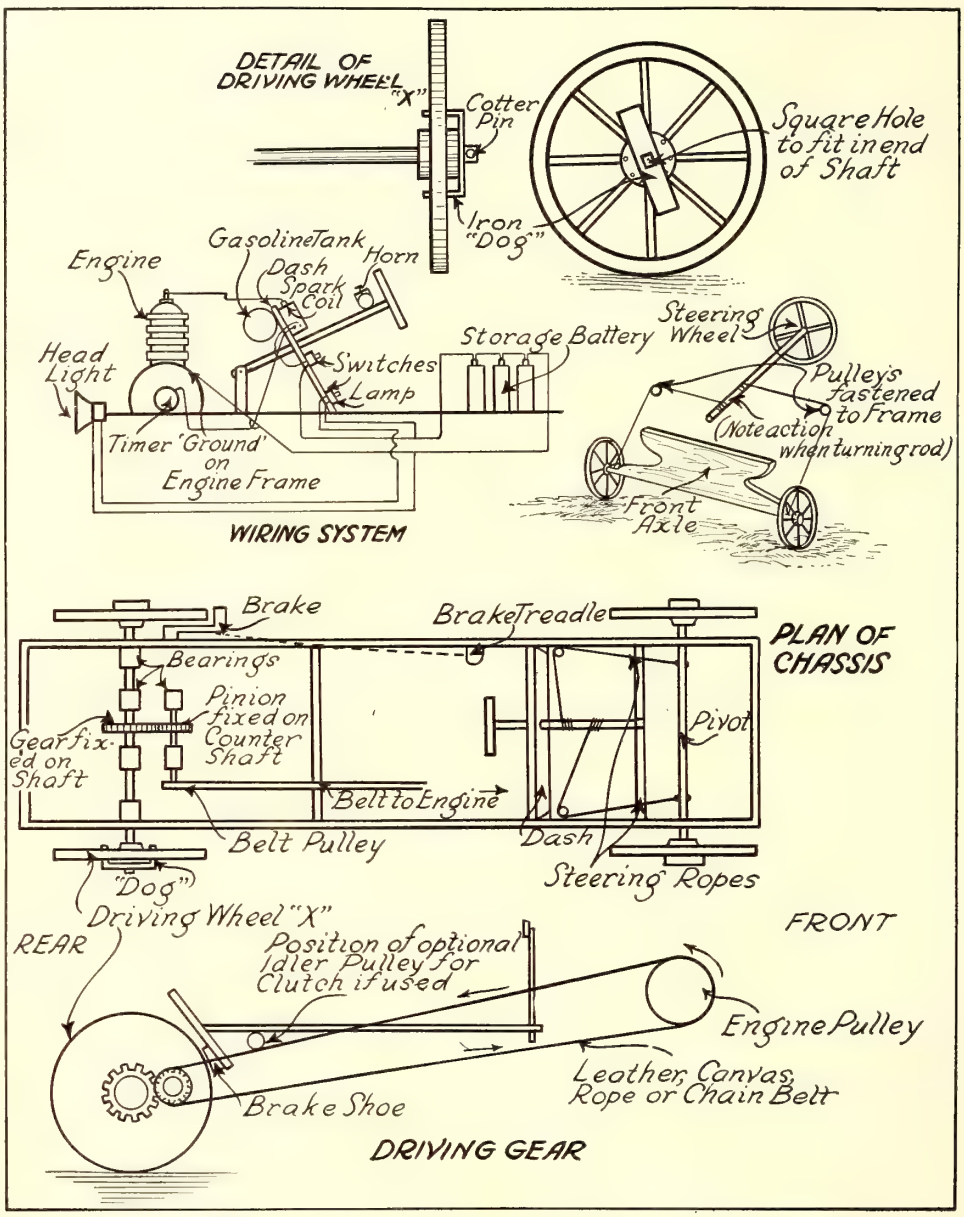
By HOWARD S. PYLE

WELL I remember my first days in the mysteries of wireless, seven years ago. It all started with the problem of ringing a bell from a 220-volt source of supply. The results exceeded my greatest expectations, but in them was kindled the fire of experimentation. The usual collection of junk accumulated in different parts of the house until finally I was forced to seek larger quarters in the attic. There began the construction of an indoor aerial of bell wire; four strands, thirty feet long and about the same height, tacked to the rafters; a "coal" detector and a receiver borrowed from the family 'phone. Three months were spent in vain endeavor to pick up the Navy Yard station, 15 miles away. I recollect trying all manner of mineral matter in the detector—from gold nuggets to tinfoil wads, finally abandoning the detector to look for other trouble.

I finally purchased a 75 ohm watch case receiver for 40 cents and began anew. Still no results, so the aerial came down post haste and was replaced by a single wire 100 feet long and 40 feet high, running parallel to a 220-volt A. C. circuit, but four feet below, for its full length. A trip to New York (my station being in Paterson, N. J.), resulted in the purchase of a highly nickeled but extremely small tuning coil of the double slide variety, a piece of silicon crystal and a potentiometer. After struggling along with meagre instructions from the first wireless catalog published, I finally jimmied the collection of apparatus (?) into a workable hook-up, according to a printed diagram and with a thrill of expectation, glued the receiver to my ear. The only response was a humming so loud that my ear sang for some minutes afterward. After three days of this I asked information of a more advanced radio friend and with his help and advice, placed my one wire aerial at right angles to the A. C. power circuit. Upon trying the set we found the hum almost entirely eliminated but "no sigs." Where then was the trouble? After a thoro investigation and testing of each individual piece, we found the wire on the tuner to be a continuous short-circuit under the sliders. An expert friend constructed and presented me with a small but well-built loose-coupler at this time, which probably was the only thing that prevented me from turning to a more gratifying art. At last after seven months of experimentation and disappointment, the coupler was hooked in and we received good signals from two stations, one about twelve, the other fifteen miles away, both *five kilowatt* installations.

This fired me to greater efforts and the remaining three years of my residence on the east coast were spent in constant experimentation and endeavor to improve on the original installation, which finally consisted of two loose-coupled receivers and a ½ K. W. transmitter, a complete description of the whole installation appearing around about the latter part of 1911 in the *Modern Electrics* magazine. A combination of circumstances resulted in my being compelled to drop Radio work for about six months, but at the first opportunity I erected a two-wire aerial 90 feet long and 40 feet high, and started in again on the Pacific Coast. I found conditions here much better, being remarkably free from the troublesome static of the Atlantic seaboard. However, the stations out here were few and even less Amateurs, as this was about the time that the Radio law went into effect. I made immediate application and received one of the first second-grade amateur licenses issued. After about a year's work, during which time nothing particularly noteworthy occurred, we again changed our residence, still remaining in Seattle, however. Right after these things began to happen, the Marconi people installed a 5 K. W. station in the tallest building west of Chicago, which brought them just three miles from me—a high-power station was establisht at Astoria, Ore., 300 miles S.W. by the same company. The Y. M. C. A. undertook the instruction of operators for commercial service and a local concern began the manufacture and installation of radio equipment on vessels of this coast. I secured employment with this concern and worked on the installation of the Alaska S. S. Co., involving about 15 complete 1 K. W. equipments. I also took up a course at the Y. M. C. A. school and settled down to real earnest work, averaging five evenings a week at my instruments. I was not equipt for sending for about two years, but spent a great deal of time in perfecting my receiving equipment. My "log book," which I have always kept up-to-date, shows many trials and disappointments which have been conquered, and makes interesting reading for me now, I can tell you.

A little later, I met thru our "ads" in a radio publication an old *United Wireless* operator who had a 1 K. W. *United* transmitting installation for sale, and this I purchased and brought up-to-date. I had hardly installed it when we again moved to our present location, and where I have practically completed a first-class 1 K. W. station, which awaits the end of war.



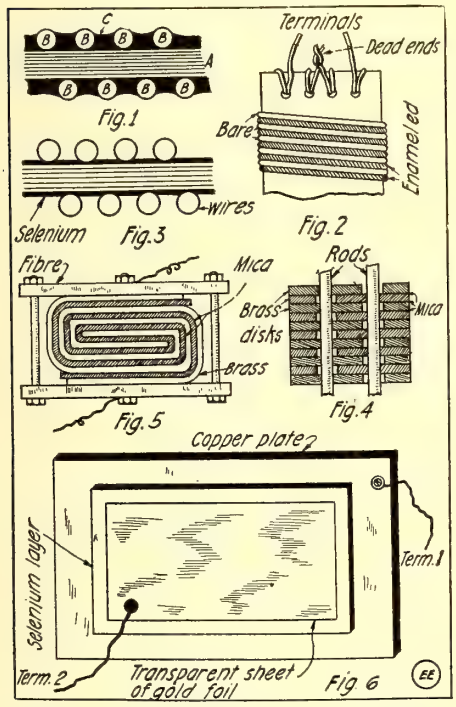
Why Wish for a Flivver-ette, "Bugs"? Here's How to Make One From the Simplest Materials Possible. Four Wheels, a Few Sticks of Wood, a Broom-stick, a Battery and Spark Coil, and Lastly—a Discarded Motorcycle Engine That Still Peeps, and You're In for the Time of Your Life, Even to Stealing Your Rival's Best Girl.

It will climb any ordinary hill. I've been working to get this perfected for nearly a year and my new drive system so far has been a great success. If any one desires any more details I shall be pleased to write them. Address me in care of the Editor, inclosing stamped envelope.

Selenium Cell Design and Construction

By THOS. W. BENSON

THAT selenium or one of its closely related elements possessing similar properties will find many uses in the near future is a logical and foregone conclusion. In the past its sporadic applications have been many, but its present status remains more or less in an experimental stage. Among other applications, we find that Minchin used it in his astronomical work, Prof. Barnard of Lick Observatory employed selenium cells in a device to automatically detect comets, Siemens for photometric measurements, Ruhmer, Bell and Taintor and others for wireless telephony and experimenters without number have employed selenium in one way or another in an effort to transmit pictures over a wire. Among these might be mentioned Senlecq, Larroque,



Various Types of Selenium Cells: Fig. 1, Cross-Section of a Bidwell Cell; 2, Modified Bidwell Type; 3, Second Type of Modified Bidwell Cell; 4, Bell and Taintor Cell; 5, the Mercadier Cell and Finally the Fritts Form of Selenium Cell, Fig. 6, Which Is the Most Sensitive Ever Discovered, the Light Shining Thru the Thin Gold Foil.

Korn, Dussaud, Liesengang and DePaloa.

Many experts have bent their efforts to the perfection of the selenium cell proper, rather than the application of the same, and it is their work with which we will deal. Among these workers, the names of Giltay, Draper, Hittorf, Adams and Day, Ayrton and Perry, Mercadier, Bidwell, Ruhmer, Hammer, Fritts and Gripenberg are the more prominent. Despite their efforts the selenium cell of today is far from being a reliable piece of apparatus. This may be due to a certain extent to the fact that the material is but little understood.

The physical changes that take place when the substance is heated are too well known to require extensive mention, but the *action of the light on the metal* is still the subject of much conjecture. And herein lies the stumbling block.

We can, however, draw certain conclusions that will assist us greatly in designing selenium cells that are nearly alike in their various characteristics. For one thing the light can only affect the *surface* of the cell, but it is reasonable to suppose, however, that the ultra-violet rays can penetrate the material to a certain extent, since it is more effective in altering the resistance of the cell. The longer light waves of the visible spectrum act on the *surface* only, since the metallic form of selenium is opaque.

Then again, just what is the action of the light when it strikes the cell? Several theories of the physical action occurring have been put forward, one being that since light is a form of electro-magnetic ether vibration it may act to cohere the particles of the metal in a manner resembling the action of the well-known coherer and thus serve to reduce the resistance of the material.

This theory was rendered highly improbable by the research work of Adams and Day, who in 1877 publisht the results of a series of experiments. They claim that the conduction thru a selenium cell differs from metallic conduction, partaking of that occurring in an electrolyte when the current passing decomposes the solution. This would seem to support the theory that the light falling on the selenium causes the same to throw off electrons and in this manner form a low resistant conductor. The latter phenomena is well known and has been the subject of much research work, particularly by Fleming.

Even so, we are now in a position to design cells with a maximum sensitiveness. As in the case of other conductors the resistance of selenium increases directly with the length and decreases as the area is increased. Therefore a cell made in the usual form, that is with wires wound on a support as in the Bidwell type, will have a low resistance due to the comparatively large area of selenium lying between the wires.

Referring to Fig. 1, a cross-section is shown of this type of cell with the selenium applied. The insulating support of slate, mica or porcelain is shown at A, the spirally wound parallel conductors at B, B, etc., while the selenium is shown at C. A cell so constructed is not sensitive, for the following reason: The light only affecting the surface of the selenium may reduce the resistance of the surface to a great extent, but the total resistance of the selenium present is only slightly affected, as will be clear by applying the law covering resistances connected in parallel.

The above condition is that usually met with in home-made cells; the writer recently constructed a cell along these lines with a resistance of but 200 ohms, its change of resistance was approximately 20 ohms from darkness to sunlight. Naturally this is not a good cell, its use being impractical since the variation is too slight to make it respond to small changes of light intensity.

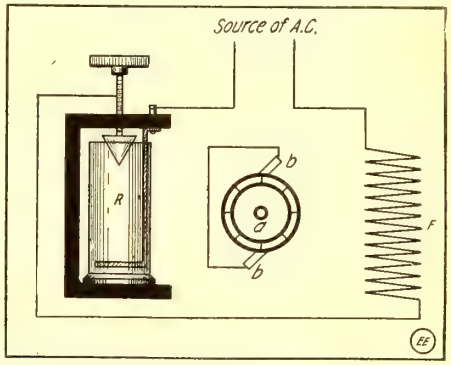
To overcome this state of affairs a Bidwell cell was made as shown in Fig. 2. In this case four wires were wound on the porcelain support. Two of these were bare and formed the terminals for the cell, the other two were enameled and were dead-ended. The selenium being applied over the wires could not get between them and in this way the area of the light-affected part formed a fairly large part of the total conducting area. This type of construction is satisfactory for general work, its ratio rarely exceeding 5 to 1, however, and the resistance is fairly high. This can be reduced to a certain extent by using fine wires, say No. 32 B. & S.

(*Continued on page* 332)

RUNNING SMALL D.C. MOTORS ON A.C.

Below is given a method which I find useful in running D.C. motors on A.C. circuits.

Disconnect the field winding from the armature and connect the brushes (b) of the



A Plan Whereby a Small D.C. Motor Can Be Operated As a "Repulsion" Type Motor On A.C. Circuits. Shift the Shorted Brushes Until Best Results Are Obtained.

armature (a) together. Then connect the field (F) in series with a variable resistance (R) and the source of current. The resistance should be low for starting, but may be increased when the motor is under full speed.

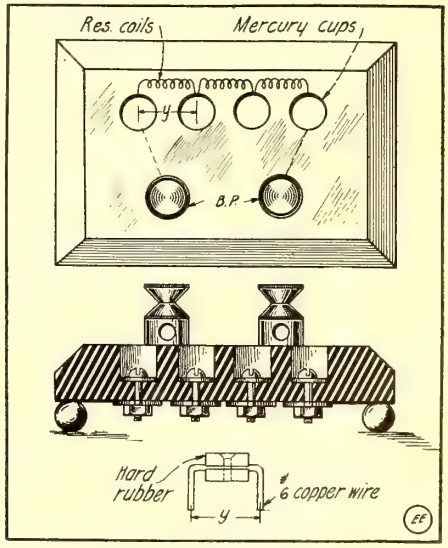
Contributed by RAE GALUSHA.

A VARIABLE RESISTANCE GALVANOMETER SHUNT.

This galvanometer shunt consists of a baseboard 4" x 6" x 1" mounted on feet made of two strips of half-inch dowel pin, each 4" long. Bore holes for the binding-posts and mercury cups, as shown in the accompanying sketch. Put all screws, washers, etc., in place and then solder in the resistances and connections.

The resistances are best made of No. 22 double-cotton insulated German silver wire, which runs nearly one ohm per foot. Relative values 1:2:4 for the resistance coils are convenient. These used singly, or two or three in series, will give a wide range of combinations.

The actual resistance of these coils will, of course, depend upon the resistance and sensitiveness of the galvanometer.



Simple and Efficient Variable Shunt for Use With Galvanometers, Employing Mercury Switch.

Short pieces of heavy copper wire bent to connect two adjacent mercury cups are used for short-circuiting the coils when not in use.

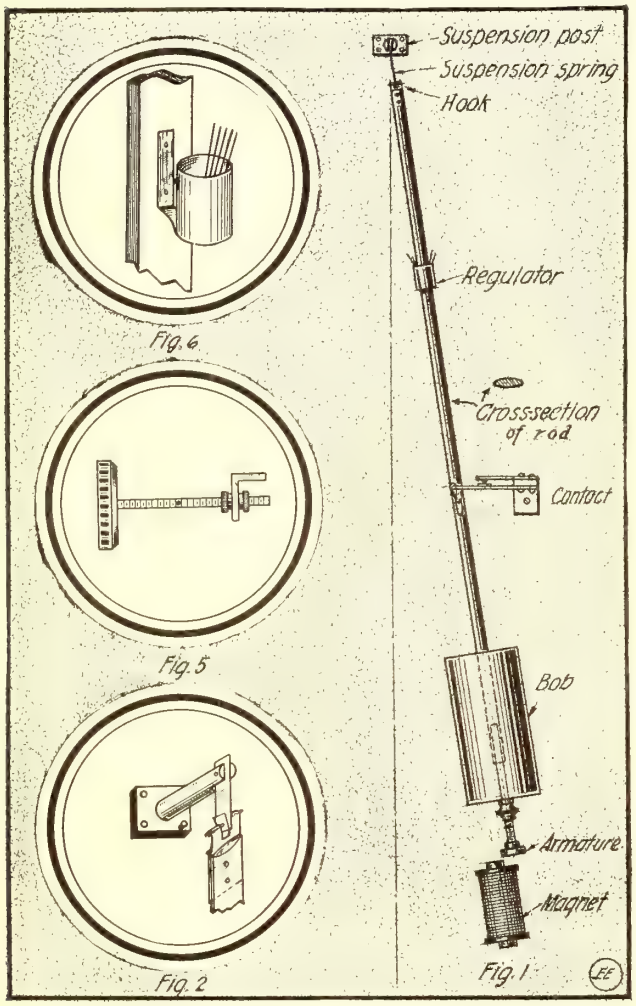
Contributed by PETER J. M. CLUTE.

Making an Electric Clock

By THOMAS REED

Part 1—The Pendulum

COME on now, "Bugs," roll up your sleeves, sit down on anything you aren't supposed to sit on, like the bench or the top of the tool-cupboard, and I'll tell you how to make your clock. ("High time he did," they say.)



Several Important Details of the Electric Clock Are Here Illustrated, Showing Among Other Things the Particular Manner of Suspending the 39-Inch Pendulum and Bob, Also the Electrical Contact Actuated by the Swinging Pendulum Rod.

In a mechanical clock, the pendulum is driven by the wheelwork; but in an electric clock (of the Hipp type at least; see page 114, June, 1917 issue) the pendulum drives the wheels. This is an advantage (for "Bug" purposes at any rate) because, there being no heavy power on the wheel-train, it can be made very light, and you aren't ruined by a rough bearing or wobbling gears as long as they're true enough to keep in mesh.

In my clock (which has an unnecessarily heavy wheelwork) the pendulum receives an impulse once every 6 or 8 seconds, when the dry-cell is fresh. The interval diminishes as the battery runs down, till just before it's played out it receives the feeble impulse every 2 seconds. One dry-cell will run the clock for 7 or 8 months; I usually put on two cells in parallel, which run it practically just twice as long, or from 14 to 16 months.

Almost all the energy is used up in driving the wheelwork. With the pendulum swinging alone, it's really surprising how little power is required; a single impulse of the magnet will drive it from 5 to 10 minutes—*minutes,* not seconds. You know the pendulum is theoretically a perpetual-motion machine, and but for friction and air-resistance would swing forever if once started. On this basis, one cell would keep the pendulum going for about 38 years, if it could stand up that length of time. Wish it would, and that were all there was to it! You could hitch on a cell when the baby was born, and leave it to him to pay for the next one when he reached middle-age—provided he'd laid by enough of the old healthy "mazuma" in the meantime; some of us don't. But of course a pendulum alone doesn't make a clock, any more than one swallow makes a—drink; it's useless to measure the time unless you record the measurement.

All the same, if any of you "Bugs" start a clock, I'd recommend you to make the pendulum and its apparatus first, and get it going nicely before you begin the wheelwork. It's easier on battery-finances, for one thing. Battery upkeep used to be quite a factor in my young days, and in my efforts to keep the upkeep down I experimented quite largely, and invented a new form of battery which I explained at some length in the August issue.

So now about the pendulum. Fig. 1 shows it at the end of the *right* oscillation, just as the contact is made. The departure from the perpendicular is exaggerated. The amplitude should be kept as small as possible, and depends upon the size of the teeth in the escape-wheel. Of course you can place your contact-post and magnet in accordance with the degree you require.

Begin at the top of Fig. 1, with the suspension-post. This is a plain brass rod, say ½" diam., attached to the back-board by a machine-screw thru the back, or better attached to a base-plate and screwed on from the front. It ought to be very strong and solid, as the slightest wiggle will throw your time all out of gee. It has a perpendicular slit in front, into which you poke the suspension-spring and pin it.

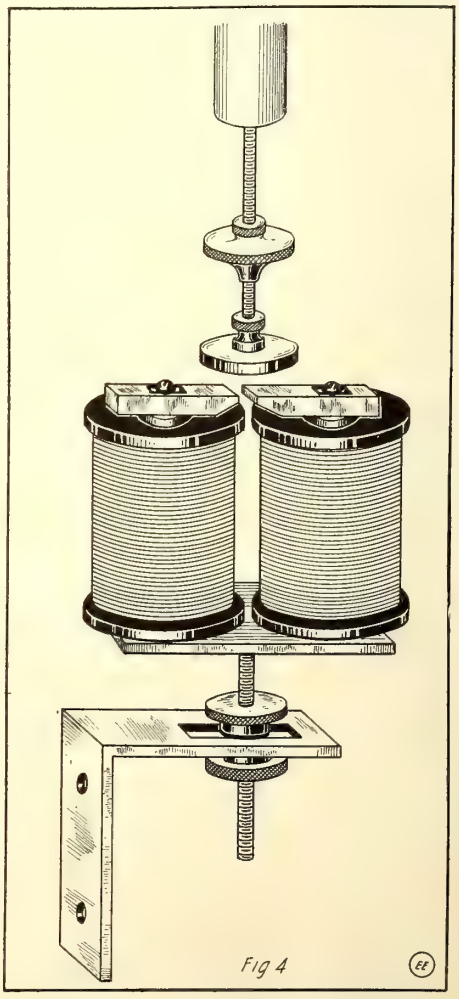
The suspension-spring you can make easily enough, if you want to. It's simply a piece of flat steel spring like a watch-mainspring, with a hole in each end for a pin. But it hardly pays to make it, for you can buy one for a nickel or so at any clock-store, much thinner than watch-mainspring (of course the thinner it is the better) and with neat brass ends. You can get big ones, but the little ones made for mantel clocks are all right. Don't be afraid if it looks small; I had a 20-lb. pendulum once hanging on one of those. Only be sure that your hanging-pins go thru the steel itself, as on these light springs sometimes the brass ends are only pinched on. Another reason for buying your spring is that a home-made one, especially if thinned by filing, is apt to have inequalities, which make your pendulum wobble.

Now then, your pendulum rod. Thank heaven in this case the best is the cheapest, for it's recommended to be made of ordinary white pine, on account of its lightness. That's on the theory of concentrating all the weight possible in the bob, but it isn't much more'n a theory; if you'd rather have a nice pretty mahogany or rosewood rod, go to it. If you have a pine rod, paint it black and shellac it to keep the moisture out.

A good size for the rod is 3/4" wide by 1/4" thick, and it's planed down rounding to an edge till it has a cross-section like a lens. This is only theoretical too, in order to cleave the air better; a square-cornered one will do about as well.

At the top of the rod you saw down a slit and set in a piece of thick sheet brass, bent into hooks as shown in Fig. 2, to hang on the pin of your suspension-spring. This enables you to take the pendulum off more easily than drawing out a pin. You'll have occasion to take it off quite a few times, you know, before it starts on its 50-*year non-stop run.*

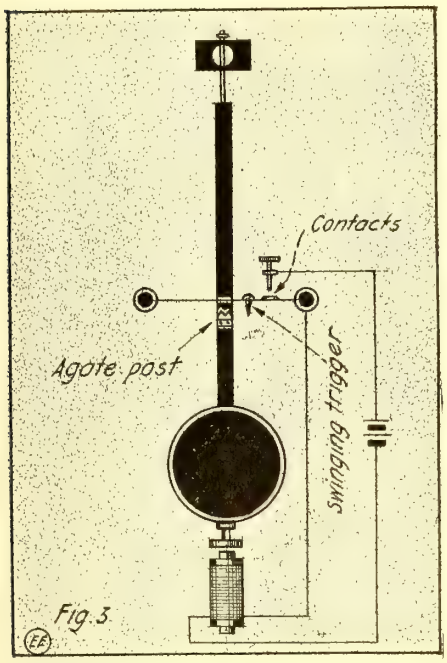
At the bottom of the rod, drill a hole lengthwise (and for the love of Mike, drill it straight!) and screw in a length of 8-32



Showing How the Pendulum Actuating Magnet Is Mounted So as to Be Readily Adjusted. It Pays to Make All of These Parts Right, Especially the Pole-pieces or Faces of the Magnet Poles. The Magnet Coils Are Periodically Excited from a Battery.

screw wire for the regulating nut and armature.

The length of a seconds-pendulum (for mean solar time) is 39.1 inches from the middle of the suspension-spring to the middle of the bob; so you won't know how long to have it unless you make your bob first.



The Electric Clock Problem Was Finally Solved by Resurrecting Hipp's Pendulum. This Design Seemed to Work the Best.

The bob can be any size, shape or weight, but practically should be a symmetrical figure, and the heavier it is the better. It takes no more power to drive a heavy one than a light one, and the heavy one eats up some slight temporary disturbances.

The cylindrical bob is easiest to make. Use a brass tube about 6" long and 2" in diameter. Make an extra foot of wooden rod the same shape as your pendulum-rod but a little larger. Stick this rod up perpendicularly in a pailful of sand, having the surface of the sand packed hard and smooth. Set your brass tube down over the rod till it rests on the sand, being sure that your rod comes exactly in the middle of the tube (top and bottom) and projects out an inch or so at the top. Now pack more sand around the tube, to hold it during the pouring process and stop the lead from running out the bottom.

Melt up some scrap lead, but don't get it too hot—not redhot, just hot enough to run freely and show up shiny. Pour it in till the tube is full, and stand by to pour a little more as it shrinks on cooling. Your wooden core will smoke, but let it smoke; a charcoal core is just as good as a wooden one, and comes out easier. When cold, drive it out, and your bob is done, except for polishing and lacquering.

The bob-regulating nut should have a good large diameter as the heavy bob takes some power, and besides it's easier to see how much you've turned the nut.

The armature is at the very bottom of the rod, and is simply an iron disc of good thickness and about 3/4" diameter. It's screwed up on your bob-screw and held fast by a check-nut on top (here's where that ever-faithful dry-battery nut comes in). If you look in the box at the hardware-store where they keep the thumping big washers, you'll probably find some punchings from the inner holes, which are just the thing for armatures. I imagine the wicked washer-makers adulterate their goods with as many of these useless punchings as they dare, to the woe of the hardware-man; but it's an ill wind that blows nobody good, and we should worry about tainted punchings.

The magnet needs pole-pieces as shown in Fig. 4, and the illustration gives what I've found to be a very good adjustable mounting. I use a magnet with coils about 1" diam. by 1½" long, wound with No. 24 wire; I imagine the entire magnet measures about 20 ohms.

The Hipp-pattern contact was described in a previous article, but if the Editor please, we'll have the illustration again here (Fig. 3) in order to get everything together. The contact is mounted on a screw-post (Fig. 5) with nuts front and back, in order to adjust the trigger to the notch very finely, and also the distance from the backboard, as the contact and magnet have to be in the same plane as the pendulum.

I past up for the moment the rinktum shown near the top of the pendulum, that looks like a flower-pot with a dead begonia in it. (Figs. 1 and 6.) That's the *precision-regulator*. You could never train a clock down to *seconds-a-day* if every time you regulated it, you had to stop the pendulum and screw the bob up and down; besides a 32 screw isn't fine enough. You must have some means of changing the rate of the pendulum without stopping it, and that with extreme delicacy, as any change you make accumulates till after the 86,400 seconds in a single day it shows up big. So you first attach a little brass cup to the pendulum (Fig. 6) about a third of the way down from the top, and put in it a dozen or so pieces of about No. 24 wire, long enough to project well out of your cup, so you can get hold of them easily with your fingers. Now you regulate your pendulum by the bob-screw till you get it fairly good, say to half a minute a day; after that, you regulate by taking wires out of the cup, or putting more in, as the case may be. Your hand can follow the motion of the pendulum easily enough, especially as the oscillation is short up near the top, so you don't have to stop it. The more you load the cup, the faster the pendulum will beat, which is opposite to what you might suppose; but the weight above tends to make a shorter and quicker pendulum there, which shortens the net *oscillating length* of the whole. As you get nearer to *seconds-a-day* you can use pieces of finer and finer wire, till finally you reach the point where the erratic changes exceed your regulation.

[*Watch for the next paper describing the wheel-work in the October issue.*]

HOW TO POLISH HARD FIBER.

Hard fiber is used to a larger extent by amateurs in making wireless and electrical apparatus, but it has the disadvantage of absorbing moisture and soon becoming a poor insulator. To overcome this difficulty I used the following method: After the fiber has been cut to size, sand-papered smooth and all holes drilled, soak a piece of waste in thin white shellac and place on the center of a piece of cloth which has been soaked in boiled linseed oil. Then bring the edges of the cloth up around the waste and twist up tight until the shellac begins coming thru the cloth. Then rub the fiber firmly but rapidly with a circular motion, and continue rubbing until the shellac begins to get sticky. Do not stop with the cloth resting on the fiber as it is apt to leave a spot. Before the polish is put on the fiber should be left in a warm dry place for a day or so to expel all moisture. After one layer has dried, the fiber may be rubbed with fine steel wool and another coat of polish put on. About three or four coats should give a fine mirror-like polish. This is the way the finish is put on pianos, etc., and if the experimenter is careful, he should be able to attain good results after a few trials. To keep the moisture out the fiber should of course be covered completely with the polish.

Contributed by E. C. SCHURCH.

A HOME-MADE "MAGNETIC" WINDOW ATTRACTION.

This window attraction is suitable for a tobacconist's or other shop and never fails to attract the passers-by, who try to solve the riddle. The effect produced is as follows: A glass dish "A" is resting on three glass knobs "C," which in turn are supported by a small wooden box "D."

About half a dozen cigarettes are lying in the glass dish. Suddenly the cigarettes rise on end and are standing nearly vertically for a few moments, then they fall back again. This is repeated for any length of time.

The cigarettes cannot be operated by threads, as they roll about when they drop back again, and as the dish is supported by three glass knobs, the average spectator does not think it likely that the cigarettes are operated from below.

But they are!

The box contains a powerful electro-magnet which consists of an iron core "F" and the winding "E." This electro-magnet is connected in series with a Thermo-blink flasher and three carbon filament lamps. The latter are connected in parallel. When the current is thrown on, the iron core "F" will be magnetized by the coil and attract the cigarettes.

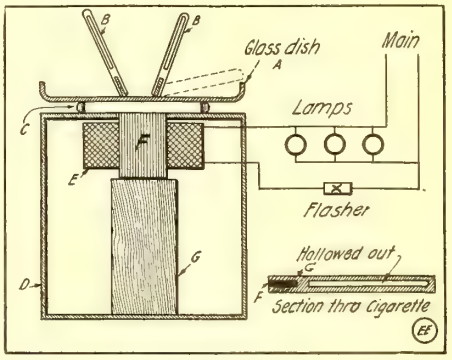
These cigarettes are of special construction and consist of a wooden part "G," and a steel part "F." The latter is made from a wire nail about ⅛ inch diameter by ⅝ inch long.

The wooden part is hollow so as to make the cigarette *dummy* rise easily when the current magnetizes the core "F."

After the current has been passing thru the circuit described above for a short time the Thermo-blink flasher breaks the circuit only to close it again in a few seconds.

Three lamps are placed in parallel so as to get the greatest amperage possible, and for the same reason carbon filament lamps were chosen.

The iron core was made of a short piece of mild steel shafting, 3 inch diameter. It was thoroly annealed before being used, so as to keep the residual magnetism as small as possible.



Details for Making the "Magic Cigarettes" Electrical Window Attraction. It Also Provides Plenty of Mystery for Parlor Entertainments.

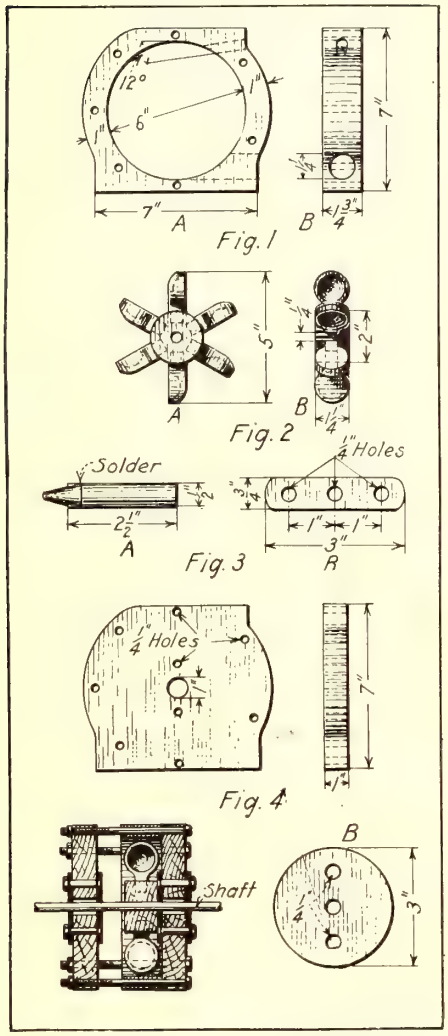
The magnetizing coil "E" consisted of about 200 turns of No. 14 gage, double cotton covered copper wire. "G" is a wooden block to hold "F" in position. The connecting wires should be led thru the bottom of the box to render them as inconspicuous as possible.

Contributed by C. A. OLDROYD.

A SMALL WATER MOTOR FOR DRIVING DYNAMOS.

By W. E. Leach.

A water motor, owing to the variety of uses it may be put to, will find ready call among experimenters. It is not at all difficult to construct and below I describe one



Construction Details for a Small Water Motor Which Will Prove Useful In Driving Dynamos or Other Light Machinery.

that I made and used successfully to drive a dynamo, sharpen tools, as a drill, and also as a small lathe.

The first thing to obtain is the materials. These consist briefly of the following:—1 piece 2" x 8" x 10" plank (hard wood), 2 pieces 1" x 8" x 10" board (pine), some ¼" x ½" board (soft or hard wood)—7 5" x 3/16" bolts, 4 1½" x 3/16" bolts, 1 piece brass tubing ½" in diameter, 2½" long (for nozzle).

To begin with, cut a case from the piece of plank as shown in Fig. 1 A and B. Bore seven ¼" holes thru this as shown. At the bottom bore a 1¼" hole for an outlet. Then at the top, bore a ½" hole about 12° to the horizontal; this is the inlet. The rotating section is made up as shown in Fig. 2 A and B. The vanes or paddles are cut from ½" boards and of dimensions shown. They are hollowed out at the ends and are set into an axle cut from a piece of hard wood 1¼" x 2" with a ¼" hole thru the center.

To make the nozzle take the piece of brass tubing above mentioned and solder to it a cone shaped piece of tin as in Fig. 3—A. Now drive this into hole at top of case until its tip first comes to the inner edge.

Now for the sides, cut two pieces out of 1" pine as shown in Fig. 4. Bore 7 ¼" holes thru these to correspond to those in the case (Fig. 1). At the center bore a 1" hole, and about 1" away from the center in a perpendicular line, drill one ¼" hole on each side of this as shown. Now make two plates 3" in diameter and ¼" thick as shown in B (Fig. 4). Bore a ¼" hole in the center and about 1" to either side bore another ¼" hole. Make two plates of iron as in Fig. 3—B. Drill holes to correspond to those in the plates, Fig. 4—B.

Give all parts two coats of good water-resisting paint and when dry assemble as follows:—Place a plate (Fig. 4—B) on the outside of the sides, put a wad of packing soaked in oil in the 1" hole. Then place an iron strip (Fig. 3—B) on the inside of each side and bolt firmly together with two 1½" x 3/16" bolts. Drive a shaft thru the rotating part. Insert one end of shaft thru one side and then place inside of case. Put the 7 5" x 3/16" bolts thru and fasten the other side together. (In setting up, if some pitch is placed between the sides and case it will prevent any leakage.) Connect the motor to any faucet by a rubber hose and it is ready for work. If all parts were smooth and bored and cut accurately, little trouble will present itself and the motor will go buzzing around at first connection.

X-RAY TUBES FOR HIGH-FREQUENCY COILS.

(*Continued from page* 309)

It is really a combination of two distinct tubes, as indicated by the heavy vertical dotted line. When the current passes in the direction of the arrow (b) X-rays are produced from the cathode and target (c and d) in the righ-hand half of the tube; alternations in the opposite direction, indicated by the arrow (a), produce a stream of rays from the left half of the tube. This is the most efficient form of high-frequency X-ray tube, as it uses both sets of alternations. It is now practically obsolete, however, as it was found that the two sets of X-rays overlapt and produced double outlines in the skiagram.

At the present time there are two types of X-ray tubes made for use with high-frequency currents. The one shown in Fig. 3 has a target of heavy copper faced with tungsten, and is mounted opposite the active cathode (c); when the current flows in the opposite direction the electronic stream from the small cathode (c^1) becomes choked out and dispersed by the constricted glass neck (d), which acts, in a measure, as a valve, eliminating the inverse discharge.

Another type of modern high-frequency X-ray tube is shown in Fig. 4, in which the cathode rays from the small aluminum mirror (c^1) focus inside a small copper cone (d), in which they are converted into heat and take no part in the production of the X-rays.

Tubes of these types may be operated by the current from a Tesla coil or from an Oudin resonator. In a previous article in the May issue of the ELECTRICAL EXPERIMENTER the writer has given details for the construction of apparatus of both these types.

When the Tesla coil is used its terminals are connected to the two aluminum cathodes (c and c^1); the Oudin coil has but one active terminal which should be connected to the active cathode (c); the small cathode (c^1) may be grounded, but this is not absolutely necessary.

X-ray tubes are spoken of as "hard" and "soft"—a "hard" tube is one which has been exhausted to a very high degree—(say, one-ten-millionth of an atmosphere)—a "soft" tube has a lower degree of exhaustion (between *one-five-hundred-thousandth* and *one-one-millionth* of an atmosphere). More current is needed to operate a hard tube, but it gives deep penetration and works more quickly. The soft tube, on the other hand, produces strong contrasts in the skiagram or fluoroscope.

Tubes have a tendency to become hard by use, the trace of residual air or gas being gradually driven out thru the intermolecular spaces of the glass by the electronic bombardment. So it is necessary to provide the tube with some means for replacing these lost ions at intervals.

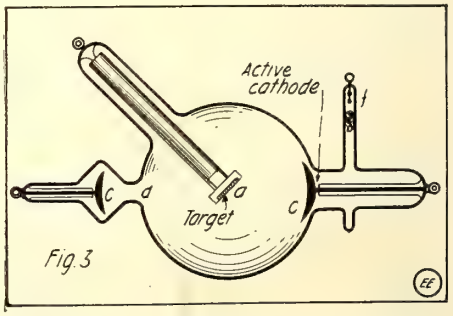
The first is of the thermic type and is now seldom used (see e, Fig. 2); it consists of a small bulb containing potassium chlorat sealed into the side of the X-ray tube. By heating this bulb with a match or spirit-lamp, a trace of oxygen is given off, which reduces the pressure in the tube to the required degree. The modern high-frequency tubes use the forms known as the "spark regulator" and the "osmotic regulator."

The first is the more common type and is shown in (f, Fig. 3). A platinum wire is sealed in the regulator tube which contains a gas-producing chemical, such as manganese dioxid, or sodium formate, f.

In practise a piece of E-shaped stiff brass wire set in a rubber handle is used to divert a portion of the current from the active terminal to the wire in the regulator; the heat from the current liberating the gas and softening the tube.

A regulator of the osmotic type is shown at (g, Fig. 4). It consists of an extremely small tube of metallic palladium sealed into the side of the X-ray bulb, the inner end of the metal tube being open while the outer end is closed. Ordinarily the tube is protected by a cylindrical glass cap. If the latter be removed, and the flame of a spirit-lamp be applied to the closed extremity of the palladium tube, hydrogen ions from the interior of the flame will be drawn thru the intermolecular spaces of the heated metal into the X-ray bulb.

Amateurs and physicians using X-ray outfits often desire to view considerable areas of the body simultaneously; this can be done only by using a large fluorescent screen and covering the X-ray tube with opaque material. Ordinary fluoroscopic screens are coated with barium-platinum-



One Form of Commercial High-Frequency X-Ray Bulb of the Single-focus Type, Utilizing An Active Cathode "C", Also a Small Cut-off Cathode "C^1". The Inverse Cathodic Stream from "C^1" Is Choked Off and Dispersed by the Constricted Glass Neck "D", Which Acts As a Valve.

cyanid and cost about $0.25 per sq. inch. A very good screen may, however, be easily made by evenly coating a sheet of white cardboard with a solution of sodium silicat and immediately sifting on it finely powdered calcium tungstat. Gently raise the screen on its edge and tap it to shake off the excess of tungstat; then allow to dry. A still simpler experimental screen may be made by painting a card several times with a strong solution of quinine bi-sulfate.

A Home-Made Arc Search-Light for the Amateur

By FRANK M. JACKSON

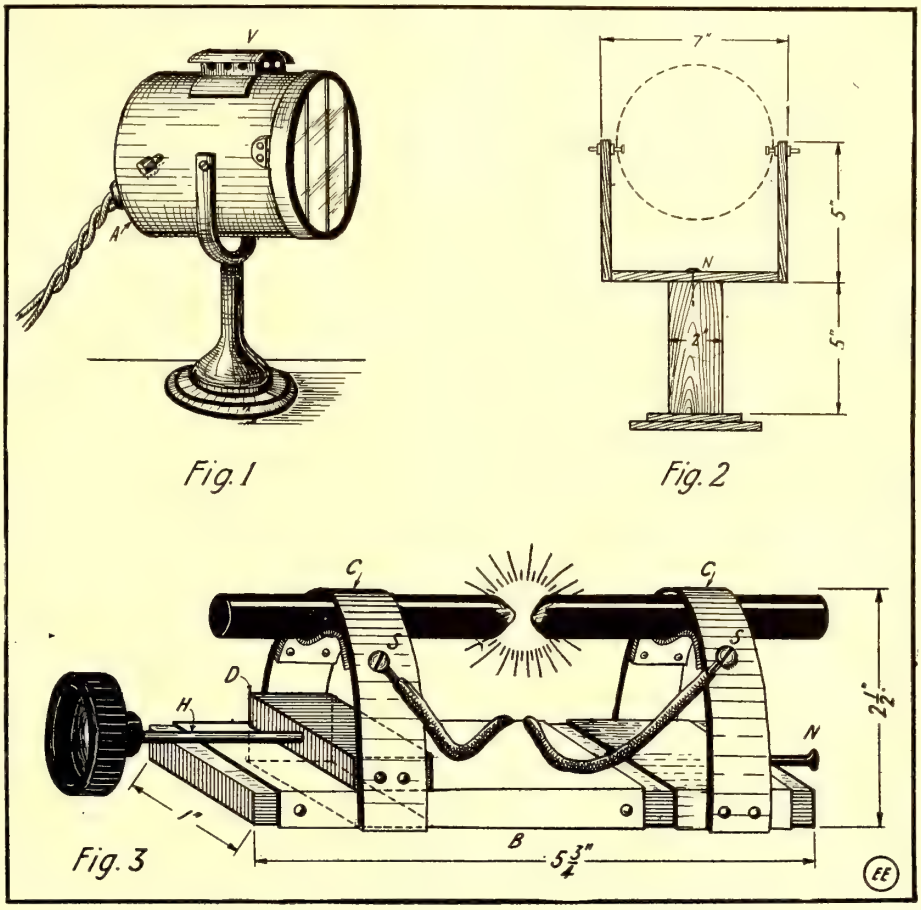
THE arc search-light here shown and described when properly constructed and focused, is capable of projecting a powerful beam that can be seen for several miles around. The amateur will find it very interesting to pick out distant objects as well as passing pedestrians and vehicles. The materials required are few, most of which are found around the amateur's home. The search-light is not difficult to construct and is quite worth the effort.

The body of the searchlight, A (Fig. 1) is a large syrup can, 7 inches long and 6½ inches in diameter. No other size can will do unless the carbon clamps and base are made to correspond with it. The ventilation top, V, is made from tin, cut and bent into the shape shown. The holes are punched to allow the heat and smoke to escape. Before fastening it to the can a large oblong hole is cut directly under it. The top is then fastened on with small stove bolts. A broom stick fastened to the back of a tin strip, bent into a sort of U shape, bolted to the back of the can, forms a handle.

The next thing to make is the base. A stand taken from an old electric fan is just the thing, but a wooden or iron one with the same swivel adjustment can be easily made and will well serve the purpose. In Fig. 2 the wooden one is shown with the dimensions. The dotted circle represents the front of the can and shows method of fastening it to the base. These bolts must be loose enough to permit movement up and down. Movement from side to side is allowed by the single nail shown at N, Fig. 2. Next procure from an automobile supply house or garage a parabolic reflector such as that from an old gas lamp. This should be about 6 inches in diameter. It is next fastened to the rear end of the search-light. This mirror reflects the light from the arc and sends out a beam greatly intensified.

Great care must be taken in the construction of the clamps, which are to hold the carbons, to follow the dimensions correctly. The wooden base, B, Fig. 3, is 5¾x1x½ inches. First cover it all over with a thin piece of asbestos. Next a strip of tin is fastened around the left hand end of the base and runs ⅗ of the way to the other end. Then a small space ¼ inch is left so that the tin strip on this end will not short-circuit with the strip on the other end. A small piece of tin is put on the right hand end, the same as the left, but much shorter. The clamp at the left hand end is adjustable. It should slide easily over the tin strip on the base. It is made from tin cut and bent around the carbon and base and then fastened onto each side of the block, D, which is 1x1x½ inches and is covered with asbestos and tin. To this block is also fastened the handle, H, with the hard rubber knob on the end. The clamp at the right is stationary and is fastened to the base. The clamps should each be 2½ inches high. A stick of carbon ½ inch in diameter and 12 inches long may be procured from a store dealing in electrical goods for only five cents. It is broken into four equal pieces to put into the clamps and held into position by the screws, S and S. Put a nail, N into the right hand end of the base.

The next thing to do is to put the clamps into the search-light can. The best way to find the position for the proper focus is by holding a candle at different distances from the reflector. When the smallest spot is projected this is the best focus. Mark this position and put the clamps in as shown in Fig. 3, with the nail at the right hand end and the handle at the left going thru small holes, one in each side of the can. If desired striped glass, as shown in Fig. 1, may be mounted on a hinged door at the front of the searchlight, but is not necessary. The searchlight is now complete.



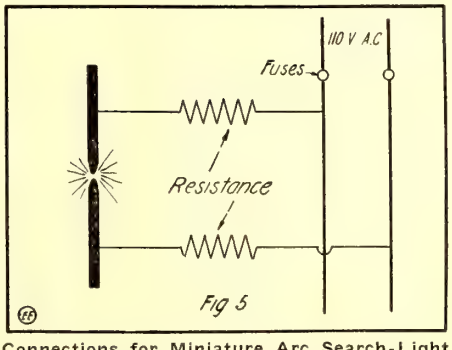
Appearance and Detail of Arc Carbon Holder for Experimental Search-Light. Many Scientific as Well as Practical Uses Can be Found for Such a Device, Including the Stunt of "Talking Over a Beam of Light."

A suitable resistance to operate with the searchlight must be constructed. This resistance is shown in Fig. 4. The two ends are each 4x12 inches and the top and bottom are each 4x18 inches. After screwing these boards together as shown, they are lined inside with heavy asbestos. Procure from a hardware store 50 feet of No. 18 soft iron wire, which will cost about five cents. Cut the wire in two 20 foot lengths and run it in zig-zag fashion thru staples in two rows 3 inches apart, the length of the boards. Fig. 4 shows how the wire is pulled thru the staples in two

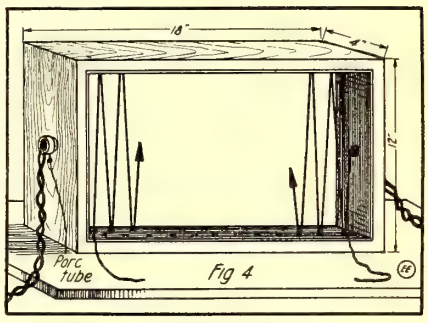
(*Continued on page* 332)



Showing the Arc Search-Light Made by the Author, Complete with Rheostat.



Connections for Miniature Arc Search-Light on 110 Volt Circuit.



How Rheostat Frame Is Made. It Should be Constructed of Fire-Proof Materials Thruout.

HOW TO MAKE IT

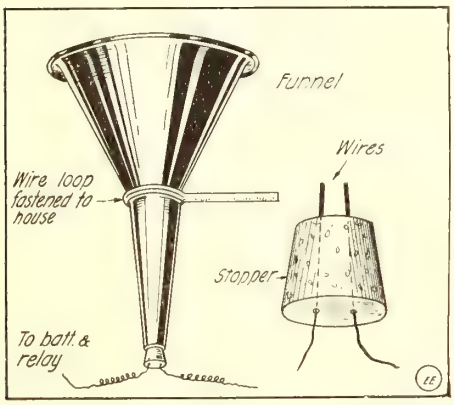


This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

SECOND PRIZE, $2.00

AN ELECTRIC RAIN ALARM.

Take an ordinary funnel, either glass or tin, and fasten it into place where the rain can get into it easily and quickly. Take a



An Electric Rain Alarm Is of Undoubted Value in Every Home. The Rain Water, Mixing With a Few Grains of Salt, Closes the Alarm Circuit.

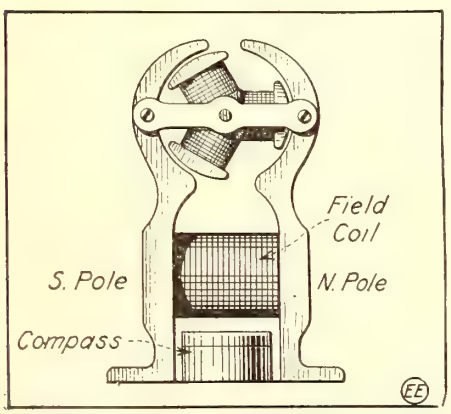
cork, or preferably a rubber stopper, with two wires thru it, as shown in the diagram, and insert in the smaller end of the funnel. The wires should be only a small space apart, and you should drop a little salt into the funnel to make the water a better conductor.

When a few drops of rain fall into the funnel it will close the circuit thru a relay and battery, thus ringing a bell.

Contributed by G. C. ZANKL.

UNIQUE EXPERIMENT WITH MOTOR AND COMPASS.

While working at my electrical apparatus, I picked up my compass and placed it near a screw-driver not thinking that



Demagnetized Compass Needles May Be Made As Good As New by Simply Placing the Compass Under the Field Legs of a Toy Motor.

it would injure the compass. After remaining there for two days, it drew all the magnetism from the needle of the compass. It would remain in any position that I placed it, making it, of course, useless. I resolved to fix it, and after experimenting with it for fully an hour, succeeded as follows: I placed the North pole of my toy motor facing North, then I placed the compass under the field coil of my motor, which I put in operation for about one minute, after which it served as a new compass. The armature should be left out of circuit.

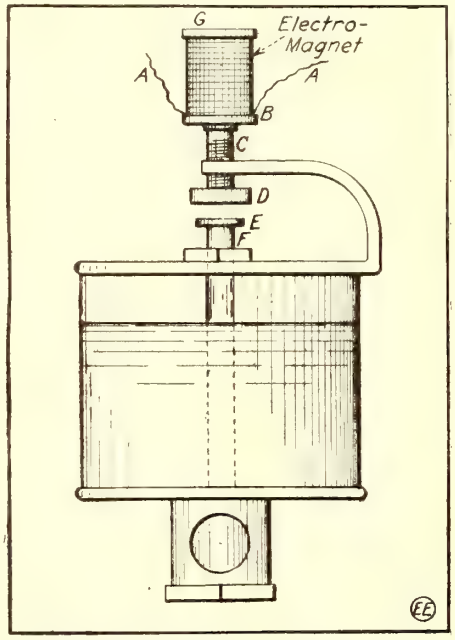
Contributed by JOHN UEBLER.

FIRST PRIZE, $3.00

A MAGNETICALLY CONTROLLED OIL CUP.

An electro magnet is used in this scheme. A are the electric wires, D is a round soft iron plate, C is the screw rod, E is an iron cap on top of the oil feed pipe F.

To open the oil cup turn on the electric current and iron disc D becomes magnetized and pulls up cap E on top of oil feed pipe F, and the oil will start to drip. When the current is shut off D loses its magnetic power. E and F drop down and close up the oil hole again. To regulate the flow of oil, B is turned and the screw rod C raises or lowers plate D. By using



A Practical Application of the Electro-magnet, Enabling the Engineer to Control Oil Cups At a Distance, Also in Groups.

a small solenoid and a rheostat the control of the oil cup can be made quite precise.

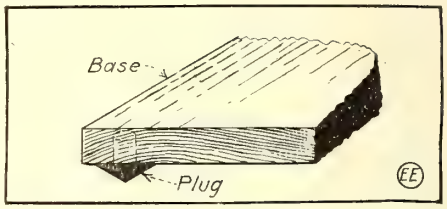
Contributed by OTTO C. HALSTRUM.

Due to the advent of the war, we are particularly desirous of obtaining manuscripts describing original and practical "Electrical Experiments." We shall continue to publish Radio articles, but what we need is snappy "Electrical" articles. Be on guard for the enemy—Repetition!

THIRD PRIZE, $1.00

TIRE PLUGS AS INSTRUMENT FEET.

After trying out various anti-shock feet, insulators, etc., I hit upon the idea of taking a rubber bicycle tire repair plug and drilling a hole in each corner of the



A New Use for Rubber Tire Plugs at Last. Why Not Use Them for Instrument Feet? Too Bad Some Genius Can't Find an Electrical Use for Old Shoe Nails.

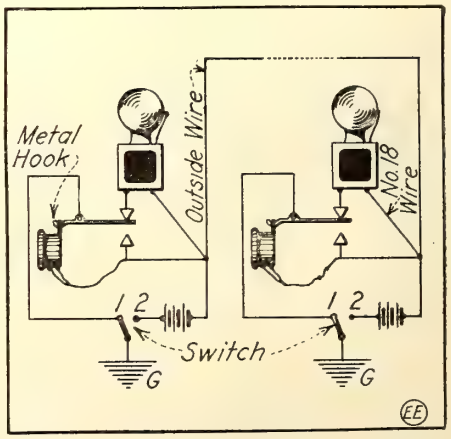
base the size of the stem and gluing the plug fast. This makes an excellent insulator as well as silent and shock-proof foot. (Ye Gods! Next!! Editor.)

Contributed by WILMER J. SLIFER.

A SIMPLE TELEPHONE.

The accompanying diagram shows a good way in which to rig up a telephone system by means of an E. I. Co., Pony receiver which may be used as a telephone (both for transmitting and receiving) up to a distance of 150 feet or more. For longer distances batteries should be connected between the receiver and line wire.

After the stations are connected as indicated, one station may ring the other by removing his receiver, the weight of which has kept the ground wire in connection with the bell, and turning the switch handle to point 2 in the diagram. To put both receivers in the circuit it is necessary to throw the switch back on point



To Make This Simple Telephone System All You Require, Are Two 75 Ohm 'Phones, 2 Call Bells, 2 Push Buttons, Batteries, 2 Switches and a Pair of Home-made Hook Switches.

1. The weight of the metal hook will cause it to drop to the lower contact.

Contributed by CLAUDE IRELAND.

THE FRANKLIN EXPERIMENTAL CLUB.

(*Continued from page* 311)

vited guests and members, and every encouragement was given to original experiments and the construction of original apparatus and for some time it was a rule that each member must perform an original experiment, however crude, at least once a month, and many well-known principles in electricity, magnetism, sound, light, chemistry, etc., were thus demonstrated and originality and initiative stimulated.

With a view to bringing before the community the earnest aims and accomplishments of the club, an elaborate electrical dinner was given on January 31st, 1891, which was attended by Mayor Haynes of the City of Newark; Senator M. T. Barrett; Supt. of Public Schools, W. N. Barringer, Sec. of the Board of Education, Lyndon Brice, and other prominent men, including William Wallace, Edward Weston, Francis R. Upton, Frank J. Sprague, James M. Beck and Richard F. Outcault. The guests were entertained by electrical experiments, and many novel effects, and regaled with food and coffee cooked by electricity. Cigars were lighted by electricity, for there were no matches to be had, and a tiny electric railway running about the table carried food, cigars, cigarettes, etc., to the guests, while in the meantime they were entertained with instrumental and vocal music rendered by a young lady seated at a piano a block away, which music was transmitted by a loud-speaking telephone thru a trumpet suspended over the table; from this trumpet hung a circular bomb, which was exploded by electricity during the feast, bombarding the guests with bonbons.

A number of electro-magnets hung suspended at various points from the ceiling and were connected in series with the lighting circuit; these magnets held up roses and carnations to each of which a tiny nail or screw had been attached, so that when the magnet circuit was broken the guests were treated to a shower of beautiful flowers, which fell all over the table. There were bears, alligators and storks about the table, equipt with blinking eyes and holding electric lamps or other ornaments, while real gold fish, which had tiny incandescent electric lamps inside their stomachs, connected by thread-like insulated wires to a storage battery were beautifully illuminated from time to time in the darkened room as they swam about in a huge glass globe. Near the center of the table were three skulls with electric lamps blinking in their eyeless sockets; they rested on a black velvet pedestal containing a concealed phonograph and frequently during the meal the guests were startled by a sepulchral voice emanating from the skulls which said:

"As ye are now, so once were we.
As we are now, so ye shall be."

Perhaps the most interesting feature of the dinner was presented in a life-sized wax figure of Benjamin Franklin loaned by the "Eden Musee," who with a benignant smile on his countenance, sat at the head of the long table and presided over the feast; periodically Franklin who held in one hand a kite string attached to a replica of Franklin's kite placed in the far corner of the ceiling of the room, would draw a long flash of lightning to a key held in the other hand and by means of a phonograph inside of his anatomy, he made an address to the guests as follows:

"My dear Friends:—

"Through the genius of Mr. Thomas A. Edison, I come back to you from the past of over a century ago. I am glad to find I am so well remembered and I am pleased to preside at this, the first annual banquet of the Franklin Experimental Club of Newark, New Jersey.

"Good things will bear repeating. Let me quote some expressions of mine, which I see have now become household words of yours.

"'Early to bed, and early to rise, makes a man healthy, wealthy and wise.'

"'If you would know the value of money, try and borrow some.'

"'When the well is dry, they know the worth of water.'

"'Experience keeps a dear school, but fools will learn at no other.'

"'Now I have a sheep and a cow, every one bids me good morning.'

"'For want of a nail, the shoe was lost; for want of a shoe, the horse was lost.'

"'Three removes are as bad as a fire, and a rolling stone gathers no moss.'

"'A small leak will sink a great ship.'

"'What maintains one vice would bring up two children.'

"'Industry pays debts, and despair increaseth them.'

"'Always taking out of the meal tub, and never putting in, soon comes to the bottom."

"'If you would have a faithful servant and one that you like, serve yourself.'

"'Sloth, like rust, consumes faster than labor wears, while the used key is always bright.'"

During the dinner some appropriate remarks bearing upon Franklin, and his work, made by Mr. Edison, and which he had *personally* recorded upon a phonograph cylinder especially for the occasion, were listened to with great interest.

At the center of the table stood a five-foot reproduction of the Eiffel Tower, lighted by many tiny electric lamps with a miniature searchlight on top. During a sudden darkening of the room the model was beautifully illuminated by colored fire set off by electricity on the various platforms of the tower; this was followed by the Marseillaise sung by Mme. Adini and M. Melchizdec of the Grand Opera, Paris, rendered by a phonograph cylinder made by the society's president in M. Eiffel's private room on top of the Eiffel Tower the day the Paris Exposition of 1889 closed.

The guests also listened with rapt attention to the voices of M. Eiffel, M. Gounod and others shouting "Vive la France," "Vive la Republique" as the booming of the official gun stationed on top of the Eiffel Tower could be plainly heard, announcing the close of the Paris Exposition; simultaneously a tiny cannon on top of the replica of the tower, which decorated the table, was fired off by electricity and the dinner and its festivities came to a close. Each guest carried away as a souvenir a medallion of Benjamin Franklin, on the reverse of which was inscribed data regarding Franklin, and the Franklin Experimental Club.

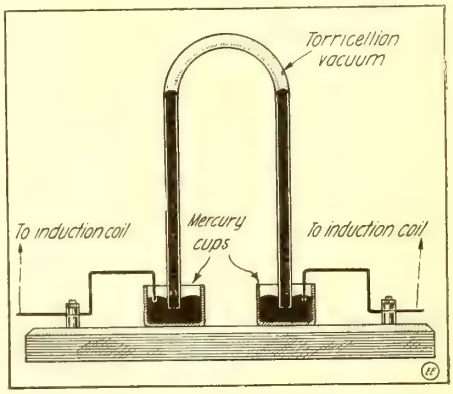
AN EXPERIMENTAL GEISSLER TUBE.

The best results and effects are obtained with discharges from the secondary of an induction coil in glass tubes when the exhaustion is carried to a pressure of about 2 mm. of mercury, and the tubes are permanently sealed.

However for experimental purposes a Geissler tube made as described below gives most satisfactory results.

Procure a glass U-tube about 34 inches high. Fill it with clean mercury, close the ends with the fingers and invert it into two vessels of mercury. Upon removing the fingers, the mercury in the two arms will fall a few inches, as shown in the accompanying sketch. This will create a vacuum in the upper part of the tube, known to physicists as a Torricellian vacuum, from Torricelli, a pupil of Galileo.

Wires are led from the mercury cups to two binding-posts, as shown. If the electrodes of an induction coil are connected to these terminals, a luminous phenomenon



Geissler Tubes Are Not Always Available When Wanted. Here's the Way to Make One in Your Laboratory.

is produced in the upper section of the tube.

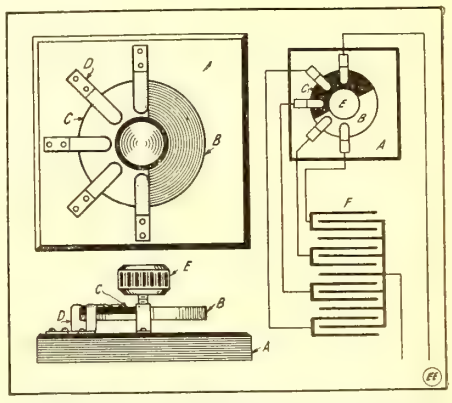
This experiment may be varied by carefully admitting different gases or vapors into the evacuated space. The luminous effects obtained thereby are very beautiful. The colors are determined by the nature of the residual gas. Hydrogen glows with a brilliant crimson; the vapor of water gives the same color, indicating that the vapor is dissociated by the discharge. An examination of this glow by the spectroscope gives the characteristic lines of the gas in the tube.

Contributed by PETER J. M. CLUTE.
(Union College, Physics Laboratory.)

A CONDENSER SWITCH OF PROVEN EFFICIENCY.

Here is a small (or any size the reader may desire to make it) switch for use on an adjustable condenser. It is simply built and will work easily without getting out of order readily.

It is made from a fiber washer and half of a brass washer, fitted so there will be an even surface as shown. The contacts are made from brass strips cut and bent into shape. For a handle an old typewri-



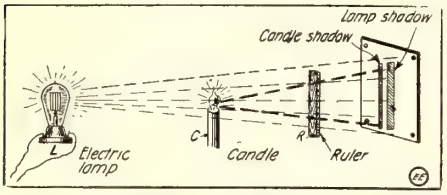
If Properly Made This Form of Condenser Switch Will Give the Best of Satisfaction. Bend the Contact Springs So They Do Not Catch on the Disc Edge.

ter knob will do. A few brass, round-head screws and a wooden base make up the rest.

Contributed by A. C. HANSEN, JR.

HOW TO CALCULATE THE CANDLEPOWER OF A LIGHT.

To compare the (illuminating) power of two lights, *e. g.,* lamp (L) and candle (C) is quite a simple matter by the following (Rumford or shadow) method: Pin to the wall a piece of white paper. About a foot away from and in front of this paper fix a rod, R (say an office ruler), vertically, says a writer in *The Amateur Photographer's Weekly.* Place the lamp L, in line

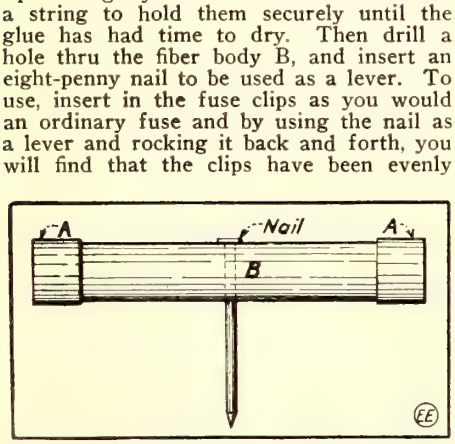


A Simple Method of Determining Candle-Power of a Light.

with the rod so that it casts a shadow of the rod, R, vertically somewhere about the middle of the paper screen. Now place the candle, C somewhere between L and R, so that the two shadows of R cast by C and L are just touching (side by side). Move C and L about until these two shadows seem to be equally dark—or light, as you may be disposed to regard matters. Now the shadow cast by L is illuminated by C, and that cast by C is illuminated by L. The illumination values are inversely as the squares of their distances from the screen. For example, suppose C is 24 inches from the screen and L is 84 inches from the screen. We see at once that dividing these distances by 12 we get 2 and 7. Squaring these numbers, we have 4 and 49, roughly say 4 and 50, *i. e.,* 2 and 25, or 1 and 12½. So that the lamplight is 12½ times the light or candle-power of that particular candle. For more precise results you must obtain a standard candle (cost about 25 cents).

FUSE CLIP CLEANER.

This is a device for cleaning fuse clips on blocks using cartridge fuses of the ferrule type, and as dirty clips do not make good contact it will prove a very useful and handy article to have. It is made from a blown fuse of the proper size to fit the block to be cleaned. Take two pieces of fine emery cloth, cut to the width of the brass ferrules of the fuse, marked A-A, and just long enough to go around once. Put a little glue on the cloth side and squeeze tightly around ferrule and tie with a string to hold them securely until the glue has had time to dry. Then drill a hole thru the fiber body B, and insert an eight-penny nail to be used as a lever. To use, insert in the fuse clips as you would an ordinary fuse and by using the nail as a lever and rocking it back and forth, you will find that the clips have been evenly



Pull This Home-made Cleaner Back and Forth a Few Times in the Fuse Clips and They Will Be Thoroly Cleaned.

cleaned, and will make a first-class contact. A large percentage of fuses are blown, or in other words melted, by the heat generated from a poor contact of the fuse, and the fuse terminals or clips.

Contributed by FRED R. KLINK.

"RADIO" COMMUNICATION OVER GAS AND WATER PIPES.

(*Continued from page* 318)

Considering the receiving apparatus necessary to pick up the buzzer signals as transmitted thru the earth, we have at Fig. 1 the simplest type of receiver, *viz.,* one employing a radio detector such as silicon, or other mineral, and a pair of radio receivers connected unilaterally to the water pipe. We call particular attention to this first circuit, as it shows a very important consideration; *i. e.,* that the radio detector circuit of whatever type used should be connected only in a *unilateral* manner so as to be excited by *one wire* or unipolar current. The detector circuit **should not under any condition be connected in a *bipolar* manner,** or the operator thereof is liable to get into serious trouble with the Government authorities. The receiving circuit Fig. 2, shows a unilateral detector with small fixt condenser shunted across the 'phones; this local circuit being tunable by means of a loose coupler, and variable condensers shown. The primary of the loose coupler is connected thru a variable capacity to the water and gas pipes.

The receiving circuit shown in Fig. 3 is similar to diagram No. 2, except that an ordinary tuning coil or adjustable aircore inductance is employed instead of a loose coupled two-coil transformer. In this circuit a variable condenser may be used as indicated by the dotted lines to properly attune the secondary circuit. Receiving diagram No. 4 is for loose coupler and an Audion detector which is connected unilaterally.

Several hook-ups are given for combined transmitting and receiving circuits utilizing a buzzer transmitter and unilateral radio receptor. These circuits are simple and no trouble will be experienced in understanding them.

Diagram No. 1 utilizes a double-contact telegraph key; diagram No. 2 calls for a single contact key, and circuit No. 3 also utilizes a single contact key, but requires a two-point switch to change the apparatus from transmitting to receiving.

A HOME-MADE ARC SEARCHLIGHT FOR THE AMATEUR.

(*Continued from page* 329)

rows, from one end to the other. A porcelain tube is put in each end.

The apparatus is connected as shown in Fig. 5. Two lamp cord wires are run from the plug and socket attachment into the resistance box and connected to the two resistance wires, one to each row. Lamp cord connections are made to the wires at the other end and led out to the searchlight. Here they run thru a porcelain tube into the searchlight, where they are connected to the screws that hold the carbons in place. Before trying the searchlight change the fuses in its circuit to at least 15 amperes. This is important, for if the searchlight is left burning continuously very long, fuses of lower ampereage are apt to blow. To use the searchlight, push in the handle with the rubber knob on it until the carbons touch. The light will not be very bright until the ends of the carbons have points burnt on them. It is a good plan to file a point on the carbons before putting them in. Different focuses can be obtained by merely turning the knob to the right or to the left. A large spot is best for short distances, while a small spot is best for long distances.

I have shown many boys in my home town how to construct searchlights similar to this one. A searchlight seems to interest every boy.

SELENIUM CELL DESIGN AND CONSTRUCTION.

(*Continued from page* 325)

for winding, but it is rather difficult to wind such wires evenly.

Another modified form of this cell construction is shown in Fig. 3. In this case the selenium is placed on the insulating support before the wires are wound on. This form was not found to be very satisfactory. It is difficult to properly anneal as the selenium is practically hidden by the wire and in use the selenium is shaded too much by the wires unless the light is traveling perpendicularly to the axis of the cell and the source at a fairly great distance.

The disadvantages of the Bidwell cell are to a large extent done away with in the forms of construction employed by Bell and Taintor, Mercadier and Fritts. A cross-section of the cell employed by Bell and Taintor in experiments with their *photophone* is given in Fig. 4. Round disks of brass or copper about one inch in diameter are mounted on two metallic rods, the plates being separated by mica washers and alternate disks connected to the rods. The result is a cylinder with alternate plates connected to the same terminal. The selenium is flowed over the surface of the cylinder in a thin layer and thoroly and slowly annealed. This construction is good where it is feasible to use a parabolic reflector, so all sides of cell may be acted upon. The thinner the film on the cell the greater the ratio of the lighted to the darkened resistance.

Where a flat cell is preferred the Mercadier type will be found useful. In this cell the conductors are wound in a flat spiral as shown in Fig. 5. Mica strips serve to insulate the plates. With a little care excellent cells of this type may be constructed. They have the same characteristics as the Bell type of cell, but are of simpler construction. Due to the fact that the strips are curved, it will be found rather difficult to make a number of these cells having the same resistance, because slight variations of the curvature between the metallic strips will result in cells of widely differing resistance.

To Ruhmer is due the credit for enclosing selenium cells in a vacuum to protect them from moisture and dust. In all types of cells in which the selenium comes in contact with the air it is advisable to make some provision to keep out moisture. This can be done by enclosing in a glass bulb or test tube. Flat cells may be enclosed in small wooden pill boxes which have a small glass window on one side. A simple construction employed by the writer is to utilize the end of a tubular flashlight. The tube was cut off just back of the threaded end supporting lens and a fiber bottom put in. The container was warmed and after inserting the cell was sealed with wax. A small threaded screw was fastened in the fiber bottom to clamp the cell in any desired position. Another method of protecting the cells is to paint them with a transparent varnish. By mixing dyes with this varnish it is possible to make a cell that will only be acted upon by one color. The transparent collors sold for painting postcards will be found suitable for the purpose.

The last mentioned cell, the Fritts, is possibly the most sensitive type ever developed. Its construction is fairly easy, but gold foil is used in the construction. It is not affected to an appreciable extent by moisture and can be made in extremely small sizes without difficulty. (See Fig. 6.)

It consists essentially of a thin film of selenium on one side of which is a copper

(*Continued on page* 356)

Experimental Chemistry

By ALBERT W. WILSDON

Sixteenth Lesson

Sulfuric Acid (History)

SULFURIC acid, is without doubt, the most important and useful acid known, and has been called, next to human food, the most valuable of products. By its means nearly all the other acids are prepared, whilst its manufacture constitutes one of the most important branches of modern industry owing to the great variety of purposes for which it is needed, as there is scarcely an art or trade in which in some form or other it is not employed. In enormous quantities

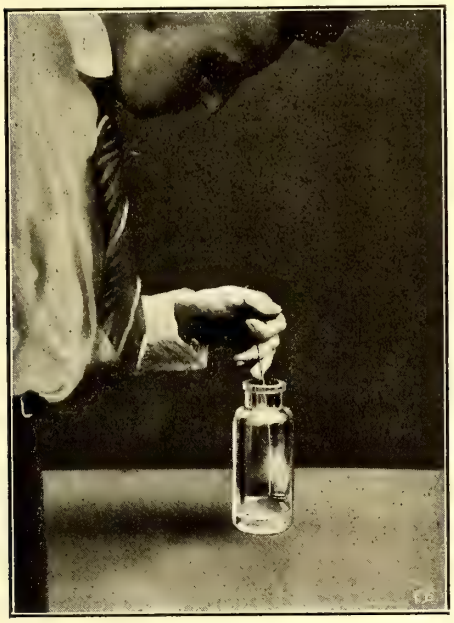


Fig. 81. Introducing Burning Sulfur In Bottle for the Minute Preparation of Sulfuric Acid—H_2SO_4.

it is used in the preparation of material for bringing food plants to maturity, in the manufacture from common salt of a great variety of compounds of Sodium and Chlorin, which enters into the making of such commercial substances as glass, soap, bleaching powder, and even bread. Scarcely any of the products of civilized life have been brought to perfection without its use, directly or indirectly. It is manufactured on an enormous scale in many countries; nearly one million tons are annually made in the United States, while Germany had, previous to the European conflict, produced a similar amount. Great Britain produced close to one and a half million tons.

Geber probably made and used this acid, which he called "Vitriolic Acid," but Basil Valentine was the first to fully describe the preparation of this acid from Ferrous Sulfate [Fe SO_4] or Green Vitriol, and to explain that when Sulfur is burnt with Saltpeter a peculiar acid is formed.

Sulfuric acid was originally obtained exclusively by heating Green Vitriol; the acid thus prepared consisted of Sulfur tri-oxid dissolved in Sulfuric acid, and from its property of fuming in the air is known as "Fuming Sulfuric acid."

The method by which the greater part of the acid is at present produced is said

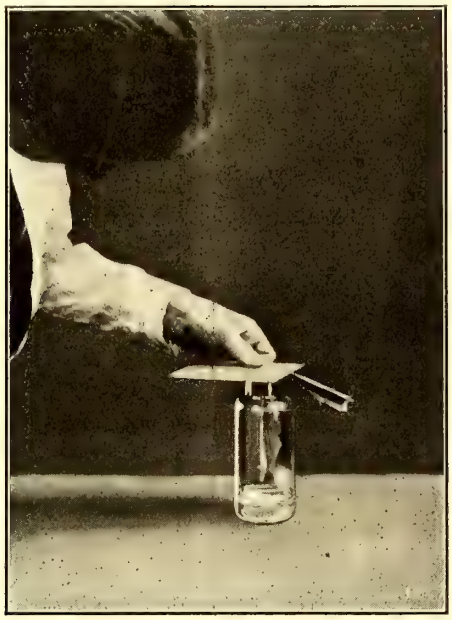


Fig. 82. Method of Introducing HNO_3 on Paper In Bottle In Which Sulfur Was Burned. For Preparation of Sulfuric Acid.

to have been introduced into England from the Continent by Cornelius Drebbel; but the first positive information which we possess on the subject is that a patent for the manufacture of Sulfuric acid was granted to a quack doctor by the name of Ward. For this manufacture he employed glass globes of about 40 to 50 gallons capacity; a small quantity of water having been poured into the globe, a stoneware pot then introduced, and on to this a red-hot iron ladle was placed. A mixture of Sulfur and Saltpeter was then thrown into this ladle, and the vessel closed in order to prevent the escape of the vapors which were evolved. These vapors were absorbed by the water, and thus Sulfuric acid was formed. This product, from the mode of its manufacture, was termed *Oil of Vitriol.*

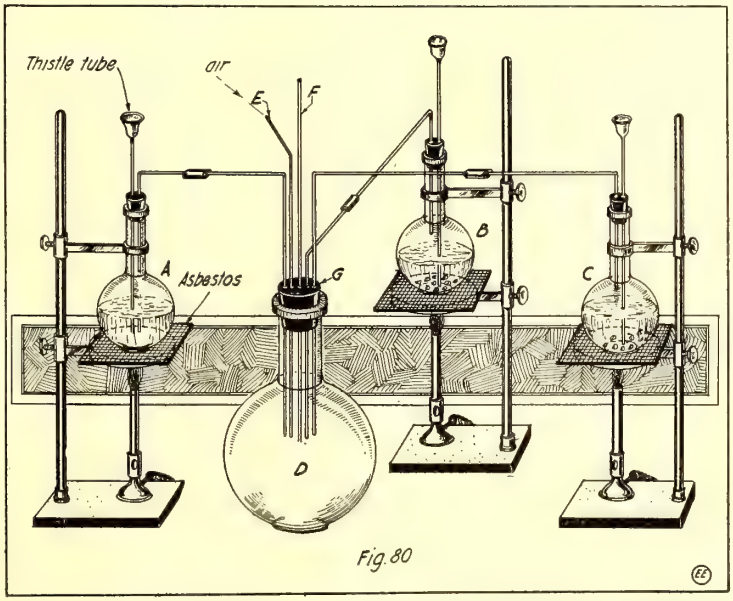


Fig. 80

Set-up of Apparatus Used in the Laboratory Preparation of Sulfuric Acid. The Apparatus Follows: A, Flask Holding Water; B, Flask Containing Copper and Sulfuric Acid; C, Flask Containing Copper and Nitric Acid; D, Central Flask, the Sulfuric Acid Generator; E, Tube for Blowing in Air; F, Ventilator Tube (Side Neck Tube in Experiment Described); G, 5-hole Rubber Stopper.

Preparation

It is not practical to make the acid from its salts. Sulfur dioxid [SO_2] in presence of water [H_2O] and some oxidizer becomes Sulfuric acid [H_2SO_4]. Sulfur Dioxid

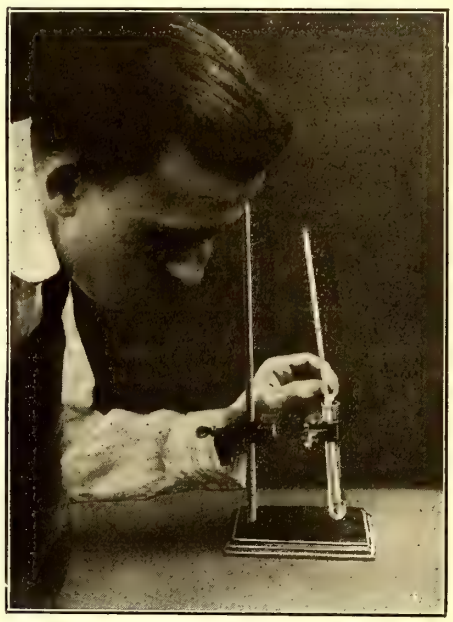


Fig. 83. Recording on Chemical Thermometer the Temperature Caused by Adding Sulfuric Acid to Water.

[SO_2] and Water [H_2O] have affinity for each other and form Sulfurous Acid [H_2SO_3], which only requires one more Oxygen atom per molecule to make it Sulfuric acid [H_2SO_4]. If Oxygen [O] were forced thru the Sulfurous acid [H_2SO_3], or if the latter were exposed to air, a weak acid would very slowly form, but in practise a stronger oxidizer is needed. Nitric acid [HNO_3], Nitrogen Trioxid [N_2O_3] and Nitrogen Peroxid [NO_2] are most effectual for this purpose. Sulfur Dioxid is made by the reducing action of Copper [Cu] on Sulfuric Acid [H_2SO_4].

$$\underset{\text{Copper}}{Cu} + \underset{\substack{\text{Sulfuric}\\\text{Acid}}}{2H_2SO_4} =$$

$$\underset{\substack{\text{Copper}\\\text{Sulfate}}}{CuSO_4} + \underset{\text{Water}}{2H_2O} + \underset{\substack{\text{Sulfur}\\\text{Dioxid}}}{SO_2}$$

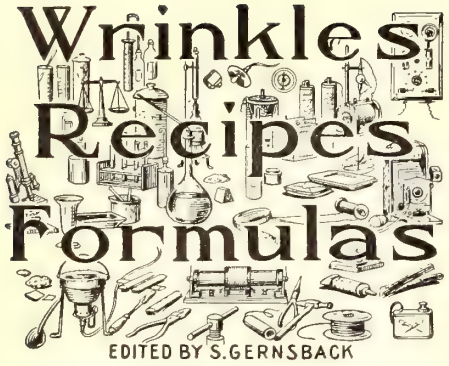
By the action of Copper [Cu] on Nitric Acid [HNO_3], Nitric Oxid [NO] is formed, and in the presence of air oxidizes to Nitrogen Peroxid [NO_2].

$$\underset{\text{Copper}}{3Cu} + \underset{\substack{\text{Nitric}\\\text{Acid}}}{8HNO_3} =$$

$$\underset{\substack{\text{Copper}\\\text{Nitrat}}}{3Cu[NO_3]_2} + \underset{\text{Water}}{4H_2O} + \underset{\substack{\text{Nitric}\\\text{Oxid}}}{2NO}$$

$$\underset{\substack{\text{Nitric}\\\text{Acid}}}{NO} + \underset{\text{Oxygen}}{O} = \underset{\substack{\text{Peroxid}\\\text{Nitrogen}}}{NO_2}$$

(*Continued on page* 351)



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

COMPOSITION OF ALLOYS.

The number of alloy compositions such as bronze, brass and babbitts which are now placed on the market by various companies are almost innumerable, each containing various proportions, and some having special ingredients but nearly all contain practically the same combination as a basis. In almost every case the composition is varied slightly according to the uses to which the part cast from the alloy is to be put.

In general the composition of the most common alloys is as given in the accompanying table:

TABLE OF COMPOSITION OF COMMON ALLOYS

Alloys	Tin	Copper	Zinc	Antimony	Lead	Bismuth
Babbitt's metal...	10	1	..	1	..	..
Bell-Metal	5	16	..	..	..	..
Brass, engine bearing	13	112	¼	..	..	..
Brass, locomotive bearings	7	64	1	..	..	..
Brass, for straps and glands.....	16	130	1	..	..	..
Flanges to stand brazing	..	32	1	..	1	..
Muntz's sheathing	..	6	4	..	..	..
Metal to expand in cooling.....	..	..	..	2	9	1
Pewter	100	..	..	17	..	..
Spelter	..	1	1	..	..	..
Statuary Bronze..	2	90	5	..	2	..
Tough brass, engine work.....	15	100	15	..	..	..
Tough brass, for heavy bearings..	25	160	5	..	..	..
Yellow Brass, for turning	..	2	1	..	..	..
Solders						
For brazing (hardest)	..	3	1	..	..	..
For brazing (hard)	..	1	1	..	..	..
For brazing (soft)	1	4	3	..	..	..
For brazing (soft) or	2	..	..	1	..	..
For lead	1	..	..	..	1½	..
For pewter	2	..	..	..	1	..
For tin	1	..	..	..	2	..

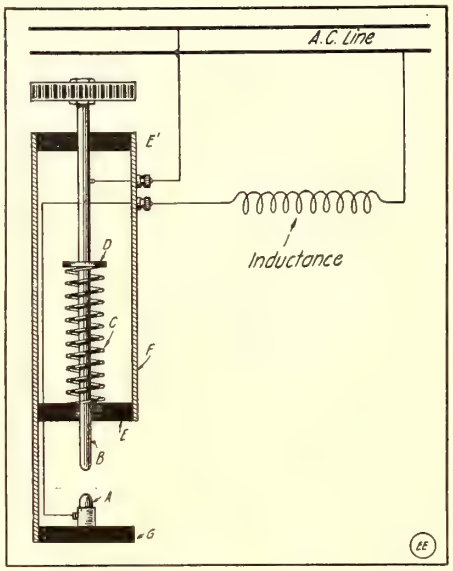
EXPERIMENT HOW TO MAKE GAS.

Take some hard coal and grind it up fine. Put it in the bowl of a clay pipe and put some plaster of Paris over the top to seal it. Then put the bowl of the pipe over or in the flame of the gas stove. In a few moments the gas will be coming out of the stem of the pipe and the same can be lighted.

Contributed by SHERMAN B. LAW.

AN ELECTRIC GAS LIGHTER FOR THE "LAB."

An electric gas lighter is not only a necessity but a convenience, especially in laboratories and such places, where gas is turned on and off at frequent intervals. The sketch shows how the writer constructed one with a few tools and in a very short length of time. The casing (F) is of hard rubber or fiber sawed as shown in sketch; the bushings (E) and (E') are also hard rubber or fiber, but can be made of impregnated hard wood. Spring (C) is to keep the movable electrode separated from the stationary electrode (A); (D) is a clamp around the movable electrode to hold the spring in its proper place.



This Electric Gas Lighter Will Be Found a Distinct Convenience in Every Shop and Laboratory. Use an Iron Core Inductance On A.C. Circuits and a Resistance Coil On D.C. Circuits.

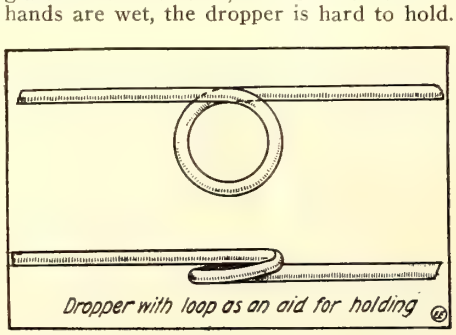
The wires leading to the line and inductance are flexible cords and may be brought out to small terminals on the side of the casing.

The inductance can be varied by the number or turns required for different cycles; the inductance used by the writer was obtained from an old A. C. arc light but one may be easily constructed by winding a number of turns of wire around a soft iron core.

Contributed by HARRY E. BEANE.

AN IMPROVED PIPETTE.

In chemical laboratories the most commonly used dropper consists of a straight glass tube. However, if the tube or one's hands are wet, the dropper is hard to hold.



Place Your Finger in the Loop of This Improved Pipette and It Simply Can't Slip from Your Grasp.

I overcame this difficulty by bending the tube so as to form a complete loop in it, of about three-fourths of an inch. One can slip a finger thru this loop and all danger of its slipping is eliminated. The sketch represents the improved dropper more clearly.

Contributed by ALFRED H. HANSRATH, JR.

HOW TO SOLDER ALUMINUM.

There are various compounds on the market for soldering aluminum, but this operation depends more on the workman than on the solder and unless considerable experience has been had it is probably better to purchase solder than to attempt making it. Zinc can be used but does not form a very strong joint. Tin can also be used, is more nearly the color of aluminum, is stronger than zinc, but is very difficult to work. A small proportion of phosphor tin added to pure tin makes it work more readily and is the basis of most aluminum solder.

The chief difficulty in soldering aluminum is that the heat is dissipated so rapidly that it cools the soldering iron and furthermore aluminum oxidizes instantly upon exposure to the air. This extremely thin film effectually prevents a perfect union being made. If the parts are well heated and melted solder kept hot while the iron is allowed to stand on it, the surface can be scraped beneath the melted solder by the point of the soldering iron, thus preventing to a certain extent the oxidization. In this way the metal can be tinned. When both parts to be brought together are well tinned, the parts can be united with some chance of success, nitrat of silver, resin, or zinc chlorid being used as a flux. A soldering tool of nickel gives more satisfactory results than a copper one as the latter alloys with the tin and soon becomes rough.

Cleaning the Metal: If the surface is of such a shape that it cannot be readily cleaned by scraping, it can be cleaned by dipping it into a solution of nitric acid in three times its bulk of hot water containing about 5 per cent. of commercial hydrofluoric acid. This causes a slight action on the surface of the metal as shown by bubbles. Rinse the metal after removing from the acid bath and dry in hot sawdust.

Aluminum Solder: The following formula, in the hands of a competent man, can be used to unite aluminum or aluminoid parts:

Tin—10 parts.
Cadmium—10 parts.
Zinc—10 parts.
Lead—1 part.

The parts to be united must be thoroly cleansed and allowed to stand two to three hours in a strong solution of Hypo-Sulfate of soda before being operated upon, or cleaned in the acid bath described above.

Contributed by AN EXPERIMENTER.

THE WHEEL GLASS-CUTTER.

Many experimenters have at some time or other occasion to cut glass, and no doubt most of them use the wheel-cutters, which are soon thrown away as of no use. Perhaps the following tip will be of service to them. I had occasion to cut some glass a few days ago, and had only an old, and, as I thought, worn-out wheel to do it with. I tried dipping it in a drop of paraffin, and was astonished to find that it cut as well as when new. I experimented with two others which I had discarded, and found that they cut equally well. Turpentine seems to answer the same purpose.

This may be a welcome tip to some of your readers; it was certainly a new experience for me.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

IN THE LANGUAGE OF "BILLY SUNDAY"—"WAKE UP! YOU ELECTRICAL 'LAB' SLACKERS!!!"

"Slackers!" 'at's what we said. Why in the name of Howling Pete is it, that you "Electrical" and converted (?) "Radio-bugs" can't get some real American spirit in your craniums and start something? The way you slack around, bemoaning the free-for-all radio experimental days, one would think "Uncle Sam" had injected a sleep-walking toxin in every mother's son of you. Suffering kilowatts, shake yourselves—"Bugs!" What's the world coming to when not one "Bug" out of 800,000 of you ohm, volt and oscillation chasers, will condescend to accept $3 in prize money?!! The devil'll get you sure as guns; said devil being We, Us & Co. Open your eyes, read Mr. Hammer's eloquent sermon on this all-important topic in this issue; likewise the Editor's. Read 'em! Preach em! Then dare to sit tight and howl "There ain't no young 'Hammers' or 'Edisons' no more." Rot! We don't and won't believe you. Now get busy and to help awaken the future Faradays, Hammers and Edisons we will give, besides the $3 prize for the best "Electrical Lab." photo, 5 (FIVE!!!) additional prizes of a year's subscription to this journal and a copy of the "Experimental Electricity Course." Come on, you sore-headed "Radio-bugs"; hit the trail; "Experimental Electricity" is King now. Redeem yourselves to-day, before it is too late. Address the Editor "With the Amateurs" Prize Contest.



A GROUP OF ALL-AMERICAN AMATEUR RADIO STATIONS.

Radio Stations of, 5—K. F. Gray, Easton, Pa. (Prize Winner); 1—William F. Warden, Jr., Mt. Dora, Fla.; 2—A. E. Facks, Brooklyn, N. Y.; 3—Harold Bennett, Clarinda, Iowa; 4—J. H. Hamilton, Philadelphia, Pa.; 6—John F. Isenberg, Altoona, Pa.; 7—Edward G. Raser, Trenton, N. J.; 8—Floyd M. Rush, Salem, Ore.; 9—Guy L. Tullis, Oskaloosa, Iowa; 10—Russell C. Cravens, Angola, Ind.; 11—S. Webster Piper, Hagerstown, Md.; 12—Lot and Hodge Alexander, Grove City, Pa.

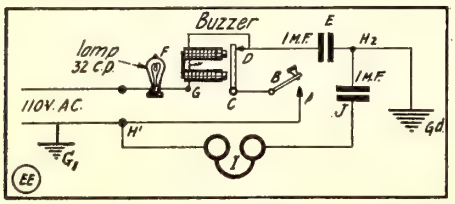
Prize Winners in "Radio Problem" Contest

We are pleased to publish herewith several of the suggestions we have received as well as the prize winning ideas telling what to do with your radio apparatus during the war. Several thousand suggestions were received from all parts of the country, but the majority of them covered similar topics to those discust below.

FIRST PRIZE $10.00.

A Non-Radio Communication Scheme That Works

I am quite sure that the following little experiment should fulfil the desired wants of my fellow



Radio friends whose apparatus is now on the shelf.

In the following explanation I will show how "idle" condensers, keys, receivers, and buzzers can play an important part in re-establishing communication between them. While the distance is limited, there should be no trouble in communicating thruout the city. I have successfully used this system for a distance of nine (9) city blocks. The circuits thus far used do not permit the reception of "Radio" signals and thereby evade the now strict law regarding Radio stations being kept closed. This is by no means a "Radio" station and cannot be clast as such. I cannot emphasize too strongly on this point regarding the fact that Radio signals cannot be heard at all; this, of course, gives us the desired results: "Idle" apparatus put back into use and communication re-established.

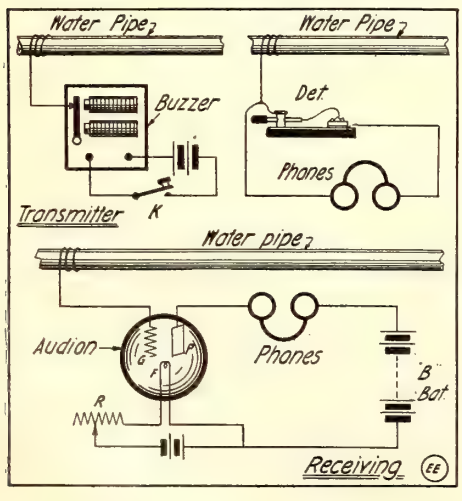
I hope that you will not fail to consider the importance of such a system when it will bring thousands and thousands of my friends back into the game and help pass these dreary days when almost any amateur would offer $5.00 to hear CQ again. The best feature of this system is that it is naturally a "break-in" system. If my friend who lives nine blocks away is sending to me and if I have QRM, I just make some dots and he stops. It certainly is interesting and we are communicating every day. As yet we have not heard a single Radio signal on it. Just previous to the declaration of war we were free from interference as we were the only ones using this circuit in town and it therefore was easy working—and it is now, until we get some other one wised up to this circuit and he starts to butt in. As we have not had any experience with interference it will be hard to state what action a third party will have on the interference question; should he interfere schedules will have to be arranged.

Again—by inserting *inductance* or *detectors* in the receiving circuit *no change* is detected; therefore none are required.—EDW. T. JONES.

SECOND PRIZE $5.00.

Buzzer Communiciation via the Water Pipe

There is about only one way left by which we can communicate without wires and use our radio



sets (that is part of them) and not be clast as "wireless" and that is to employ some sort of ground system, such as a water or gas pipe or two ground plates.

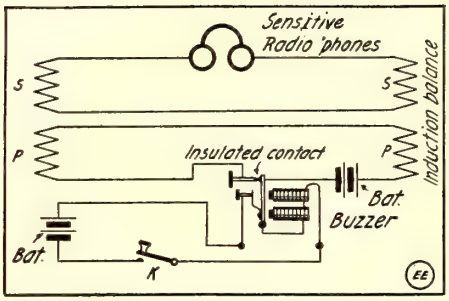
Another "Radio-bug" of this city has a friend in Toronto, Can., who reports that the experimenters there are using a water pipe for the conductor, a buzzer for transmitting, and an Audion in the receiving circuit. They are covering about ten miles with this system. We have no more "dope" as to the exact hook-up at present. The accompanying hook-ups might be worth trying.

In cities where the amateurs are close together there could be relays; if the range is short this would be quite a bit of fun and keep us from getting too rusty.

A spark coil or a transformer could possibly be used to take the place of the buzzer for greater distances.—OLIN M. WARREN.

How to Use Your Radio Apparatus for Scientific Tests

As I have actually used my wireless apparatus with success as follows, other experimenters will find these uses practicable and interesting. As the



directions for constructing the apparatus can be found in back numbers of THE ELECTRICAL EXPERIMENTER, I have refrained from giving construction data here.

If you have a high-priced pair of head 'phones they need not remain idle, for they can be used in connection with a Hughes "Induction Balance." With such a "balance" you can test the sensitiveness of various receivers, determine the degree of magnetism in all metals, test the hearing ability of your friends and the relative frequency of currents. In connection with this instrument your receiving condensers, both fixt and variable, will come in handy. Your buzzer set can be used in frequency tests.

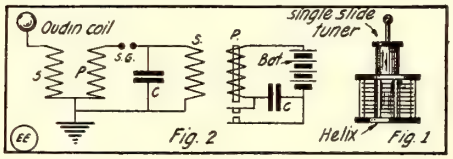
The helix or oscillation transformer can be used to advantage in the operation of a musical arc or speaking arc. Such an arc light is a source of much amusement and the mystification of your friends.

If you have a coherer set with a good relay, you can easily construct a selenium cell to use with the relay. With such a cell you can start a motor by waving your hand, or make an "electric dog," and numerous other experiments. An Audion can be used to advantage in connection with the selenium cell.

Finally boys be patriotic and run a nice big American flag up your wireless mast. Show your patriotism!—ROBERT CHANDLER.

Oudin or Tesla Coil from Tuning Coil and Helix

Take a single slide tuning coil and remove the rod and slider. Then set the coil inside a helix



(see Fig. 1) and by connecting up as shown in Fig. 2 an Oudin coil will be the result.

Burned out Audion and electric bulbs make good giessler tubes. By nailing copper plates to the kitchen chair a valuable "Sing Sing Death Chair," to mystify the spectators will be added to your apparatus.

When father's "weather foot" begins to itch and makes him angry, place him on the electric chair (easily said) and give him a shock. A few such shocks will cure his gout and put him in a better mood. High frequency currents are recognized as a good remedy for many aches and nerve troubles.

Trusting that the reader's imagination will help him with other stunts, I bid you .— —.. . . ..—, .—. .— —.. .. ——, ..—. .—. . . . —. —.. ...

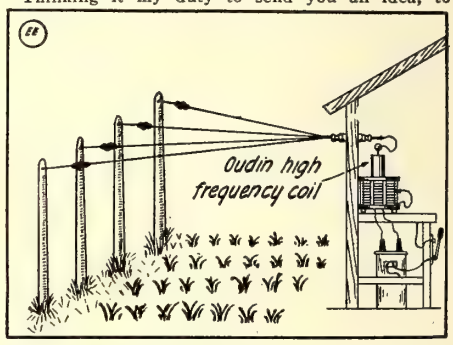
—LEWIS MOSKOWITZ.

Exhibit Amateur Radio Apparatus

It seems to me that about the best use to which the amateur wireless operator might put his apparatus during the war would be to install it in the nearest Signal Corps recruiting station. Its more or less intricate appearance as a whole undoubtedly would attract attention and enlistments. Furthermore, it would arouse enthusiasm for wireless on the part of the fellows too young to fight; and, at the conclusion of hostilities, they might go in for wireless. As such an experiment would undoubtedly act directly for the good of the nation, and, ultimately, for the good of wireless itself, it seems to me that this is about the best use to which the amateur might put his apparatus during the war.—JAMES R. ALLEN (9EU).

Electric Vegetable Cultivator

Thinking it my duty to send you an idea, to



answer the question *"What can I do with my wireless apparatus,"* every amateur ought to help solve the food question and he can if he adds a Tesla coil to his outfit and uses his apparatus as an "Electric Vegetable Cultivator" or else an X-ray outfit.

If he makes an Electric Vegetable Cultivator, he will not only derive pleasure out of it, but profit also.—BRUNO BONKOFSKY.

Convert Radio to Electrical "Lab."

Why not enlarge your wireless station and change it into an electrical laboratory? Almost every amateur has on hand odd electrical apparatus, such as bells, magnets, motors, dynamos and the like. Such apparatus as this with the wireless set will make up a large part of the laboratory equipment and, aside from making it look "electrical," will find a practical use. Such parts of the wireless set as the spark coil or the step-up transformer will be of special value in performing Tesla experiments or in X-ray work. Likewise other parts will find uses equally as practical. From time to time articles in THE ELECTRICAL EXPERIMENTER will be of great value to the amateur in his work and I am sure many of them will explain the uses of wireless instruments in the laboratory.

Money spent in laboratory apparatus and for electric books is always well invested.

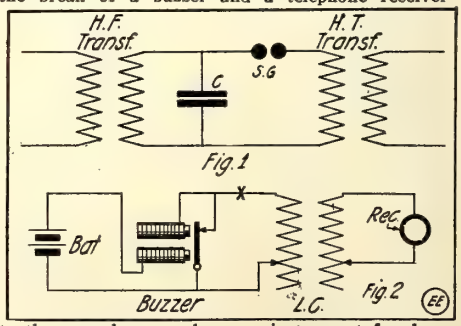
May the wireless enthusiasts get together on electrical laboratory work, thru THE ELECTRICAL EXPERIMENTER and clubs thruout the country, as they have been in wireless telegraphy.—FRANK M. JACKSON.

More High Frequency Stunts

Herewith are given a few ideas for the use of radio instruments during the war.

The average amateur sending set is an almost complete high frequency generator. All that is necessary is to insert within the old helix or oscillation transformer primary a secondary of fine wire on a cardboard tube of suitable length. The result is a high frequency coil of either the Tesla or Oudin type. See Fig. 1 for connections.

By connecting a loose coupler primary across the break of a buzzer and a telephone receiver



to the secondary, we have an instrument for demonstrating electromagnetic induction, for tuning and coupling to some extent and for code practice as well as for measuring purposes. See Fig. II.—JACOB HALLER, JR.

Several other good ideas will appear in the October issue.

Laboratory "Contest"(?)

TOO bad. Too bad. Here we have gone and advertised for three solid months that we wanted photos from "bugs", experimenters, *et al*, showing their laboratories. Uncle Sam says: "Boys, Wireless is taboo, just now. Nix on the ether waves." The EXPERIMENTER being a patriotic sort of a chap, promptly seconds the motion. The radio amateurs not to be outdone, not only second the motion, but triple and quadruple it, i. e., they fire radio-station photos at us till the postman staggers under the load.

Question: Why when wireless is forbidden do we get twenty radio-station photos a day, where before the war we received but two or three? Verily, verily, the ways of human nature are strange.

At any rate this month we proudly exhibit one specimen. Yes this one is the real stuff, no fake about it, honest. And what's more—hang the modesty stuff—it shows your editor in person. You always wanted to know what kind of a mug he has, didn't you? Well you've had your wish. True, the picture is not a very recent one, having been taken some odd 19 years ago, but it's the best to be had, of those memorable days. If we were to tell you that the proud young person in the picture was 13 years old when it was taken, you could of course figure out quickly how old the "ancient crab" is at present. But as modesty forbids such statements we will not indulge in them.



"La-dies an' Gen-tell-menn! This Way, Please—and Don't Crowd Too Much. Here You Behold the Ge-nnu-ine and Only Photo in Captivity Portraying Your Editor's Phiz! Yes, La-dies, the "Ancient Crab" Was Some "Bug" Once!

At any rate your young hopeful was as big a "bug" as grow nowadays. Yep, he *was* some "bug." There was nothing that was not represented in that "lab" of his. Of course, wireless was not as yet invented in those days, but telephones, batteries, magnetos, spark coils, meters, Tesla coils, motors, dynamos, etc., all were here in a great array. And believe us, fellow bugs and buglets, we had *some* fun. There was a telephone line and a telegraph line to our friend's house and we even had a Bell Photophone, made with a crude selenium cell, and a telephone receiver of antique vintage. This, as you probably know works by talking over a ray of light, using the back of a vibrating mirror as the sender, while the selenium cell, telephone and battery form the receiving station.

With this apparatus we covered about 200 feet at first. The transmission of speech was very good and the articulation fine—if we yelled loud enough. We might add that we could hear just as well without the apparatus! But, as real dyed-in-the-wool experimenters, we did not give up. Rather finally we "obtained" (censor deleted the mode of "obtaining" it) a commercial selenium cell, and with this we actually transmitted articulate speech over a light ray about ¼ of a mile. It worked real well, too, and it is a matter of constant surprise to us that present day "bugs" don't go in for this sort of work. It certainly is a whole lot of fun to talk over a mere ray of light.

Next came another sort of "wireless" phone. This was an earth conductive system* by burying a set of metallic plates, 100 feet apart at different levels in the earth. A microphone and batteries connected with the plates. The receiving end consisted of a set of similar plates, spaced equally apart, and buried at different levels, too. A simple telephone receiver connected with the plates. Speech was thus actually transmitted over a distance of one mile, and this outfit worked for a long time. By using large zinc and copper plates, this system was improved in 1903 and over 3 miles were then covered.

But your young hopeful's main and staple vice in those days was batteries. Without fear of contradiction we make the sweeping assertion that he spent more time and money on batteries than any other boy, alive, dead, or as yet to be born, Thomas Reed inclusive!! Batteries, ah! You elusive, ever perplexing devils! And we made every one ourselves, no "boughten" ones for us.

Ah, yes, those brave Bunsen's! Some batteries! Strong as an ox, both in current *and* smell! But we fixt the fumes alright, you bet. How? Simplicity itself! On top of the vile-smelling nitric acid, contained in the porous cups, we poured about one inch of petroleum! That stopt the fumes *almost* entirely and the batteries kept on working longer. Ten such batteries each about 12 inches high, could light a dozen or more 16 volt 8 C.P. old time carbon lamps, and what's more, the Bunsen's kept doing it for 2-3 weeks on one filling, feeding the lights each night. And the lamps burned remarkably steady, too. Of course, the cleaning and filling was a nasty, messy job, and many a pair of shoes and pants were ruined by the strong acids, but in the pursuit of science, we stop at no such commonplace items as these!

Our photo shows the young battery "bug" surrounded by his Bunsen's. As may be noted, they gave quite a spark on short-circuit. Soon, however, we gave up the vile-smelling Bunsen's and we then ran the whole gamut of the battery will-o'the-wisp. Chromic-acid, one and two fluid; Daniel copper sulfate; Edison-Lalande copper-oxid; gravity copper sulfate cells; peroxid of lead-zinc (a good battery by the way) down to Upman's chlorin-gas battery. Yes, we believe there is no battery that was ever invented that we did not actually try out. Some day we'll describe a few new ones, so as not to be humiliated by Tom Reed!

At any rate we finally settled down and compromised on an 8 cell glass jar storage battery, giving 16 volts and 40 ampere-hours. Each of these 8 cells were connected to a "Pachytrop" exactly described by Mr. C. A. Oldroyd in the March, 1917, issue of this journal. Turning the handle 90 degrees connected all the cells in parallel. Another turn connected the cells in series. While connected in parallel the eight storage cells gave, of course, about 2 volts, and in this position they were charged by eight very large copper-oxid-caustic soda-zinc batteries. These cells are ideal for storage battery charging, and will be described fully in a later issue, if we can find the time. Suffice it to say that each cell was made of black sheet iron in the form of a tray, about 18 inches long by 12 inches wide. The height was but 3 inches. These trays were copper-plated inside and a stout copper wire was soldered in a corner. This formed the positive pole. The bottom of the tray was covered with a ½" layer of Cupron nuggets,* while in each corner of the tray there was a small porcelain insulator. On top of these a heavy zinc plate, well amalgamated was placed. The tray was then filled with a solution of caustic potash, so that it stood ½" over the zinc plate. On top of the caustic potash we poured a layer of mineral oil. The battery was then ready to operate at once, and it gave about 0.9 volt and 12 amperes. This voltage dropt to 0.7 when charging the storage cells. The eight tray-batteries, therefore, gave over 6 volts, enough to charge the storage batteries.

These Cupron cells were "all to the good" and gave no trouble worth mentioning. They did not mind in the least being short-circuited for hours at a time, and the steadiness of the current is amazing. These batteries are perfectly odorless, require no attendance and need not be filled for months at a time. Nor are materials consumed when they stand idle.

Now "bugs," for the love of Pete, get busy and shoot along those "lab" photos. *We* aren't paid to write up this sort of "dope." Soon we'll strike! Lookatatime! 1 A. M.!! Have you no pity on the overworked "old man"?!

* See "The Wireless Telephone," by H. Gernsback, Page 26.

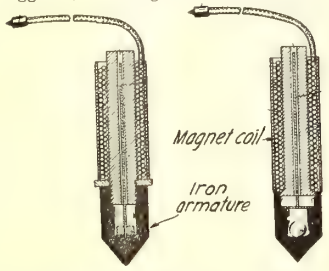
* Cupron is a higher form of the ordinary commercial copper-oxid, i. e., suboxid.

LATEST PATENTS

Magnetic Battery Gage

(No. 1,231,708; issued to Emerson L. Clark.)

A simple form of battery gage especially for use with dry cells. The cost of the device is very low, and it is extremely simple and rugged in design. It indicates

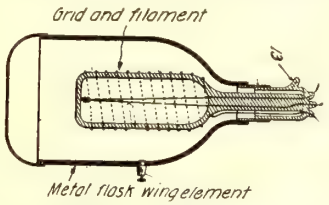


whether a cell is up to standard by means of an audible signal or by the sense of touch. A low resistance magnet coil is wound on the non-magnetic frame, and when the point of the instrument is placed on one battery terminal, and the flexible lead touched to the other terminal, the coil will produce a magnetic field, thus pulling up the iron armature. This can be heard when attracted by the magnet core, and if the finger is placed over the top of the hollow core, the rising armature pin will strike the finger, giving a second form of indication. The inventor gives details for elaborating the moving armature design so as to use scales; thus permitting of calibrating the instrument for any strength of current.

Metallic Audion

(No. 1,230,874; issued to Lee de Forest.)

Dr. de Forest, the well-known radio inventor, has here developed

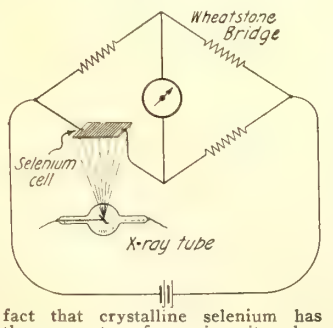


an especially desirable form of Audion blub, which is made of metal so as to stand transportation better than glass. Moreover, the metal flask containing the grid and filament elements serves as the wing or plate. The grid support is preferably all glass, and the patent contains details of assembling the flask and other parts. Finally a metal bottom is welded to the open end of the flask, and the completely inclosed receptacle thus formed is connected to a vacuum pump, and thereby exhausted of air thru the usual tip.

Measuring Gage for X-Rays

(No. 1,229,740; issued to Robert Fürstenau.)

This invention is based on the

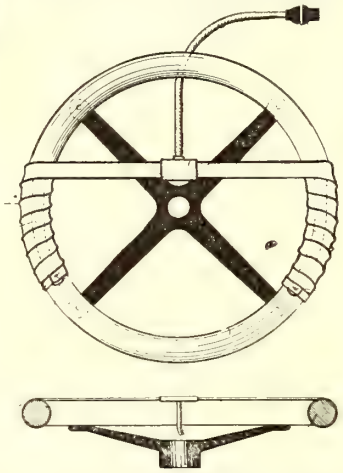


fact that crystalline selenium has the property of varying its electrical resistance when subject to the action of X-rays. This resistance variation is very slight for X-rays, but the patentee overcomes this objection by placing the selenium cell in one branch of a Wheatstone bridge as shown in the diagram. The arrangement and the strength of the resistances are so calculated that when the selenium cell is not exposed to any rays, a current flows thru the galvanometer of the bridge in a direction which is opposite to that of the current flowing thru the instrument when the cell is exposed to the rays.

Electric Steering Wheel Heater

(No. 1,230,788; issued to Even J. Rohne.)

If you have had occasion to drive a motor car in the winter time, you will most probably agree with

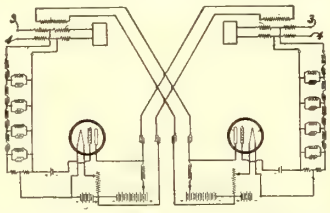


the inventor of this device that some simple form of heater for the steering wheel will prove a very welcome addition to the automobile world. The invention here shown comprises a long flexible ribbon made of leather, cloth, etc., folded upon itself to form a flat casing which serves to support and insulate the electric heating elements or wires, and which elements may be connected either in series or in multiple. The electric heater may be connected to the storage battery or dynamo of the automobile, and takes but little current.

Electric Wave-Filter

(No. 1,227,113; issued to G. A. Campbell.)

This patent relates to an electric

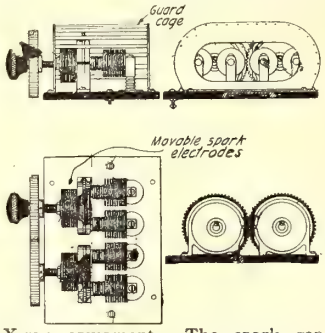


wave filter utilizing a multiplicity of interconnected and specially tuned circuits comprising inductance and capacity especially adapted to transmit with negligible attenuation. sinusoidal currents of all frequencies lying within a range of pre-assigned limiting frequencies, while attenuating and extinguishing sinusoidal currents of frequencies lying outside the limits of the pre-assigned range. This wave filter is applicable to wireless telegraphy and telephony, multiplex high frequency wire telephony, etc., and particularly for use on telephone repeater circuits. The diagram shows two Audion type relays connected with the wave-filter circuits, and in series with a telephone line, each side of the line being connected to the terminals 3 and 4.

Spark Gap Improvement

(No. 1,231,489; issued to C. E. Campbell.)

A unique design of spark gap intended particularly for high power

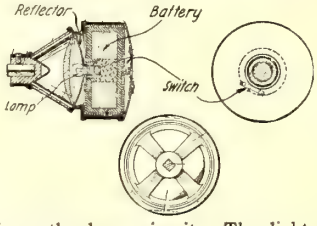


X-ray equipment. The spark gap shown comprises one or more pair of stationary spark electrodes, each electrode being fitted with a large number of cooling vanes in the manner shown. Opposite each pair of stationary electrodes there is provided a disc electrode threaded on the outer perifery and arranged by gears or otherwise with a suitable adjusting knob, so that the one or more discs can be advanced or receded from the stationary electrodes; thus varying the gap length.

Door-Knob Flashlight

(No. 1,230,942; issued to August Sundh.)

The outermost face of the knob comprises a diafram with a switch attachment, and when deprest this

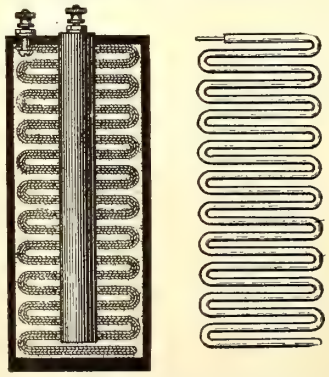


closes the lamp circuit. The light is reflected by means of a lens and two distinct reflectors placed at right angles to the axis of the knob, thru a glass container and between the supporting spider of the knob itself. A new battery may readily be replaced by unscrewing the outer diafram switch cap.

Unique Dry Cell Battery

(No. 1,231,057; issued to Herbert R. Palmer.)

Apparently this idea presents a marked advance in battery design. The patentee claims to have increased the life of a given size of dry cell three hundred per cent over the ordinary type of the same size and weight. This remarkable effi-

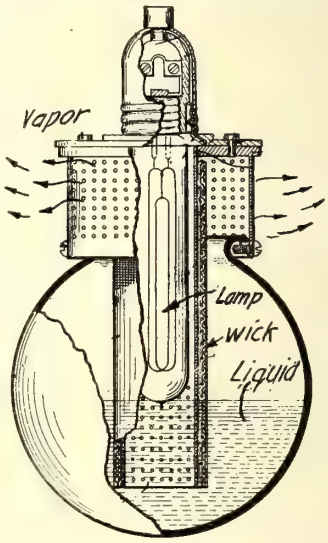


ciency is attained by employing a long, undulating strip of zinc, which is thoroly encased in a porous material such as bibulous paper, and then bent or corrugated as shown in a sinuous form. The zinc is first perforated so that the carbon cathode can pass thru the various undulations of the encased zinc element without touching the zinc itself.

Electric Disinfector and Deodorizer

(No. 1,230,342; issued to R. Thornberg.)

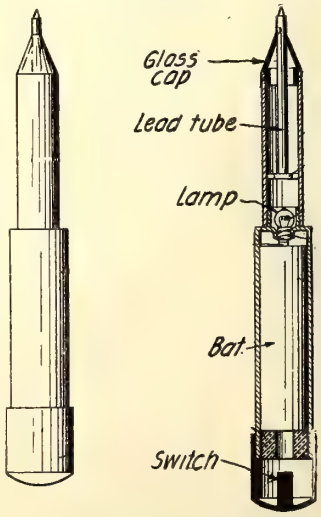
An ordinary tubular incandescent lamp is employed as the source of heat for vaporizing the disinfecting or medicating liquid, which is placed within the glass bulb in the manner illustrated. A



perforated tube surrounds the lamp, the tube itself being covered with an absorbing wick. In this way the liquid is spread out so as to realize the full vaporizing benefit from the heat of the lamp, and the vapor escapes thru the perforated ring at the top of the device as shown by the arrows.

Illuminated Pencil

(No. 1,230,721; issued to E. V. Kelly.)



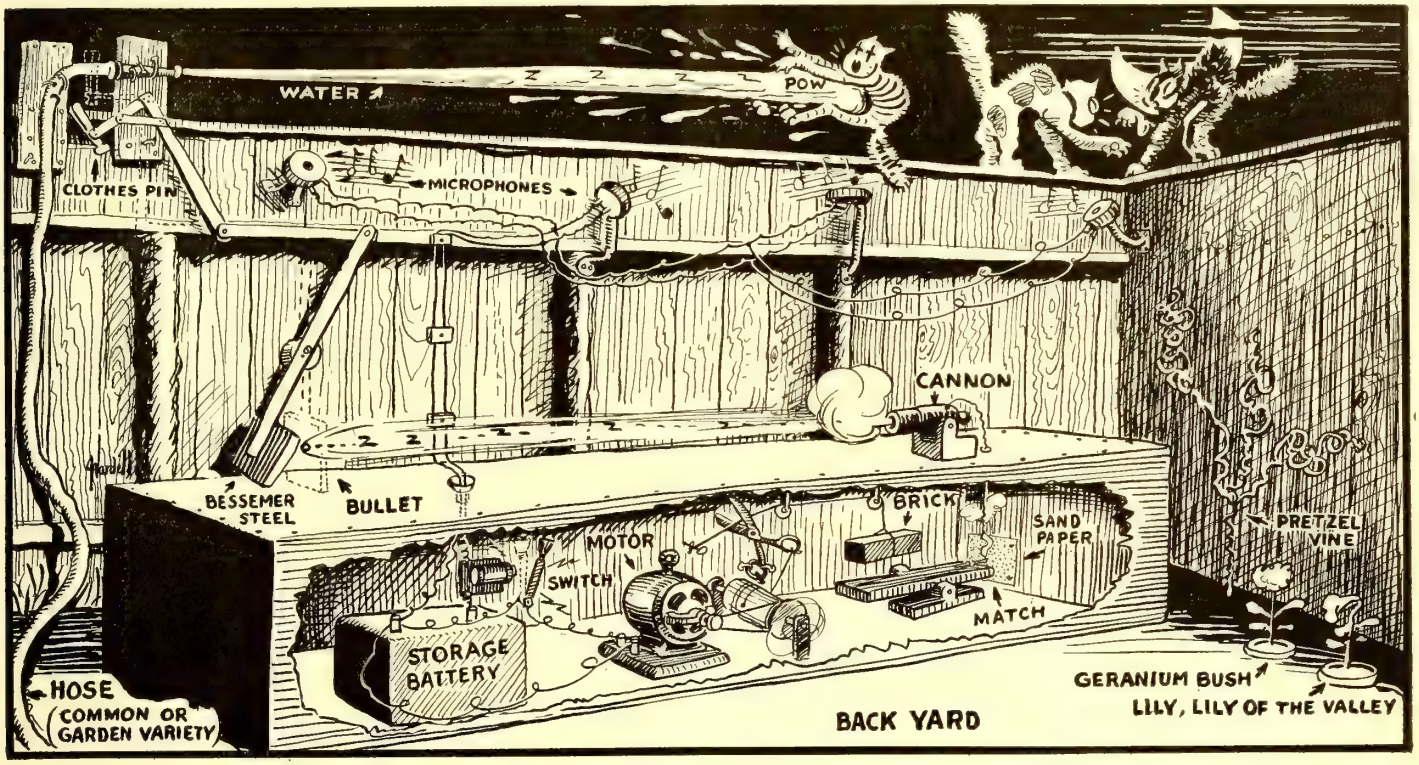
A useful invention comprising a suitable casing containing a miniature dry cell, small tungsten lamp, and means for holding the pencil lead as well as a switching device. To open or close the lamp circuit, the sliding cap at the end of the pencil is moved into or out of contact with the lower end of the dry battery.

Phoney Patents

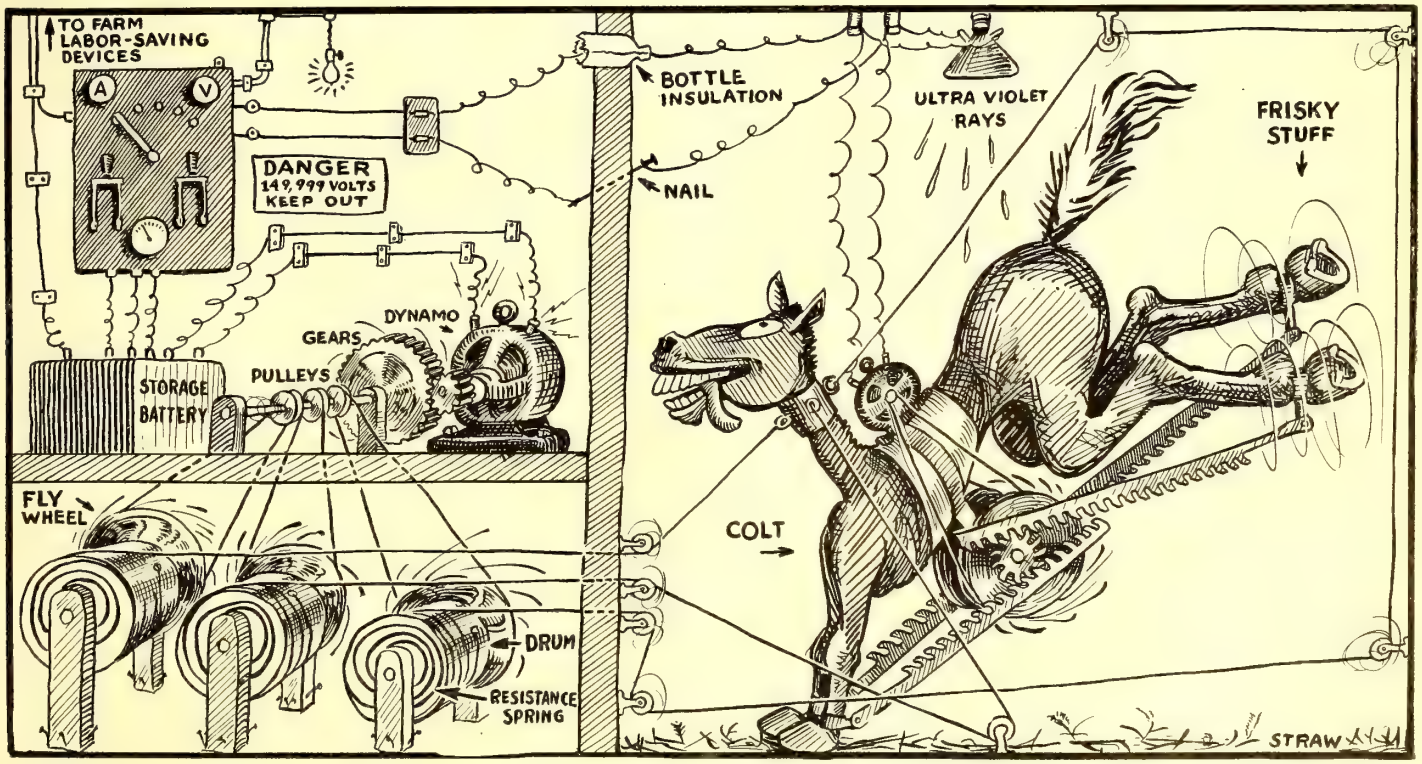
Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for the entire universe.

We are revolutionizing the Patent business and OFFER YOU THREE DOLLARS ($3.00) FOR THE BEST PATENT. If you take your Phoney Patent to Washington, they charge you $20.00 for the initial fee and then you haven't a smell of the Patent yet. After they have allowed the Patent, you must pay another $20.00 as a final fee. That's $40.00! WE PAY YOU $3.00 and grant you a Phoney Patent in the bargain, so you save $43.00!! When sending in your Phoney Patent application, be sure that it is as daffy as a lovesick bat. The daffier, the better. Simple sketches and a short description will help our staff of Phoney Patent examiners to issue a Phoney Patent on your invention in a jiffy.

PHONEY PATENT OFFIZZ



FIRST PRIZE: Catextingwisher. Music of Feline Cats Impinges Upon Sensitive Microphones Near Top of Fence. These Operate Relay Thru Storage Battery. The Latter Operates Motor Attached to Winding Drum. String on This Winds Up, Closing Scissors. Scissors Cut String. Brick Drops on See-Saw Board. This Rubs Match At End of Board on Sand Paper. Match Lights Fuse of Cannon, Which Goes Off. Bullet Hits Bessemer Steel Target Which Pulls Lever, Thus Opening Water Supply. Water Stream Extinguishes Cats and Music.
Inventor: H. Gehrig, Cincinnati, Ohio.



COLTPOWER: The Prodigous Power Let Loose by Frisky Colts Has Never Been Harnessed. This Pattent Solves the Trick. By Attaching Gears and Racks to the Colt, Every Time He Gets Frisky and Kicks, He Generates Electricity Thru the Dynamo Attached to His Back. Likewise If He Feels Like Jumping and Running About, Steel Cables Attached to His Collar Will Operate Certain Spring Drums, Which Latter Thru Pulleys and Gears Work the Dynamo. Thus Lots and Oodles of Juice Is Generated.
Inventor: Paul Cromwell, Elkins, W. Va.

QUESTION BOX

This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

KITE ANTENNA.

(825.) Everett Converse, Ft. Collins, Colo., writes us:

Q. 1. Please tell me if No. 24 bare copper wire suspended from a kite would make a satisfactory aerial and what would be its wave length, if 400 feet of such wire was used?

A. 1. 450 meters.

Q. 2. Would this No. 24 bare copper wire be all right to wind a tuning coil with and what would be good for insulation between turns?

A. 2. Yes. The insulation between turns should consist of a silk thread impregnated with shellac. A still better method of winding this wire is to make a thread on the surface of the tube by placing it on a lathe and winding the wire in the threads so formed. This is an ideal method and all commercial coils of this type are made in this manner.

INDUCTION MOTOR.

(826.) Paul E. Nelson, Fort Smith, Ark., wishes to know:

Q. 1. Can a two-phase, 220-volt, 60-cycle ½ H.P. induction motor be changed to run on 110-volt, 60-cycle A. C.?

A. 1. Yes, by rewinding the stator or field coils so as to be operated on 110 volts.

Q. 2. About how much power would be developed?

A. 2. The power developed will be the same, or ½ H.P., since the motor will now consume twice the current it would when operated on 220 volts.

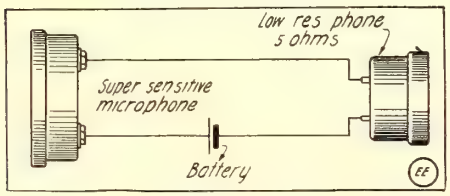
SUBMARINE COMPASS.

(827.) Cyril Thorn, St. Louis, Mo., inquires:

Q. 1. I would like to know how a submarine can use a compass. I should think that the steel shell of the submarine would act as a magnetic screen to the earth's lines of force. Of course, I mean when they are submerged.

A. 1. Submarines do not employ a magnetic compass but they use a gyroscopic compass which is not affected by magnetic bodies but by the earth's rotating forces. It would be impossible to use a magnetic compass on a submersible due to the massive iron hull surrounding the compass, which would act as a magnetic screen as you mention.

DETECTOGRAPH.



Hook-Up for Sensitive Telephone Set or "Detectograph."

(828.) Owen Walker, Lewiston, Me., writes us:

Q. 1. What instruments are necessary for me to build a *detectograph?*

A. 1. A sensitive microphone, a low resistance telephone receiver and a flashlight battery.

Q. 2. Where can I buy them?

A. 2. You can purchase these parts from the Microphone-Detector Co., 26 Cortlandt St., New York City, N. Y.

Q. 3. Please give me a diagram of connections.

ODD PHOTOS WANTED AT $1.00 EACH!!!

Now is the time to make your Kodak pay for itself in a real practical way. We are after interesting photographs of out-of-the-ordinary electrical, radio and scientific subjects and are willing to pay $1.00 *cash for every one we can use. Please bear in mind that for half-tone reproduction in a magazine, a photograph should be particularly sharp and clear. Of course, if a subject happens to interest us particularly well, we can have the photo retouched. For the general run of subjects, however, it does not pay to go to such expense. Therefore, please take pains to properly focus and expose your pictures. It often happens that a really mediocre subject well photographed wins approval over an excellent subject poorly photographed. And don't send us plate or film "negatives"; send unmounted or mounted "prints," preferably a light and a dark one.*

As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 *to* 150 *words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.*

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, *233 Fulton Street, New York City.*

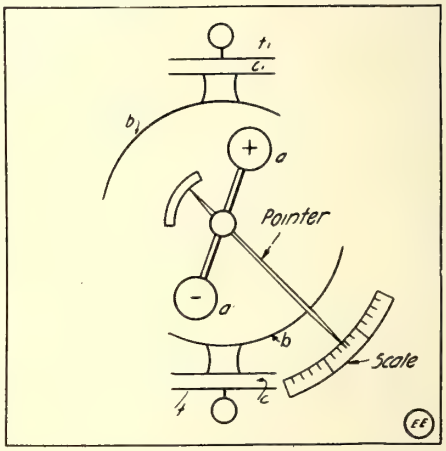
A. 3. The wiring diagram of the instruments is given herewith.

ELECTROSTATIC VOLTMETER.

(829.) Henry Manville, Los Angeles, Cal., writes:

Q. 1. Kindly describe and explain the action of an electrostatic voltmeter as used in the measurement of high tension electromotive forces.

A. 1. The Kelvin voltmeter, developed by Lord Kelvin, its inventor, is suitable for direct or alternating currents from 40 to 100,000 volts. A certain well-known



Connection and Principal Parts of Electrostatic Voltmeter Such As Used In Measuring High Potentials.

company has developed a line of electrostatic voltmeters for pressures from 2,500 to 120,000 volts using condensers in series. In the diagram a and a_1 are movable condenser elements consisting of hollow spherical members supported on a steel ball bearing mounted on polished jewels; b and b_1 are covered metallic sheets forming the opposite plates of condensers which a and a_1 approach as they rotate; c and c_1 are pairs of plates of condensers in series, being connected on one side of the instrument t and t_1 and on their other side to the inner condenser plates b and b_1. The rotation of a and a_1 is opposed by controlling springs, the position of equilibrium where the attraction between the fixt plates b and b_1, and the moving cylinders a is balanced by the springs; the indication is given by a pointer moving along the scale shown. The containing case is filled with oil which buoys up the moving element, acts as a damper to the moving system besides maintaining high insulation and increasing the capacity.

D'ARSONVAL GALVANOMETER.

(830.) George Whiting, San Francisco, Calif., asks:

Q. 1. What is the size of wire used on the winding and what is the coil suspended by, a flat strip or a wire, on a D'Arsonval galvanometer of the reflecting mirror type?

A. 1. The size of wire used in these type of galvanometers depends upon the degree sensitiveness of the instrument, but in general the wire used on the coil is a No. 38 double silk covered magnet wire. The coil is suspended by a thin strip of phosphor bronze.

Q. 2. What is the resistance of 80 feet of No. 30 soft iron wire?

A. 2. 34.8 ohms resistance.

Q. 3. What is the ratio of movement on

a galvanometer mirror to the foot; *i.e.*, suppose the mirror moved .0001 of an inch, how much would the spot of light from the mirror move at 1 foot distance and at 8 feet distance?

A. 3. It would be impossible for us to give you this data as it is necessary to know the angular momentum of the moving element, which means that the weight of the element is required which is necessary to determine the time constant of the coil. Furthermore, it will be necessary for us to know the curvature of the mirror, in order to give you the intensity of illumination which the mirror will throw at the distance specified.

STORAGE BATTERY FOR SIX-INCH COIL.

(831.) Sidney Tholan, Washington, D. C., would like to know:

Q. 1. How many storage batteries would a six-inch spark coil require, or how many volts and amperes would it require to give best results, with an aerial 50 feet high and 75 feet long, consisting of four wires? How far would this coil transmit in a tuned sending outfit?

A. 1. Three 6-volt, 80 ampere-hour storage batteries will be required to operate the six-inch spark coil.

18 volts and 4 amperes is the power consumed by the coil. About 30 miles can be covered with this outfit.

Q. 2. Does a helix step up the voltage, or amperage or does it step up both?

A. 2. A helix does not necessarily step up the voltage or amperage, but it is used to attain resonance of the closed oscillatory circuit, and to regulate the length of the emitted oscillatory wave.

RADIO DISTANCE FORMULA.

(832.) Joaquin Agusty, San Juan, Porto Rico, asks:

Q. 1. How many pounds of No. 14 D. C. C. wire will be necessary for the primary of 1½" spark coil, core 8½" long by ¾" diameter?

A. 1. Two and a half pounds.

Q. 2. How may I magnetize a piece of iron in order to make a permanent magnet in any desired form?

A. 2. The best manner by which you can magnetize a piece of steel (not iron) of any desired shape is to wind four to six layers of No. 20 B. & S. magnet wire around the iron, which is to be magnetized and passing a current of electricity thru it. Care should be taken to see that the current is a uni-directional one or direct current and this source is best obtained from a storage battery or direct current dynamo.

Q. 3. Which is the formula used to compute the range in miles of a radio receptor? For example, a complete receiving set with coupler and suitable antenna and 'phones, tunable to 3,000 meters, what is the maximum distance for receiving signals in good weather conditions?

A. 3. There is no formula which gives the receiving range of a receptor. The only formula of such nature is adaptable to transmitting apparatus.

HYSTERESIS VS. SELF-INDUCTION.

(833). W. C. Phillips, Julian, N. C., wishes to know:

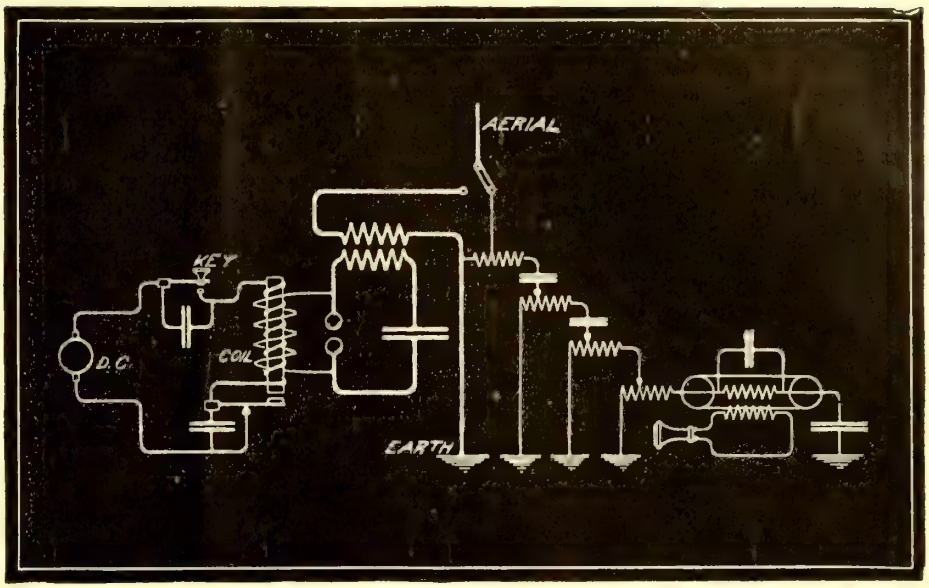
Q. 1. Is hysteresis the same in a magnetic circuit as self-induction in an electric circuit?

A. 1. Yes.

TESLA TRANSFORMER QUERY.

(834.) Wm. Oshback, Philadelphia, says:

Q. 1. I have a Thordarson one K. W. 60 cycles transformer, the voltage across the secondary terminals is 20,000. Is the



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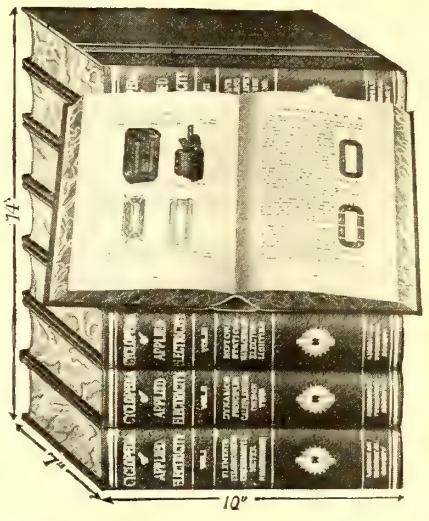
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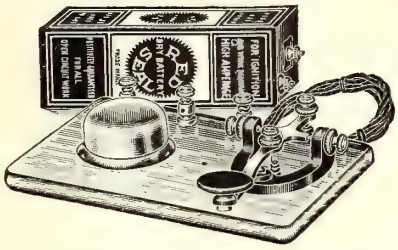
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secondary voltage of the above transformer too high to construct the 24-inch high frequency apparatus for medical and lecture use, as given by Dr. Frederick Finch Strong, in the May and June issues? If the above case is possible and the ratio of the Tesla coil is 1 to 80, what will be the secondary voltage of the Tesla coil? Why is a rotary spark gap used between the condenser and Tesla transformer?

A. 1. The voltage of the transformer is sufficient to operate the Tesla high frequency transformer, but regret to say that it is impossible to estimate the voltage obtained from such an instrument as the conditions are entirely different from those of magnetic type of high tension transformers. The voltage of a Tesla transformer runs in the neighborhood of millions of volts at the secondary terminals.

A rotary spark gap is used between the primary of the Tesla coil and the secondary of the Thordarson transformer to increase the spark frequency of the closed oscillatory circuit which causes an increase of secondary voltage and frequency in the Tesla transformer secondary. It also acts more efficiently than a fixt gap, which tends to arc and heat up.

BRAKE HORSE-POWER CALCULATION.

(835.) Earl Lea, Memphis, Tenn., asks:

Q. How would you calculate the brake horse-power of a motor when the following data is on hand? The lever arm of the brake is 3 feet long and the reading of the scales is 30 lbs., when the motor is running 1,000 R. P. M.

A. 1. The following formula gives the relation of the factors named with that of the brake horse-power:

$$\text{B.H.P.} = \frac{2\pi \text{ L N W}}{33{,}000}$$

Where 2π = constant.
L = length of lever arm in feet.
N = revolutions per minute of shaft.
W = force in pounds at end of lever arm as measured by scales.

Substituting your values in the above formula we get:

$$\text{B.H.P.} = \frac{2\pi \times 3 \times 1{,}000 \times 30}{33{,}000} = 17.1$$

Q. 2. Knowing the brake horse-power of a motor, how would you determine the efficiency of the motor?

A. 2. It will be necessary to determine the electrical power taken by the motor under test and dividing the B.H.P. by the electrical horse-power, multiplied by 100, which will give the percentage efficiency of the motor.

Q. 3. What is the nature and object of the commutating field produced by the interpoles of a dynamo?

A. 3. Its object is to assist commutation, that is, to help reverse the current in each coil, while short-circuited by the brush, and thus reducing sparking. The excitation of the interpoles being produced by series turns, the field will vary with the load, and will if once adjusted give good commutation at any one load, keep the same proportion for any other load, provided the iron parts be not too highly saturated.

TELEPHONE AND TELEGRAPH INTERFERENCE.

(836.) ———, asks:

Q. 1. What are the characteristics of the "D'Arsonval" currents mentioned in the article "Electricity and Life" in the May issue of THE ELECTRICAL EXPERIMENTER? How can apparatus be constructed for their production?

(*Continued on page* 343)

SPY AERIALS.

(*Continued from page* 300)

third story of a brick dwelling. This is not fiction, but an actual fact, and consider for the moment that such an iron fire-escape is very much smaller compared to the metal fence, which may run for several hundred feet or more.

Fig. 10 shows two other novel schemes, which a desperate enemy might employ to signal his confederates. The first of these is the ordinary railroad track which invariably rests on wooden ties, and it would not be very difficult at all to thoroly disguise the connecting wire from the railroad track to the apparatus, even by digging a small ditch and covering it over. The operator might even have the temerity and good sense to use a nearby house or shanty, which no one would ordinarily suspect, and moreover he might only visit the scene of these operations at night, which would naturally make his detection and apprehension extremely difficult.

Many of our office buildings are fitted with extensive *metallic grill work* enclosing elevator shafts and the like, which are very often insulated from the ground, and thus provide another chance for an enemy to receive wireless messages.

The ordinary *motor-boat* may appear peace-like enough when speeding along the coast, but it is not improbable that such a vessel might contain an enemy wireless outfit. It is easy to see that if such a boat could be at large along the coast, that it would cause considerable trouble, as on the one hand it could readily intercept radio messages from shore by means of a concentrated antenna as shown in Fig. 11, and the wires of which might even be placed between an inner or outer hull to defy detection, and on the other hand, such a floating information base could readily communicate with a submarine or "raider."

Finally, we come to the use of the *concentrated radio antenna,* of the type described some months ago in THE ELECTRICAL EXPERIMENTER, and which was tested with extreme satisfaction at the radio laboratory of Union College. It is not at all difficult to see that a radio Spy who knew his business could readily deceive most anyone for an indefinite length of time by simply constructing one of these concentrated aerials which could be erected between the *real wall* of a room and a *false partition* or wall covering. If a room happened to be small, it would be readily possible of course to use more than one of these concentrated aerials, placing them on various walls of the room, and covering them over with a board partition, or in some other way cleverly disguising the presence of the aerial.

Of course the every-ready radio inspector will tell you that the wireless Spy cannot exist for any length of time, and in fact for only a short time, for the reason that the Government experts are equipt with the latest radio-locating and detecting instruments, which enable the inspectors to rapidly close in on any suspicious wireless wave, and to thus locate the apparatus.

But this is not all of the story by any means, as there has been perfected in the last year or two a particularly clever wireless system of which but little is known, but which utilizes for one thing an inaudible note, or in other words an undamped wave, and messages when transmitted by this system are not sent out in a continuous series of signals, but in an intermittent series of signals, all of which characters are eventually recorded on a special receiving instrument, which co-relates individual characters, so that eventually the Spy at the receiving end has before him the original message, in a secret code to be sure.

A. 1. The characteristics of D'Arsonval currents are of such nature that they produce continuous uni-directional impulses. They are usually of lower potential than Tesla currents.

Q. 2. Can a telegraph set be used (without interference with telephone service) employing one wire of the city telephone system and using the ground as a return, if the telegraph message was to go thru the central station switchboard? If this is possible, please give hook up.

A. 2. Yes, we would suggest that you refer to the article on page 197 of the July issue of this journal.

Q. 3. How far can messages be exchanged by means of the inductive wireless telephone described in the May issue of the "E. E."?

A. 3. 30 to 100 feet.

PRODUCTION OF ELECTRIC OSCILLATIONS

(837.) Otto Patersen, Camden, N. J., desires information as to:

Q. 1. What is the best way to generate electric oscillations of any desired frequency?

A. 1. There are several ways by which electric oscillations can be generated, viz., by means of the electric arc, alternator, metallic arc, and vacuum tube or Oscillion. The last contrivance is the most convenient for such work.

Q. 2. Is the Chaffee gap adaptable for radiophonic work?

A. 2. Yes.

Q. 3. What are the main features of the Chaffee gap?

A. 3. The use of aluminum and copper spark electrodes are the fundamental features of this particular gap.

ELECTROMAGNET TO FRY EGGS.

(838.) P—— A——, Chicago, Ill., wishes information on the large A.C. electro-magnet described in the March, 1917, issue of this journal by Raymond Francis Yates.

A. 1. We believe that the large electro-magnet as described in the article by Mr. Yates will perform its work satisfactorily; the strength of the same is due to the product of the current in amperes, multiplied by the number of turns of wire in the coils. You will thus see that if the current is kept constant and the number of turns increased, you will gain considerably thereby.

On the other hand, with a constant source of potential or voltage an increased number of turns will simultaneously increase the resistance of the coil which will reduce the current passing thru it. Therefore, it is quite possible that in some cases the total result will be less than expected, or even attained, with a less number of turns, owing to the reduced current.

However, with the electro-magnet in question it will be possible to increase its strength by increasing the turns as you suggest for the reason that this magnet is not designed for the full line potential, and, therefore, you can adjust the current so as to keep it constant with the increased turns by means of a resistance or reactance coil.

For most experiments, and particularly those cited by Mr. Yates, the electro-magnet *must be excited by alternating current;* not direct current. It will require considerable resistance in series if used on direct current as much more current will then flow.

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(839.) Edward A. Brand, Springfield, Ill., writes us:

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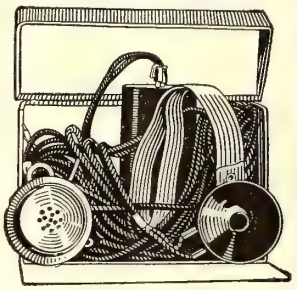
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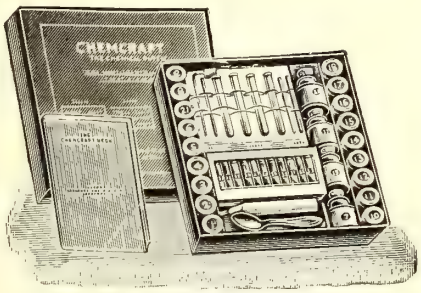
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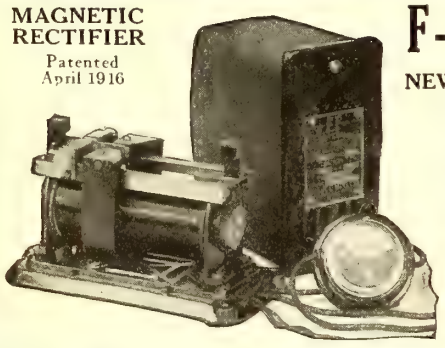
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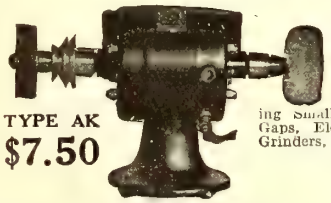
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You might also obtain some very valuable information in this direction by communicating with the Bachelet Medical Apparatus Co., 320 Schermerhorn St., Brooklyn, N. Y., who represent Mr. Bachelet in this country.

4 K.W. TRANSFORMER QUERY.

(840.) Ralph H. Seipel, Elwood City, Pa., sends us design of 4 K.W. transformer on which he wants advice.

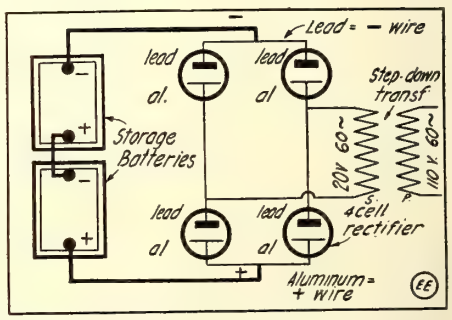
A. 1. It would seem that the transformer you describe will be all right to operate at a load of 4 K.W. at intermittent periods as you mention. The size of the primary wire is correct and agrees with the designs usually followed in this work.

With respect to the number of primary turns to be connected in circuit for the different kilowatt in-puts, this would work out as follows:

The secondary voltage will vary inversely as the number of primary turns, *i.e.*, as the number of primary turns in the circuit are reduced the secondary potential will increase and *vice versa*. We have not investigated the entire design of your transformer, but presume that with all of the primary turns in circuit, that you have so proportioned the windings and the iron core, that it will take 1 K.W. from the primary mains or develop 1 K.W. in the secondary winding. If such is the case, then with 50 primary turns in circuit, the secondary potential will be twice that with 100 turns, and the output of the transformer will be doubled or 2 K.W. The secondary current remains approximately the same. With 25 primary turns in circuit, the inverse ratio would then be as 4 to 1, and the secondary potential would be four times that with 100 primary turns and the output of the transformer 4 K.W.

ELECTROLYTIC RECTIFIER TROUBLES.

(841.) Mr. H. C. B———, Ft. Towson, Okla., writes:



Proper Connections for Electrolytic Rectifier and Step-down Transformer.

Q. 1. I have tried to get my electrolytic rectifier working, but can not get it to rectify.

A. 1. We have noted what you have to say concerning the electrolytic rectifier. In the first place, there is no question at all as to whether the aluminum-lead or aluminum-iron rectifier will rectify, for it certainly will.

There are several particular reasons why these rectifiers do not apparently work to their proper efficiency at first. One of the most important of these is that the aluminum plates must become properly *formed* by electrolytic action, and it can only do so in many cases, or at least in a majority of cases, where it is possible to pass direct current thru the rectifier for a short time.

Otherwise this *forming current* may be supplied from a 110 volt A.C. line with some lamps in series, allowing considerable current to pass thru it for a short period, or until the lamps become dim, denoting that the gas film has formed.

Another reason why these rectifiers do not always work perfectly at first, is due to the fact that the solution may not be fresh, and this is a point well worth looking into. The Editor remembers one particularly obstinate case of this nature in which he suggested that the user take a fine pen-knife and scratch criss-cross on the face of the aluminum plate. This will sometimes hasten the formation of the fine gas film which gathers on the surface of the aluminum, and which of course is the principal desideratum in the operation of the electrolytic rectifier.

You might also try a warm solution at first, as these rectifiers work most efficiently with a hot solution or when a solution has heated up some. We have data on a rectifier of the aluminum-lead type employing a saturated solution of ammonium fosfate and which has been tested at the Electrical Testing Laboratories of New York City.

If you are sufficiently interested in the theory and operation of this electrolytic rectifier, we shall be pleased to furnish you with a duplicate copy of the engineering report given by the above laboratory at a charge of $1.

EXPERIMENTAL PHYSICS.

(*Continued from page* 312)

the fourth time you continue as before, except that instead of going past the gong you strike it. Your partner sets the stop-watch as he sees the flag reach the vertical position on the *fourth* swing and touch the gong, and then stops the watch when he hears the sound. On looking at the watch it will be noticed that the sound was heard *three* seconds after the flag reached the vertical position and struck the gong. Since the distance between you and your partner was 3,300 feet and it required three seconds for the sound to travel that distance, we see that the speed of sound is about 1,100 feet per second, or about 1,000 miles per hour.

EXPERIMENT 42—The method of Experiment 41 can be carried out very carefully and the results obtained will be quite accurate. For those not having access to a stop-watch, the following method is given: Figure 32 represents a light wooden box 4″ by 25″ by 45″, approximately. A hole is cut at D and the inside of the box which can be seen thru this hole is painted white. B is a small block of wood painted black and attached to the top of the box by a string E. The length of this string and block together should be thirty-nine inches, and when drawn to position A or C and let go, it will oscillate back and forth as a pendulum and the black block will pass the white opening *once in each second.* If on trial it does not pass exactly each second it can be slowed down or speeded up by lengthening or shortening the string. When it is adjusted it is what is known as a *Seconds Pendulum.* Let your partner pound loudly on the side of the box just when the block (bob) B passes the white hole and keep doing so each time while you in the meantime move back away from the pendulum. As you move away, the pounding will be heard after the bob passes the white hole, and keeps losing and losing until it is lapt by the bob and the sound again coincides with the bob's passing the white hole. Obviously since the sound has been lapt by the bob and the pendulum is a seconds pendulum, *it takes the sound just one second to travel from the box to you.* On measuring the distance, it is found to be about 1,100 feet. Thus far we have noticed that sound will not pass thru a vacuum, but that it will pass thru ordinary matter, and usually the heavier the matter the faster the sound travels thru it.

The Indians put their ears to the ground to hear the noise of approaching horses, since the ground is heavier than air, and the sound travels faster and appears louder. If two stones are clapt together under water the sound is louder to the person with his ears in the water than to the person with his ears out of the water. (If you don't think so, try it!) In air sound travels always at the same speed, 1,100 feet per second, and *all different kinds of sound, whether of different pitch or of different loudness, travel at the same speed.* Thus the gentle squeak of the high string of the violin, and the low thump of the bass drum, and the ear splitting wail of the cornet of the symphony orchestra of the Movie show reach our ear at the same time.

EXPERIMENT 43—Loosen a low string from some stringed instrument, such as a banjo, guitar, mandolin, violin, etc. If now it is plucked and gradually tightened until it just gives off a low musical note, it will be seen to vibrate rather slowly. On tightening it a little more we notice that the *note* given off is of *higher pitch* and that the *vibrations are faster.* This leads us to the next important principle, namely that the *pitch of a note* depends on the *frequency of vibration* of the source, *i. e.,* the faster the source vibrates the higher the note. If one looks inside the piano, it will be noticed that the bass notes are given by long, heavy, loose strings, and that the high notes are given by short, thin tight strings. The laws of vibrating strings can be stated as follows:—the *tighter* the string the *faster* it vibrates and consequently the *higher the pitch* of the note given off; the *shorter* the string the *faster* it vibrates and consequently the *higher the pitch* of the note. Pitch should not be confused with loudness. Loudness depends upon the distance of the sound source from the listener. Also loudness of a sound depends upon the amount of the disturbance. A small fire-cracker disturbs a small amount of air, and the sound is weak, while a large salute disturbs a large amount of air and a loud bang results.

EXPERIMENT 44—Obtain two medium-size cans of peaches, or pears, or whatever canned fruit you like best. Now remove the tops and the contents of the cans. With a thin nail and hammer, punch a whole in each of the bottoms of the cans. "Borrow" about 100 feet of Pa's fishing line. Pass the ends thru the holes in the cans and tie them inside to match sticks.

If now the string is stretched as in Fig. 33 and your partner talks into his can, you will hear him distinctly. When he is thru talking you can talk into the can and he will hear you distinctly. When you talk into your end of this telephone you cause the air in the can to vibrate, which in turn causes the bottom of the can to vibrate. The end of the can causes the tightly stretched string to vibrate, and the string causes the bottom of your partner's can to vibrate. The bottom of his can causes the air in his can to vibrate and it in turn cause the membrane in his ear to vibrate so that he hears your voice.

In other words, the disturbance which you cause in the air near your mouth has been transmitted to the air immediately near your partner's ear, which gives the

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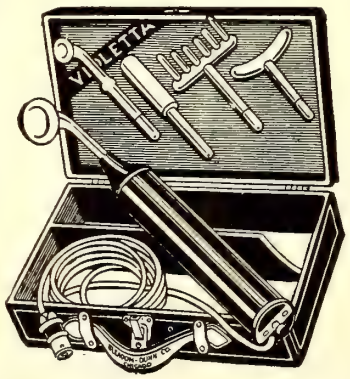
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same effect as if you were standing beside your partner and talking to him. The modern commercial telephone works on a similar principle. The diafram which corresponds to the bottom of the can in our case, is made to vibrate by the motion of the air caused by speaking. This vibration is transmitted *electrically* to the receiver at the other end; the receiver at the other end causes the air at the listener's ear to vibrate and the listener hears the speaker. The electric auto horn consists essentially of a thin metal disk or diafram which is made to vibrate rapidly by the electric current and the vibration of the diafram causes a disturbance in the air which may herald the approach of a Ford, a brass band, or a cat-call. The phonograph also depends upon the vibration of a disk or diafram. The needle is attached to the diafram by a small lever. As the needle passes around the record it vibrates according to the indentations in the record. This vibration is communicated to the diafram by the lever. The vibration of the diafram causes the air in the horn or sound box to be disturbed. On placing the thumb gently on the diafram (reproducer) one can *feel* the vibrations.

It may be well to note just how the sound is transmitted thru the air. If a half-dozen billiard balls are placed in a straight line touching each other, and then the cue ball is made to strike the end ball, the ball at the other end will move out and the others will remain in their places. In the transmission of sound, instead of billiard balls we have the molecules of air. The molecules do not touch, but are very close together and hence we get only a slight displacement. The sound is thus transmitted from molecule to molecule in all directions. Obviously if a molecule at the source of the sound vibrates in a certain way the molecule near the listener will vibrate in that very same way, since each individual motion has been transmitted as it was made.

EXPERIMENT 45—If ten or a dozen olive bottles or other bottles are placed in a row, and partially filled with water as in Fig. 34, on blowing over the tops a thin flat jet of air, musical notes will be heard. The jet of air may be secured by blowing thru a rubber tube at the end of which is attached a flattened Bunsen burner *wing tip* which can be purchased for a few cents. On adding to or subtracting from the water in the various bottles the various notes of the musical scale can be gotten and then one can by a little practise learn to play simple melodies. This interesting experiment illustrates the working of the organ pipe. A thin flat jet of air passing over a column of air causes the column to vibrate; the longer the column the lower the note.

Just as a billiard ball on hitting the cushions of the billiard table is reflected, so when a sound wave caused by the vibration of a molecule hits an object, it is reflected back. If the reflecting surface is near, because of the tremendous speed at which the sound travels, the reflected sound and the original one are heard at practically the same time, simply re-enforcing each other. If, however, the distance is sufficiently great, the reflected sound reaches the air later, and we call this the *echo*. If a sound is caused by a source vibrating in an irregular manner, the vibrations interfere with each other and the result is a *noise*. If, however, the source is vibrating in a regular manner, the sound is pleasing and is called a *musical sound*. Both are disturbances of the air, but the former is a disturbance to those hearing it.

(*To be continued*)

ELECTRIC "BLOODHOUNDS" TO FIND AND DESTROY U-BOATS.

(*Continued from page* 298)

inconceivable how the noise of these powerful engines could be deadened entirely so that the super-sensitive microphone-Audions would not detect it, when they once came into a reasonable range.

The authors confidently look forward to an early trial of the idea, feeling convinced in its feasibility and successful application to the U-boat peril.

The electric torpedo bloodhound depends upon several well-known physical and electrical laws for its mode of attacking and destroying a submerged U-boat. Principal among these are the utilization of sound waves, such as given off by the engines and propellers of a submarine, and also the principle of the *induction balance*. The presence of a metallic mass as for instance a submarine hull, will upset the electrical balance of two coils, which fact is here made use of and which will prove efficacious over a considerable distance; at least several hundred feet, when a sensitive galvonometer relay, such as the Weston type, is employed for indicating the state of balance in the coils. As for the practical range of sound wave control thru water, this scheme has been successfully applied by the Allies, particularly along the French coast, for detecting and locating submarines up to twenty miles distant.*

Instead of simply listening for the sound of an enemy submersible, as in the scheme just cited, the authors propose to cause these sound waves coming thru the water to spell the end of the tricky sub-sea craft. Furthermore, it is evident both theoretically and practically, that if we can pick up the sound of a submarine five miles away and amplify it so as to make it plainly audible in a telephone receiver, that it is certainly possible to cause this same subaqueous wave to actuate a properly tuned and sensitive microphone, which in turn actuates an Audion amplifier (or Brown telephone relay). This device then closes or opens certain local control circuits connected to the propeller, rudder and diving plane mechanism of a special torpedo of the general type illustrated.

Of course someone will immediately ask: "Why not make the device full automatic and turn it loose in a submarine infested area?" This sounds like good logic and possibly is under certain limited conditions, but we must not forget that our electric submarine "bloodhound" would have no scruples about attacking friend as well as foe; steamer as well as submarine. Therefore, it seems the best logic to attach one of these torpedoes to a submarine chaser by means of a flexible electric cable, which is attached to an automatic-release drum. The commander of the mother-ship thus retains control over the ever-vicious U-boat "bloodhound," which, once it hears a submersible purring away in the briny depths, immediately proceeds to dive straight for it, prepared to sink the suspected craft, whether friend or foe and which, if made full automatic, would blow the under-sea fighter to bits, without any parleying whatsoever. For these and other obvious reasons it is best to retain control of the electric torpedo.

As seen in the illustration, Fig. 1, the electric "bloodhound" has quite an interesting internal make-up. In general, there are two *induction balance* coils arranged on port and starboard of the nose as shown clearly in the front cover illustration. The forward compartment contains also a powerful electromagnet for holding the torpedo against the submarine hull; a special signaling electromagnet is provided as shown, which, when intermittently excited by means of a telegraph key on the bridge of the submarine chaser, causes the sliding brass rod inside the holding magnet core to work up and down. Thus it becomes possible to telegraph the Herr Commander of the U-boat, that unless he will arise at once and surrender he will be blown to bits by the 200 pounds of gun cotton in contact with his craft. Moreover, the U-boat officer can reply by telegraphic signals sent out thru his regular electric under-water sound telegraph, the signals being picked up either by one of the microphones on the electric torpedo or by a regular sound wave telegraph receiver of the Fessenden type, as used by practically all ships today.

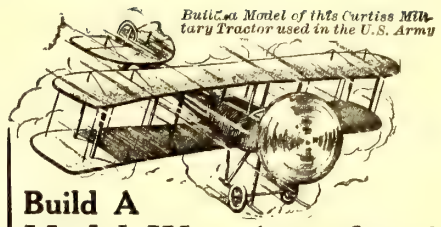
The forward compartment also contains the interrupter, battery, etc., for exciting the coils of the *induction balance*, details of this apparatus being given in Fig. 2. Note that the secondary coils of the balance are connected to a super-sensitive galvanometer relay, which acts to close certain control circuits going to the rudder, plane and propeller solenoid mechanism. This apparatus comes into control of the "bloodhound" when the microphone control has brought it to within a few hundred feet of the submersible, where sound reverberations would tend to throw the microphone control somewhat off. Several sets of tuned microphones are placed along the top and bottom, as well as the sides of the torpedo as indicated.

The next compartment would contain the explosive, usually gun cotton, to be detonated when desired by throwing a switch on the submarine chaser. The center space is occupied by an electric gyroscope, used for stabilizing the torpedo, also solenoid magnets for controlling the diving and raising planes on the exterior of the hull.

Next we come to the mast. This is hollow to permit of the electric control cable and pilot lamp cable passing down thru it to the interior of the torpedo. The pilot lamp (fitted with semi-circular reflector to throw light toward tender vessel) and flag are carried on a short pole mounted on a weighted ball-float as illustrated. If the "bloodhound" takes the "scent" and dives, the ball-float automatically releases and floats on the surface of the water for the guidance of the officers. The pilot lamp (for night work) is supplied with electric current thru a flexible cable which reels out from an automatic drum in the manner apparent. The movements of the torpedo can thus be gaged quite accurately.

Passing to the next "aft" compartment, this is devoted to the batteries, relays, amplifiers and other auxiliary electric control instruments. Behind this there come the propeller motor and rudder control solenoid magnets. See Fig. 1.

**See article describing the method of applying the sound wave detector for submarine detection and location in the January, 1916, issue of* THE ELECTRICAL EXPERIMENTER.



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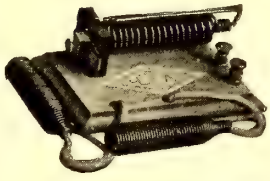
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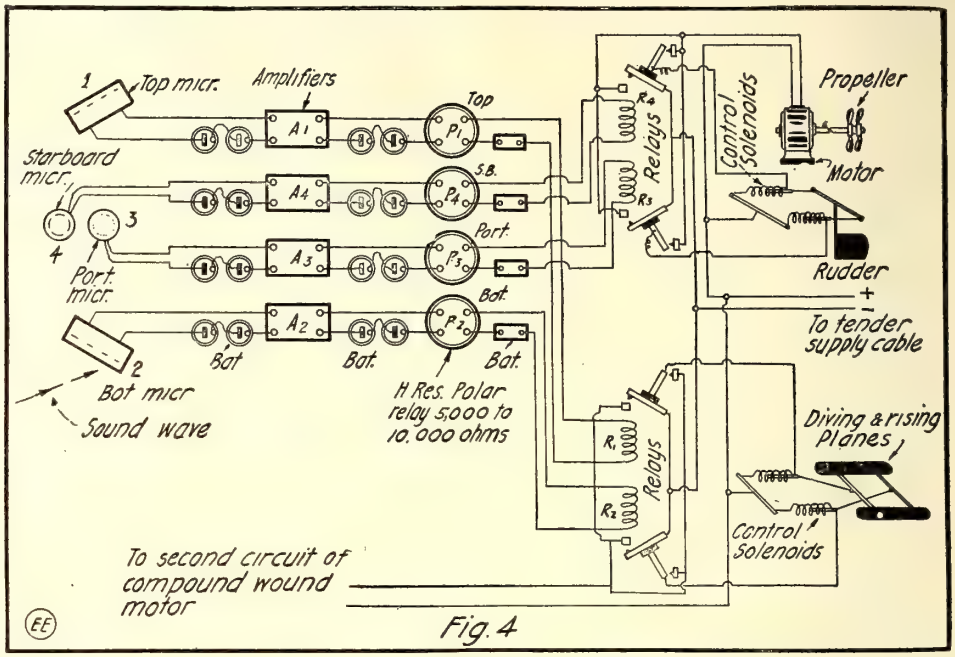
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The diagram, Fig. 3, shows the circuits for the retaining and signaling electromagnets in the nose of the torpedo. The smaller or signaling magnet is controlled by a telegraph key on the submarine chaser as aforementioned. The holding magnet coil would be excited as soon as the torpedo started in motion, or it could be arranged to be excited only when the torpedo had approached to within a few feet of its prey.

Many readers will no doubt be sufficiently interested in this almost human submarine annihilator to study some of the peculiar control circuits necessary to bring about the results already described, and particularly the method used to prevent the torpedo from striking the propellers of the enemy sub-sea fighter. The principal electric control functions are outlined in the diagram, Fig. 4, which will help to make clear how the device actually steers its own course toward the invisible enemy.



Microphone Connections to Various Amplifier, Relay and Solenoid Control Circuits In the Electric U-boat "Bloodhound."

First, we have the four distinct sets of tuned microphones, disposed on the top, bottom and two sides of the torpedo. These microphones are designed especially to respond to the peculiar note given off by the engines and propellers of a submarine and thus do not respond to the sound of the torpedo's propellers or that of the tender ship. It is also possible to shield the microphones so that they will not be affected by the sound of the torpedo's propellers.

Keeping in mind the location of the four sets of microphones or sound detectors, it is easy to understand that if these are properly connected to the control mechanisms, that a sound wave emanating (generally speaking) from any one of four directions will cause the "bloodhound" at once to start in that particular direction, i. e., it may dive either up or down, right or left, or in some angular direction between these by the co-action of two sets of control apparatus.

As will be observed the propeller motor is compound wound so as to be controlled by both sets of relays, i. e., those controlling the rudder solenoids or those working the diving plane solenoids. The supply cable from the tender furnishes current for the propeller motor as the diagram shows.

The mode of action will best be seen by considering that for instance a sound wave strikes microphone No. 2, on the bottom of the torpedo. The resistance of the microphone is changed, causing the amplifier A. 2, to act simultaneously. The latter device boosts the microphone signal several hundred times in strength, enabling the high resistance, polarized relay P2 to close its local circuit to special relay R. 2.

This relay, R. 2 (and its brothers, R. 1, R3 and R4) are provided with special armatures, having insulated contact arms on them as shown. Hence, when the sound wave has finally caused relay R. 2 to close,

(*Continued on page* 351)

U.S. PATENTS

PATENTS AND TRADE MARKS

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War Inventions Wanted

History will repeat itself in the present War. The greatest victories will be won, not through overpowering numbers, but through the surprises wrought by invention. Life and property will be saved for the Nations by inventions. The Government is ready to experiment with and carefully consider any inventions which will aid in winning and ending the War. The **Special War Bulletin** just off the press will give you a good idea of what is needed. We will send it to you free of charge. Located in Washington, we are in close touch with the proper Government Officials who should be approached with inventions for use in War time, and we will advise you fully how the disclosure should be sent.

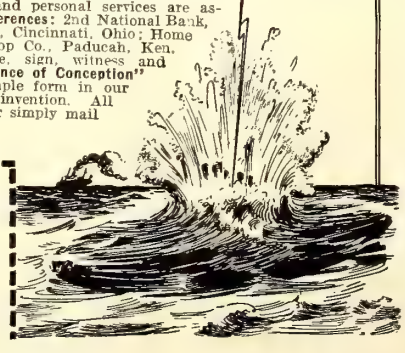
Our cooperation with an inventor is, **First**, to help him establish his rights before sending a sketch, drawing or model to any attorney; **Second**, to give a frank opinion whether it will pay to patent his idea, based upon our extensive knowledge of the patent laws, manufacturers' wants and facilities; **Third**, to obtain for him on reasonable terms, a patent that absolutely protects; and, **Fourth**, advise and assist him in making the invention a source of profit by outright sale, territorial grants, obtaining royalty, or the independent manufacture of the invention.

All matters are held strictly confidential, and personal services are assured by our **Service Guarantee Contract. References:** 2nd National Bank, Washington, D. C.; John P. Roth Packing Co., Cincinnati, Ohio; Home Savings Bank, Washington, D. C.; Duskil Mop Co., Paducah, Ken.

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PATENT ADVICE

Edited by H. GERNSBACK

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

COMBINATION SWITCH SPARK GAP.

(170.) Claude E. Jonnson of Leoti, Kansas, has sent in a very clever design of a combined antenna switch spark gap and lightning protector, and wishes to have our advice on this design. Mr. Johnson wishes to know if the idea is practical and whether a patent may be obtained, etc.

A. The idea looks feasible to us, and has several points in its merit. While a patent might be obtained on this invention, we have little hope that this will be remunerative financially, for the simple reason that there is no market for radio devices at the present time. However, after the close of the war, this might be worked up into a profitable patent. The idea is as good as it is novel.

NOVELTY FAN.

(171.) Sidney Brown of Lake Charles, La., has submitted to us an illustration and description of novelty lights to be installed in a ceiling fan. Our correspondent would like to have our opinion as to whether this is a practical invention, and whether it would be worth while to have it patented.

A. While the idea is novel, we think the device would cause too much flickering. In other words, the light would be quite unsteady, and would hurt the eyes of whoever is in the vicinity of this fan. It might be all right, however, for advertising purposes, and we would advise our correspondent to get in touch with a patent attorney.

PATENT QUESTIONS.

(172) Alif Byran of Nephi, Utah, wants to know:

Q. 1. How does a person obtain a patent?

A. 1. There are two ways of obtaining a patent. You can prepare your own patent drawings, and describe the application of the patent yourself by writing up specifications in a certain manner, and sending them to the patent office, paying the government fee of $20.00.

It is safe to say, however, that not one in ten thousand inventors ever take out their own patents, as they have no technical experience in preparing the drawings and presenting the claims in a legal manner.

The right way is to employ a capable patent attorney, such as you will find listed in our advertising columns, and this is not only the cheapest in the long run, but the best method.

Q. 2. What does a patent usually cost?

A. 2. It is impossible to state this in figures as it depends entirely upon the article to be patented. Some patents are so simple that they only need a small drawing and very little explanatory text, and the claims are perhaps few and simple. Other patents need a great many illustrations which necessitates several sheets of drawing, and we have seen patents that have from twenty to twenty-five printed pages of text, and anywhere up to 100 claims. Naturally such patents cost a great deal more. It all depends how much work the patent attorney has to put into the application. Usually the patent attorney will tell you how much he is likely to charge for his work. The government fee is of course always the same, no matter whether the patent is a long or short one. The fee is $20.00 with the application, and then there is a final fee when the patent is allowed of $20.00 also.

Q. 3. Can you always get a manufacturing company to manufacture a patented idea if it is a good one?

A. 3. If the idea is of merit, there certainly should not be much trouble in disposing of the patent to some reputable concern; that is, if the idea is really a good one. As a rule, there is a market for everything good and practical, and while it may take time and trouble to find the right concern, if the patent is really a meritorious one, it can as a rule be disposed of.



PATENTS

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PATENTS WANTED

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Name..... *Address*.....

THE RADIOTONE and What They Think of It

I was very much pleased with the neat and compact looks of the "RADIOTONE." I have not seen one buzzer that can beat it for twice or THREE TIMES THE PRICE. I use it for finding the sensitive part of the mineral in my crystal detecter and for learning to receive messages when connected with one or more receivers, and a telegraph key to break the circuit. I also wish to say that I think that any one who invests 90c in a "RADIOTONE" will be better pleased with the results in the short as well as long run than any other buzzer that costs twice the price.

PRIVATE P. H. REMPEL, 4th Co., C. A. C.
U. S. ARMY, Ft. Rosecrans, Calif.

I wish to say that your "RADIOTONE" Buzzer works better than I ever thought it would, and I don't think there is a BETTER BUZZER ON THE MARKET. It also gives a very classy appearance to any wireless outfit. It cannot be praised too highly.

PERRY CRAWFORD,
13 Ten Broeck St., Albany, N. Y.

I have given your "RADIOTONE" Buzzer a thoro test and find it to give VERY GOOD SATISFACTION. Also that I am very much pleased with it and that it comes up to my expectations. I would recommend it to all learners as a very good Buzzer. In case I have any more orders I will extend them to you.

W. H. CRUDGINGTON,
U. S. S. UTAH, Box E, care of P. M., N. Y.

I received my "RADIOTONE" Buzzer a few days ago, and have tried it out in a number of ways. It is exactly like you describe it, and one of the biggest advantages of it is that the sound is always EXACTLY WHERE YOU WANT IT, right in the receivers. It is by far the best buzzer I have seen on the market. It has also a very beautiful appearance, and has one of the CLEAREST AND HIGHEST PITCHED TONES any buzzer that I have yet come across. Thanking you again for your wonderful buzzer, I am,

Yours very truly,
HOWARD A. PAGE,
900 Harrison St., Lynchburg, Va.

Your "RADIOTONE" Buzzer certainly came up to all my expectations. Its tone is exactly like that heard in a regular wireless phone. It is not affected by high altitude nor damp weather. It is as beautiful an instrument as one could wish to see. IT IS SILENT. That is the most important of all in the work for which I use it. It produces a clearer and higher-pitched tone on less current than a buzzer of any other make that I have tried. IT HAS NEVER STUCK nor FAILED TO RESPOND instantly to the application of current since I have had it. I wish you and the E. I. Co. every success and I will do everything in my power to help you as you are a PROMPT AND SQUARE DEALING COMPANY.

C. M. McBURNEY,
Fort Bayard, N. Mex.

I wish to say that your "RADIOTONE" Buzzer is the only test buzzer that I have seen in which I can find NO fault whatever. I received it in good condition and it is that way now, THOUGH I ACCIDENTALLY DROPPED IT SEVERAL FEET. I am using it on a code practicing set. It has the best tone of any buzzer that I have seen.

LESTER SHIPLEY,
Care of J. O. Tate Electric Co.
118 Main St., Bedford, Va.

I have given the "RADIOTONE" Buzzer which I have received from the E. I. Co. a thoro test and find it satisfactory in all respects. I also used other buzzers, but the "RADIOTONE" IS THE BEST THAT I HAVE EVER USED and BEYOND MY EXPECTATIONS. The other goods that I received are also satisfactory.

A. WITMER,
Muir, Pa.

I am very pleased to say that I am satisfied with the results obtained from the "RADIOTONE" Buzzer. It gives a really WONDERFUL IMITATION OF A WIRELESS MESSAGE.

GEORGE DIMON,
Lavallette, N. J.

ELECTRO IMPORTING CO.
231 Fulton Street New York City

E. I. Co., 231 Fulton St., New York City, N. Y.

On your absolute guarantee that your "RADIOTONE" works exactly as described by you, I enclose herewith 90 cents plus ..... cents for postage for one instrument. You guarantee to refund this amount to me if I am not entirely pleased, providing I return the "RADIOTONE" within 3 days after its receipt. YES

I also enclose NO 6 cents postage for your 200-page Electrical Cyclopedia, with 600 illustrations, and 500 instruments, etc.

Name .....

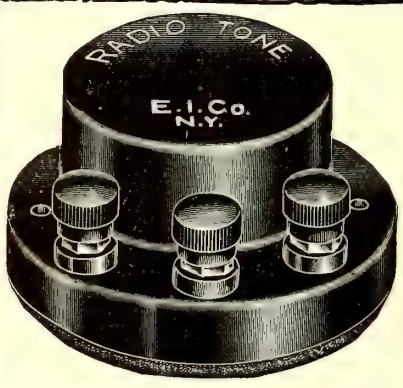
Address .....

City .....

FROM A RADIO EXPERT

The "RADIOTONE" Buzzer which the E. I. Co. sent me some time ago has been thoroly tested out in my Laboratory, and I am very pleased to give you my opinion concerning its performance.

The tone and frequency of the instrument is TRULY A MOST WONDERFUL and perfect reproduction of a MUSICAL WIRELESS NOTE and when used in connection with a wireless receiver it would be most difficult to distinguish its rich tone from that of a real wireless station with FIVE HUNDRED CYCLES in the primary circuit. One of the most commendable features that the buzzer possesses is that of being capable of standing up under continuous service WITHOUT THE ANNOYING "STICKING" effect that has been so characteristic of other buzzers that I have had occasion to test. In conclusion I can say that both in performance and appearance the "RADIOTONE" is truly a WONDERFUL LITTLE INSTRUMENT. RAYMOND FRANCIS YATES, 815 Niagara Ave., Niagara Falls, N. Y.



No. HK 1800

The "Electro" Radiotone

HIGH FREQUENCY SILENT TEST BUZZER

The RADIOTONE is NOT a mere test buzzer, it is infinitely more. Mr. H. Gernsback who designed this instrument labored incessantly to produce an instrument which would imitate the sound of a high power Wireless station as heard in a set of phones. This actually has been achieved in the RADIOTONE. This instrument gives a wonderful high pitched MUSICAL NOTE in the receivers, impossible to obtain with the ordinary test buzzer. The RADIOTONE is built along entirely new lines; it is NOT an ordinary buzzer, reconstructed in some manner. The RADIOTONE has a single fine steel reed vibrating at a remarkably high speed, adjusted to its most efficient frequency at the factory. Hard silver contacts are used to make the instrument last practically forever.

Yes, the RADIOTONE is **SILENT.** In fact, it is so silent that you must place your ear on top of it to hear its beautiful musical note.

You will be astounded at the wonderfully clear, 500 cycle note, sounding sharply in your receivers, when operated on one dry cell. **To learn the codes, there is absolutely nothing like it.** With the radiotone, a key and one dry cell and ANY telephone, a fine learner's set is had. Two or more such sets in series will afford no end of pleasure for intercommunication work. Particularly now that we cannot use our Wireless sets, the **Radiotone** is already in wonderful demand. All the interesting things as described with our **CODOPHONE** (see our big ad on page 353, this issue), can be performed with the **Radiotone,** a key, a dry cell and a phone.

Radiotone as described.....each **$.90**

Shipping Weight 1 lb. Don't forget postage.
IMMEDIATE SHIPMENTS

I have thoroly tested your "RADIOTONE" Buzzer, which I received a few days ago, and find that it is very efficient in all respects. It is all that you claim it to be. The tone is so soft that it cannot be heard unless the ear is placed a few inches from the instrument. This makes it very desirable for testing detectors. I THINK THAT THERE IS NOTHING BETTER FOR LEARNING THE CODE, since the signals sound just like a high power wireless station. Everyone who has a wireless station or who wishes to learn the code should have a "RADIOTONE." BENNIE GREENSTEIN,
827-11th Ave., N., Minneapolis, Minn.

I received your "RADIOTONE" on June 20th, and tested it thoroly, and found it has the BEST IMITATION OF WIRELESS SIGNALS. All Amateurs should purchase one of these "RADIOTONES" if possible, and do self-practise during the war. I hope all Amateurs, who purchase one of these "RADIOTONES" will find it as great a help to them as I have.

Yours truly, GEO. TANAKA,
AMATEUR 6 ATQ, San Francisco, Cal.

After testing the "RADIOTONE" I am pleased to say that it is the best toned buzzer on the market. The main thing is that IT DOES NOT STICK as so many others do, even among the high priced buzzers, when practising. I am using it with Omnigraph transmitter, 2 M.F. Condenser, 75 Ohm phone and small resistance shunt across phone. With the aid of battery rheostat and shunt resistance, I CAN OBTAIN EXACTLY SAME PITCH AS N.A.A.

FRANK WARMINSKI,
806 S. Milton Ave., Baltimore, Md.

I am entirely satisfied with the "RADIOTONE" Buzzer which I bought from you. It works fine, being BETTER THAN I EXPECTED IT WOULD BE AT THE PRICE. At first I didn't think that it would be very good at the low price, but it is all right. It appeals to me mostly because of ITS QUICK RESPONSE to the opening and closing of the key.

JOHN B. MOORE,
Delaware Co., Downsville.

I am pleased to say that after testing it out in a student's buzzer set, it comes up to my best expectations. H. D. STRAUGHN,
Ripley, Okla.

Am in possession of one of your "RADIOTONE" test buzzers and wish to say that I could not have expected a more silent instrument, as well as the EXACT TONE OF A HIGH POWERED WIRELESS STATION.

S. W. DEARING,
R.2, Covington, Tenn.

It gives me great pleasure to recommend your "RADIOTONE" test buzzer. I find it very sensitive and responsive, ALWAYS EMITTING THE SAME HIGH PITCHED NOTE. But the best feature of all is ITS SOUND-PROOF CASE.

C. A. W. McMURTRY,
94 Gladstone Ave., St. Thomas, Ont.

I wish to say that I have given your "RADIOTONE" Buzzer a thorough testing and find it stands up beautifully under the conditions. Connected to a 75 ohm phone and a No. 10010 Junior Fixed Condenser per diagram in your catalogue, it makes an ideal practise set, the note of which can HARDLY BE DISTINGUISHED FROM "ARLINGTON." The "RADIOTONE" has EXCEEDED MY EXPECTATIONS by far. E. A. ARMSTRONG,
R. R. No. 1, Indian River, Ontario, Can.

I have used your "RADIOTONE" Buzzer, and find it THE BEST EVER USED. I find it very useful for a layman to learn the code quickly. I would recommend it to any one interested in wireless.

ANDREW SCHRINER,
1722 Putnam Ave., Brooklyn, N. Y.

I have had the opportunity of making practical tests with one of your "RADIOTONE" BUZZERS, and I feel justified in making the following statements concerning it:

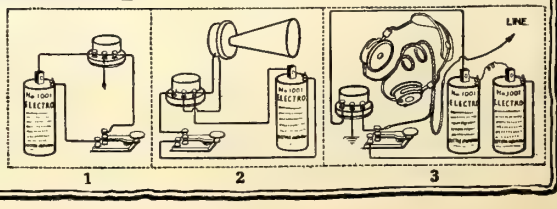
1. It is handsome in appearance,
2. It is practically noiseless in operation,
3. It gives a clear note of CONSTANT FREQUENCY,
4. It is equal in performance to other buzzers selling AT SEVERAL TIMES ITS COST.

I have been perfectly satisfied with the "RADIOTONE" and I will be glad to recommend it to anyone. E. K. SNYDER,
717 Lake Boulevard, St. Joseph, Mich.

Fig. 1. As a radio mineral tester.

Fig. 2. With 75 ohm phone and horn for practicing code.

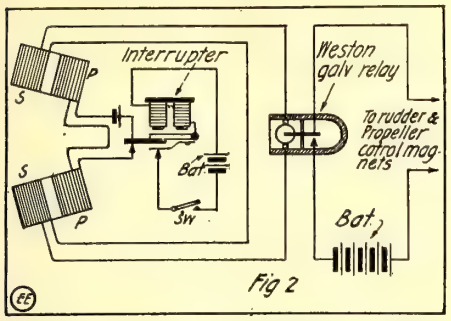
Fig. 3. For intercommunication. Works several miles on 2 dry cells.



ELECTRIC "BLOODHOUNDS" TO FIND AND DESTROY U-BOATS.

(*Continued from page* 348)

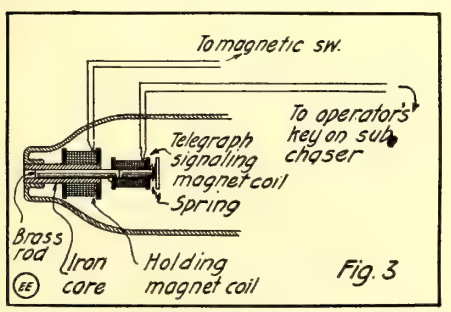
it completes a circuit thru one winding on the propeller motor, causing the torpedo to get under way. It is made to dive at the same time by the inert action of the *opposite* relay, R. 1, thru whose armature the diving plane solenoid is excited; the planes are thus placed at the proper angle



"Induction Balance" Connections In Electric "Bloodhound." A Sensitive Galvanometer Relay Is Necessary.

to carry the torpedo downward. The same action occurs for steering the torpedo to right or left, the *opposite* "R" relay serving to actuate the proper solenoid to swing the rudder to port or starboard, as the case may be. Of course, there are a number of refinements which could be introduced such as interlocking cut-outs, semi-manual control from the tender, etc., but the basic principles of such control are here outlined.

To prevent the "bloodhound" from running its nose dead into the submersible's propeller blades, it is possible to provide several means for overcoming this contingency. Suppose for example that we connect a special relay in shunt to the amplifier secondary circuits, which relay would only operate when the torpedo had approached within, say, 50 feet of the enemy, the received sound wave being then sufficiently strong to close this relay. Again, consider that this sluggish relay was caused to operate a time limit circuit-breaker or relay, which could be set to open its secondary control circuit after a time period of sufficient duration to carry the torpedo one-third the length of the submersible past the propellers. Thus it is seen that it is possible to so set the control apparatus that when the torpedo has reached a distance of, say, 50 feet from its prey, that the special relays just described could be caused to control the planes and rudders so as to steer the "bloodhound" parallel with the sub-sea boat for a distance one-third its length; then the time limit relay



Details of "Holding" and "Telegraphing" Electro-Magnets of Electric U-boat "Bloodhound."

would open, the *induction balance* apparatus would be acted upon by the metallic hull; its galvanometer relay would take control of the rudder, planes and propeller and steer the missile straight for the enemy. As soon as the torpedo hit the hull, its holding magnet would retain it securely in place and the propeller motor would stop.

The commander of the submarine chaser boat can then either blow up the submarine without further ado or he can pursue the more humane mode of signaling the U-boat commander to come up at once and surrender with the whole crew.

OFFICIALS ARREST JOHANN ZENNECK.

Acting under special orders from the Department of Justice at Washington, United States Deputy Marshal Linford Denny recently arrested Prof. Johann Zenneck, German radio expert, and took him to Ellis Island, where he will be interned for the duration of the war.

EXPERIMENTAL CHEMISTRY.

(*Continued from page* 333)

Steam is furnished by boiling water.

$$\underset{\text{Water}}{H_2O} = \underset{\text{Steam}}{\widehat{H_2O}}$$

The gases thus formed, H_2O [Steam], Sulfur Dioxid [SO_2] and Nitrogen Peroxid [NO_2], mingle in the large central flask, and combine as follows:

$$\underset{\text{Steam}}{\widehat{H_2O}} + \underset{\text{Sulfur Dioxid}}{SO_2} + \underset{\text{Nitrogen Peroxid}}{NO_2} = \underset{\text{Sulfuric Acid}}{H_2SO_4} + \underset{\text{Nitric Oxid}}{NO}$$

Nitric Oxid [NO] takes oxygen again from the air, forming Nitrogen Peroxid [NO_2], and once more passes on half of it. The action is very peculiar and continues so long as there is a supply of oxygen. Nitric Oxid is therefore called a *carrier of oxygen*. It is thus seen that the nitric oxid [NO] is a reducer, Nitrogen peroxid [NO_2] an oxidiser.

The Chamber acid, has a specific gravity of 1.5 and is about 65% acid and 35% water. This is strong enough for the manufacture of sodium sulfate [Na_2SO_4], one of its two main uses. If stronger, it absorbs much nitrous anhydrid [N_2O_3]. It is then removed from the chambers and reservoirs, and evaporated in open lead pans till it has a specific gravity of 1.75. Stronger than this it dissolves considerable lead, and it is then evaporated in platinum crucibles till the specific gravity is 1.83. This is about the commercial strength; pure acid being 1.854.

The *contact method* of making the acid which is now coming into considerable use in this and other countries, involves the very simple principle of making SO_2 into SO and leading the latter into water.

Properties—*Physical*

1. Sulfuric acid is a thick, oily, and corrosive liquid without color or odor when pure. It usually has a brown color due to the presence of charred organic matter, such as straw and dust.

2. Specific gravity if pure 1.854; commercial about 1.83.

3. It possesses a sour taste and acid reaction.

4. It boils at 338 degrees C. (about 642 deg. Fah.) and freezes at about zero.

5. It is miscible in water, with which it reacts and condenses.

Chemical

1. It reacts with most metals to form sulfates; if dilute, liberates hydrogen; if strong sulfur dioxid. Its action takes place at a low temperature, hydrogen is evolved, providing sufficient water is present to dissolve the metallic sulfate formed.

$$Zn + H_2SO_4 = ZnSO_4 + H_2$$
$$Fe + H_2SO_4 = FeSO_4 + H_2$$

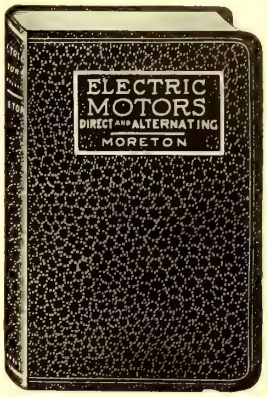
Mercury [Hg], silver [Ag] and Copper [Cu] are not affected by the action of cold [H_2SO_4], but if concentrated acid is used

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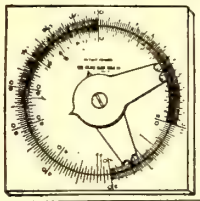
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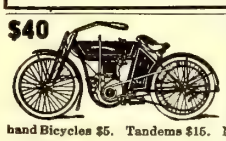
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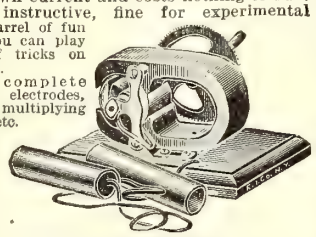
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and the temperature raised sufficiently, they react, reducing part of the sulfuric acid, forming sulfur dioxid and water, and metallic sulfates:

$$Cu + H_2SO_4 = CuSO_4 + 2H$$
$$H_2SO_4 + 2H = 2H_2O + SO_2$$

Thus at ordinary temperature, sulfuric acid acts like hydrochloric acid, exchanging its hydrogen for metals, but when hot and concentrated, it acts also as an oxidizing agent.

2. Sulfuric acid does not affect Gold, or Platinum, and only hot, concentrated, affects Lead.

3. At red heat it dissociates into H_2O and Sulfur trioxid [SO_3], and thence Sulfur dioxid [SO_2] and oxygen [O].

4. It possesses great affinity for water.

The fact has been repeatedly illustrated in experiments already performed that sulfuric acid has a very strong tendency to absorb water and form compounds with it, thereby causing great heat to be formed in this action, and attention is called to the necessity for caution in mixing this acid. *Always pour* sulfuric acid *in small quantities into the water, while stirring the same vigorously.* If care is not exercised in mixing this acid with water, the heat may crack the container and spatter the hot acid.

The tendency of sulfuric acid to absorb water may be illustrated by the following examples:

(a) When concentrated, it absorbs moisture from the air, and from gases passing thru it.

(b) It is frequently employed in the laboratory to dry gases, since it is not volatile at the ordinary temperature.

(c) Wood, paper, sugar, starch, etc., and many organic substances are blackened by the acid, due to the acid removing both the hydrogen and oxygen, forming water, and leaving carbon.

From oxalic acid [$H_2C_2O_4$] or alcohol [C_2H_6O] it removes hydrogen and oxygen, causes them to combine to form water, and absorbs the latter.

$$H_2C_2O_4 = H_2O + \widetilde{CO_2} + \widetilde{CO}$$
$$C_2H_6O = H_2O + C_2H_4$$

Its action on the skin, producing painful sores, and on organic matter generally, is due to its affinity for water.

5. It neutralizes and dissolves bases and metallic oxids to form sulfates:

$$2KOH + H_2SO_4 = K_2SO_4 + 2H_2O$$
$$Ca(OH)_2 + H_2SO_4 = CaSO_4 + 2H_2O$$
$$ZnO + H_2SO_4 = ZnSO_4 + H_2O$$
$$Fe_2O_3 + 3H_2SO_4 = Fe_2(SO_4)_3 + 3H_2O$$

USES

As stated under the history of this acid, it is used in almost every art or trade, either directly or indirectly. Its manufacture is the king of industries.

Probably the uses which would be of most interest to readers of this journal would be when used in conjunction with electricity.

1. In lead storage batteries, in the charged state, a positive plate of lead peroxid [PbO_2] and a negative plate of finely divided lead, are introduced into sulfuric acid. When discharged, the surface of both plates has been changed to lead sulfate [$PbSO_4$]. The plates may be brought back to their original condition by sending a current thru the battery in the reverse direction. Storage battery plates are usually made by two general methods, which are only modifications of the original Planté or Faure process.

The Planté process includes all methods in which the active material is made from the plate itself, which should be pure soft lead. There are numerous methods of accelerating the formation. Usually the surface is worked up mechanically by cutting grooves, provided it has not been cut in this form. The next operation is to produce the necessary amount of active material. The plates are frequently permitted to stand in some corroding solution of acids that produce a thick layer of lead sulfate [$PbSO_4$], for a certain time. The lead sulfate may then be reduced electrolytically to lead, or oxidized to lead peroxid [PbO_2]. When acids other than sulfuric are used, these must be thoroly washed out before the battery is ready for use. For instance, a mixture of Nitric and Sulfuric acids would have the effect of producing a layer of sulfate.

The theory of the lead storage battery which is generally accepted is known as the "Sulfate theory," and is due to Gladstone and Tribe. Sulfuric acid combines with the plates on discharge, and is set free on charge, according to this theory. On discharge, hydrogen is deposited on the lead peroxid which reduces it to lead oxid [PbO], which is changed to lead sulfate [$PbSO_4$], as represented by the equation:

$$\underset{\text{Peroxid}}{PbO_2} + \underset{\text{Hydrogen}}{H_2} + \underset{\text{Acid}}{H_2SO_4} = \underset{\text{Sulfate}}{PbSO_4} + \underset{\text{Water}}{2H_2O}$$

At the same time the sulfate radical [SO] is deposited on the lead plate and changes to lead sulfate:

$$\underset{\text{Lead}}{Pb} + \underset{\text{Radical}}{SO_4} = \underset{\text{Sulfate}}{PbSO_4}$$

The sum of these two equations is the total change in the storage battery on *discharge:*

$$\underset{\text{Peroxid}}{PbO_2} + \underset{\text{Lead}}{Pb} + \underset{\text{Acid}}{2H_2SO_4} = \underset{\text{Sulfate}}{2PbSO_4} + \underset{\text{Water}}{2H_2O}$$

When in the *discharged* state both plates are covered with sulfate. Upon *charging,* the reaction on the positive plate is:

$$\underset{\text{Sulfate}}{PbSO_4} + \underset{\text{Radical}}{SO_4} + \underset{\text{Water}}{2H_2O} = \underset{\text{Peroxid}}{PbO_2} + \underset{\text{Acid}}{2H_2SO_4}$$

While in the negative plate:

$$\underset{\text{Sulfate}}{PbSO_4} + \underset{\text{Hydrogen}}{H_2} = \underset{\text{Lead}}{Pb} + \underset{\text{Acid}}{H_2SO_4}$$

The sum of the last two equations represents what takes place in the whole battery on *charging:*

$$\underset{\text{Sulfate}}{2PbSO_4} + \underset{\text{Water}}{2H_2O} = \underset{\text{Peroxid}}{PbO_2} + \underset{\text{Lead}}{Pb} + \underset{\text{Acid}}{2H_2SO_4}$$

This equation is just the reverse of the one given as the sum of the first two equations (No. 3), and the changes taking place both on *charge* and *discharge* may be represented by the reversible equation:

$$\underset{\text{Peroxid}}{PbO_2} + \underset{\text{Lead}}{Pb} + \underset{\text{Acid}}{2H_2SO_4} \rightleftarrows \underset{\text{Sulfate}}{2PbSO_4} + \underset{\text{Water}}{2H_2O}$$

From right to left this represents the charge, and from left to right the discharge.

(This use as regards storage batteries is taken from the manuscript which the author has in preparation on "CHEMICAL ACTION OF STORAGE BATTERIES.")

2. This acid is the basis of the manufacture of most other acids, and so of most salts. The manufacture of alkalies too, including sodium carbonat, depends mainly upon this acid.

3. Its action on bones to make fertilizers. This action transforms an insoluble calcium phosfate [$Ca_3(PO_4)_2$] into a soluble one [$H_4Ca(PO_4)_2$], thus enabling plants to absorb the phosfate from soils on which fer-

(Continued on page 354)

EXPERIMENTERS!

The "Electro" Codophone

(Patents Pending)

Now that we are for the time being, deprived of using our Radio outfits, it behooves us as good Americans to become proficient in learning the Wireless as well as Telegraph Codes. Operators who know the Code are, and will be, in ever rising demand. The Army and Navy need thousands of operators right now.

So far the Government has not been able to obtain any way near all the operators it requires. Not alone does the Federal Government call for thousands and thousands of operators for the army and navy, but nearly all of our many states require operators for the militia. Here is the great opportunity of a life time for you.

Would you rather fight in the trenches, or punch the key behind the lines? Either way you benefit your country. **Which do you prefer?** And it is SO easy to become an operator. You do not necessarily require a teacher, nor do you have to go to a school to learn. 30 days of intelligent study will make you proficient. **Can you qualify NOW? Are you proficient?** Can you send and receive when your country calls you?

THE "ELECTRO" CODOPHONE
(Patents Pending)

which we present herewith is the outcome of several months of intense study and experimentation of our Mr. H. Gernsback. It supersedes our former Radiotone Codegraph, which comprised a **Radiotone silent Buzzer, a loud talking telephone receiver** and **a key.** As in all of his work Mr. Gernsback strives for simplicity. So he combined the three above mentioned instruments with one stroke into **ONE** single instrument. He combined the Radiotone Buzzer and the loud talking receiver into a single unit, not only mechanically, **but electrically as well.** This involves **an entirely new principle**, never before attempted, and on which basic patents are now pending.

What this remarkable instrument is and does.

The "Electro" **Codophone** is positively the only instrument made that will imitate a 500 cycle note exactly as heard in a Wireless receiver, so closely and so wonderfully clear, that Radio operators gasp in astonishment when they first hear it. And you need no receivers over the ears to hear the imitation singing spark, which sounds for all the world like a high-pitched distant powerful Radio Station. No, the loud-talking receiver equipped with a horn, talks so loud that **you can hear the sound all over the room,** even if there is a lot of other noise.

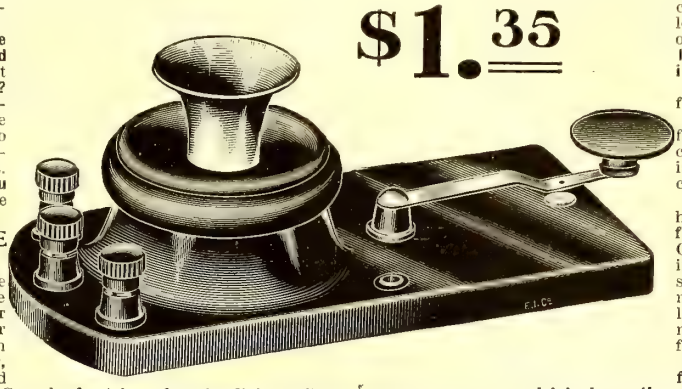
THAT'S NOT ALL. By lessening or tightening the receiver cap, a tone from the lowest, softest quality, up to the loudest and highest screaming sound can be had in a few seconds.

FURTHERMORE, this jack-of-all-trades marvel, can be changed instantly into our famous silent Radiotone test buzzer, simply by replacing the metal diaphragm with a felt disc, **which we furnish with every instrument.**

FOR INTERCOMMUNICATION. Using two dry cells for each instrument, two **Codophones** when connected with one wire and return ground, can be used for intercommunication between two houses one-half mile apart. Any one station can call the other, no switches, no other appliances required. No call bell either, the loud-talking phone takes care of this.

AS AN ARMY TYPE BUZZER. Last, but not least, **two Codophones** with two 75 ohm receivers can be used to converse **over miles** of fine (No. 36 B & S Wire), so fine that no one can see the wire. Or you can use a long metallic fence and the ground, or you can communicate **over your 110 volt line up to several miles, using no wires, only the ground.**

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Full directions how to do all this furnished with each instrument.

One outfit alone replaces the old-fashioned learner's telegraph set, consisting of key and sounder, which is all right to learn the telegraph code but not the wireless codes.

The "Electro" **Codophone** is a handsome, well made instrument, fool proof, and built for hard work. Contacts are of hard silver ⅛ inch in diameter, that will outlast the instrument. Base and housing is of metal throughout, horn and key lever nickel plated and buffed. Three new style metal binding posts are furnished.

There is also a neat code chart and full directions **enabling any intelligent young man or girl to learn the codes within 30 days,** practising one-half hour a day.

Sizes: 6¾ x 3 x 2⅝". Shipping weight, 4 lbs. **$1.35**

The "Electro" Codophone as described, complete

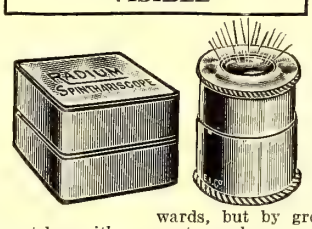
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THE "ELECTRO" SPINTHARISCOPE

As usual we lead—others follow. Now the **Spinthariscope,** first to be introduced to the American public by us. The **Spinthariscope** was originated by the famous English Radium expert, Sir William Crookes. Everyone knows that Radium gives off a tremendous amount of energy which goes on for several thousand years, with undiminished force.

MAKING RADIUM VISIBLE



Radium gives off a number of rays of which the **Alpha rays are known chiefly for their great power.** These electric rays are invisible to the naked eye, the same as are X-rays. But if we take a small amount of Radium and place it in front of a zinc-sulfide screen, the latter lights up. If the radium speck is arranged suitably the Alpha rays will bombard the zinc sulfide with a veritable hail of electrons and the screen begins to scintillate like Fourth of July fireworks.

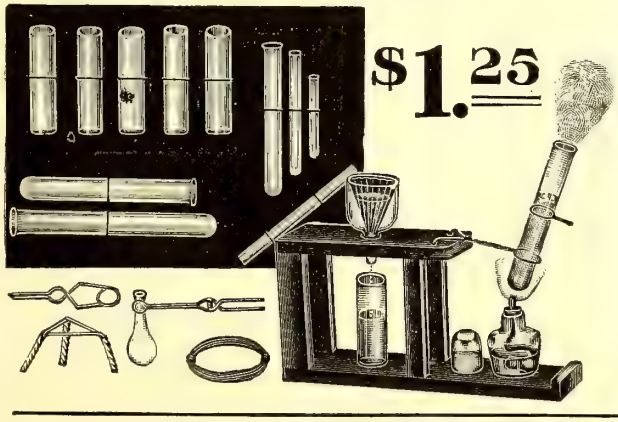
This is the principle of the **Spinthariscope,** which we present herewith. It is a little instrument made of two neatly nickeled metal tubes, one telescoping into the other. The top tube has a powerful lens. The bottom contains the zinc-sulfide screen and a minute quantity of REAL RADIUM, **too small to do any harm.** The instrument can only be used in the dark. After the top tube with the lens has been adjusted to the right focus, we observe a vividly illuminated green background, glowing in a soft light. As the eye becomes accustomed to it, we begin to see the **ELECTRONIC BOMBARDMENT** of the Alpha rays from the Radium. It looks exactly like tiny fireflies flashing off and on in the dark night. The more we look the better we see the miniature fireworks. We are now in the presence of the most marvelous substance man ever knew, **RADIUM** and its uncanny forces—Radium, which some day will turn the world upside down.

The **Spinthariscope** up to now sold from $10.00 upwards, but by greatly simplifying it the cost has been brought down by us to such a nominal figure, that no one can afford to be without this most important and marvelous instrument.

You owe it to yourself to own one. It is small enough to be put into your vest-pocket, and interesting enough to show it to all of your friends. **It will continue to operate after you are dead 2500 years!** We guarantee the instrument to be genuine and to contain a minute quantity of **real Radium salts.** "Electro" Spinthariscope, in neat box and directions for use, as described..... **$1.00**

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LABORATORY OUTFIT!



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We have spent considerable time to combine just such a practical outfit and present it herewith to our friends.

The outfit is complete as per illustration and consists of:

1 **Stand,** made of well quartered oak, varnished three times, so as to be acid proof and grooved on top and bottom, so that it will not warp in getting wet. Size 5¾ inches high by 11½ inches long.

1 **Glass Spirit Lamp.** Size 3½ inches by 2 inches. Uses wood alcohol and is invaluable to the experimenter. Besides being used to heat test-tubes contents as per illustration, it can be used to bend glass rods and tubings, to solder wire, etc.

1 **Glass Filter Funnel.** This funnel is made of heavy glass that will not break easily. It fits accurately in the hole on top of the Filter stand and is provided with a thick rim on the outlet, so that a rubber hose can be attached to it, without slipping off.

1 **Glass Rod,** to be used in stirring and mixing.

10 **Test Tubes,** made from the best imported glass. A new feature of some of the test tubes is that they have a flat bottom and therefore can be placed on any table if desired, needing no special stand.

1 **Roll of Copper Clad Steel Wire.** This wire is to be used to make a number of useful articles as shown in the illustration, such as test-tube holders, tripods to support retorts, etc. We furnish a blue print with the outfit, showing how to make all these wire articles.

Now this whole outfit as described costs you only **$1.25**

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EXPERIMENTAL CHEMISTRY.

(*Continued from page* 352)

tilizers is used. Rain dissolves the soluble superphosfate, as $H_4Ca(PO_4)_2$ is called, and it is carried to the roots of plants and thence circulated by the sap and deposited in the fruiting parts of the plant. Food plants, like the cereals, will not come to maturity or fruitage without phosphorous in this form. In this way our daily bread is in part supplied by sulfuric acid.

4. Another important use is in the preparation of sodium sulfate [Na_2SO_4], from sodium chlorid as a step in the sodium carbonat [Na_2CO_3] manufacture. Sodium carbonat forms the basis of such industries as the manufacture of glass, soap, saleratus, baking powders and most alkalies.

5. Besides these uses, sulfates are formed by action of the acid on metals or their salts.

6. Directly or indirectly H_2SO_4 is employed in the preparation of compounds for bleaching, dyeing, printing, electroplating, telegraphy, galvanizing iron plates and wire, cleaning metals, making shoe blacking, glucose, mineral waters, soda waters, ether, nitroglycerine, gun-cotton, vegetable parchment, celluloid, etc.

EXPERIMENT NO. 89

Preparation from H_2SO_4, Cu, HNO_3, and H_2O.

CAUTION.—This experiment should be performed in a well ventilated room, or under a hood.

The author has found this experiment, when carefully made, an excellent and very interesting one.

As this experiment requires several of each piece of apparatus, many readers will not want to go to the expense of purchasing the additional pieces required. If this be the case, it might be well to try and borrow these from a friendly druggist, if he has them, or, if you have some friends who are interested in chemistry, who have the pieces, you might be able to work this experiment with them. Again, if several get together and each pay for the additional apparatus, it may be performed, by this method, at the same time, it will undoubtedly create sufficient interest, for the others to start experiments of their own, and in this way, each experiment could be performed by the several people at the same time.

Have four Erlenmeyer or Florence flasks, three of which are plain, thin glass, and of 125 to 250 cc. capacity; the other of 250 cc.; *thick glass* and side neck (not given in the illustration) with a rubber stopper to accommodate the numerous delivery tubes. The three small flasks have 2-hole rubber stoppers, each carrying a thistle and a right angle delivery tube, and each is set on an iron tripod, or ring stand with an asbestos pad. The delivery tubes lead into the large flask, and should extend at least two-thirds of the distance to the bottom. The fourth hole in the stopper of the receiving flask contains a short tube with a rubber connector to another tube used as a mouthpiece, for blowing in air.

Pour into one of the small flasks, 25 cc. of water, into each of the other two not over 10 grams of copper scraps. Adjust the apparatus and then pour into one of the flasks containing copper 25 cc. of sulfuric acid. Heat the flask containing water, and also the one containing copper and Sulfuric acid. As soon as the water boils and action begins in the other heated flask, pour into the third flask containing copper alone, 22 cc. of nitric acid diluted with half water. Apply gentle heat to this last one, if necessary. Remove the heat for a minute from the other two flasks. In all cases heat must be carefully regulated. The fumes in the large flask should become white, then red, then white again. When they become white, blow into the receiver thru the mouthpiece, and if necessary to change them to red, heat the flask containing nitric acid, or even put in more acid. Bear in mind that sulfuric acid can only be made when red NO_2 fumes are present. Hence keep alternating the heat for the three flasks and blowing into the receiver. The breath furnishes oxygen, which combines with the nitrogen dioxid [NO] from the nitric acid to form nitrogen tetroxid [NO_2], which latter gives up half of its oxygen to the sulfurous acid [H_2SO_3] to form sulfuric acid [H_2SO_4].

After continuing the process twenty minutes, clean the entire apparatus, save the acid made, and wash and save any remaining copper.

EXPERIMENT NO. 90

Made from Sulfur, Nitric acid, Water and Air.

The reactions in making sulfuric acid, and its preparation on a minute scale, may be shown by the following experiment.

Burn in a wide mouth bottle of 250 cc. capacity a piece of sulfur the size of a split pea, placed in a combustion cup and set on fire in the usual way, as shown by Fig. 81. Keep the receiver nearly covered with a glass plate. When combustion stops, take out the sulfur, keeping the bottle still covered. Fasten a small tuft of cotton to a splint and dip it into a little Nitric acid in a dish. Or fold a piece of old book or newspaper about 5 x 8 inches, with folds about ½ inch in width, and immerse about an inch of this folded paper in 5 cc. of Nitric acid so as to saturate it, but avoid dripping. Take the cover momentarily from the wide mouth bottle and bring the acidified cotton or paper in contact with the fumes, alternately raising and lowering it; then hang it on the inside of the bottle and cover it at once, letting it stand for five minutes or more, as shown by Fig. 82. Now boil 10 cc. of water in a tube, and, having taken out the acidified cotton or paper, pour it while hot into the bottle. Cover the latter with a stopper or the hand and shake it vigorously a minute or two,

(*Continued on page* 358)



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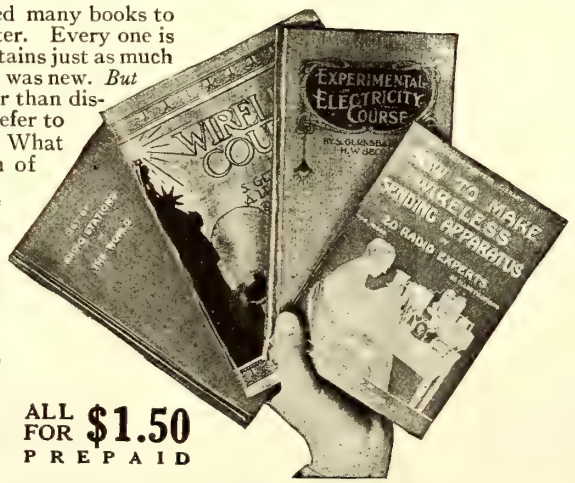
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MANUFACTURING MAGNETISM.

(*Continued from page* 313)

thing left to see is why the atoms, or elemental magnets, act like gyroscopes and line up when the bar is rotated. Let us remember that one of the assumptions of the modern electron theory of matter is that every atom is believed to be composed of a positive nucleus or center, about which the negative particles or electrons rotate at high velocity, as in Fig. I. It is not hard to see that each atom therefore acts as a gyroscope (called in this case a gyrostat). Also the revolving electron constitutes a minute electric current flowing in a circle about the nucleus, and like all electric currents flowing in such a manner, it has a magnetic field directed thru its orbit in the direction of the vertical arrow. Ordinarily, when a piece of steel is strongly magnetized by stroking it with another magnet, it seems that all or a majority of these little electro-magnetic systems are forced about until they point in the same direction, and the magnetism of all of these added together constitutes the magnetism of the whole body.

This gives us a theory of magnetism which is quite an advance over the old so-called molecular theory of magnetism which asserted that no matter how much a magnet be subdivided the parts would always be little magnets just like the first. The advance which has been made in the theory is shown in Fig. II.

By rotating a bar of iron or steel about a longitudinal axis these atomic gyrostats line up like so many spinning tops and the bar is magnetized. So far it has not been possible to overcome the internal force of the iron sufficiently to magnetize the bar except very weakly, but this has been done, and repeated experiments all agree, showing that a new method of producing magnetization has really been obtained, and showing that the assumptions concerning the atom were true.

This method of magnetization suggests a new explanation of the earth's magnetism, as being due, in part at least, to the rotation of the earth. Such a calculation, however, only accounts for a very small part of the earth's magnetism, and we are led to conclude that either the magnetism of the earth is due in very small part to rotation, or else our knowledge of the physical state of the molten interior of the earth may be too little upon which to justify in any way a calculation based upon the observation of a solid bar of iron.

About a year ago a somewhat incautious newspaper reporter sent word to his paper that a new metal had been discovered with about a hundred times the magnetic permeability of iron, and that soon a small electric power plant could be carried in the pocket. Although the latter statement may not be so far from the truth, the former, like the alchemists of old, is a long, long way from being realized. In fact, it was a mere rumor suggested by some research work of Trygve Yensen (at the University of Illinois), who was studying an iron-cobalt alloy (Fe_2Co). This work, tho not at all startling, is nevertheless of no little interest to both scientists and engineers alike, because it deals with a metal alloy having a higher permeability than iron itself. This alloy was really discovered by Weiss of Zurich in 1912, who found it had a saturation value of magnetization ten per cent. higher than that of pure iron. Up to this time it had been supposed that such a metal was a practical impossibility. Thruout the usual range of field strength the permeability is twenty-five per cent. higher. If the alloy proves itself commercially practical this would mean a twenty-five per cent. reduction in size and amount of wire on dynamos, motors, transformers and other such pieces of apparatus.

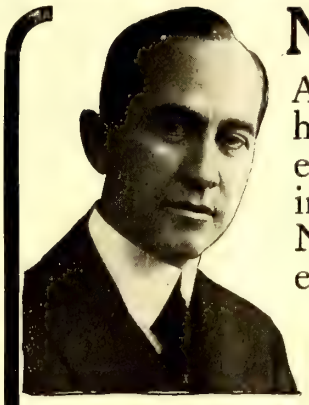
Heusler probably paved the way for the discovery of this alloy when he found the famous alloys which bear his own name in 1903. These alloys composed of manganese, aluminum and copper; and of manganese, aluminum and zinc, are themselves strongly magnetic tho the elements composing them are non-magnetic.

The two facts, that a magnetic alloy can be made from non-magnetic metals, and that an alloy of higher permeability than any known can be made of iron and cobalt, tho they seem at first in contradiction to ordinary law, are in reality quite in harmony with recent theory. If the atom consists of a nucleus about which a number of electrons revolve, and if all the electrons do not revolve in the same plane or same direction the magnetic effect of the atom may be anything from maximum to zero, depending on how much the revolving electrons tend to neutralize each other. Figs. III and IV represent simple conditions showing atoms with two electrons having maximum and minimum magnetic strength.

When a number of neutral atoms of non-magnetic elements enter into a new relation, as in the case of the Heusler alloys, then it seems probable that a change takes place so that the electronic orbits shift, and if the electrons no longer oppose each other the neutral atom then becomes magnetic.

Such a theory suggests that alloys with a still greater permeability than the iron-cobalt alloy just mentioned, will be found at some future time.

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THE MARVELS OF RADIO-ACTIVITY.

(*Continued from page* 303)

Sir William Ramsay, in his last article, penned just before his death, said:

"Radium has been prepared in the state of a metal; it is white, hard, and is soon attacked by the air and the moistness of the atmosphere, and turns into a white powder—the oxid. (Radium metal was

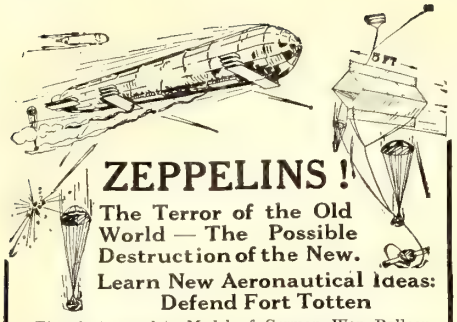


Radiograph of Several Objects Made With 2 Grams of Uranyl Chlorid in Thirty Hours By the Author.

first produced in 1910 by Madame Curie and Dr. Debierne, by the electrolysis of the chlorid into a mercury cathode, the mercury being subsequently volatilized. See the *Comptes Rendus de L'Acadamie des Sciences,* vol. 151, page 523, 1910.)

"The gas from radium changes quickly into a solid metal which Soddy and Rutherford called 'radium-A'; it in turn changes still more quickly into a second, termed 'radium-B'; from it a third, fourth and fifth successively develop, which they named 'radium-C,' 'D' and 'E,' respectively; 'E' changes into 'F,' and that turned out to be the same as the Curies' 'polonium.'

"During each of these changes, a rela-



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WANT TO "SWAP"?

See page 359

tively enormous amount of heat is given off; now, heat is a form of energy; and Rutherford and Soddy ascribed the successive changes to what they called the 'degradation' of the radium and its products, that is to radium changing into another element, namely the gas termed by Rutherford 'emanation' but now known as 'niton.'

"The change of radium into niton is accompanied by the emission of 'alpha rays,' one of the kinds observed by Becquerel to be emitted from uranium. When radium-A is formed by the degradation of niton, alpha rays are also expelled; radium-A changes into radium-B, however, with the loss of no alpha-rays, but only the beta-rays; and beta-rays were shown, later on, to be identical with electrons. What are alpha rays?

"The present writer (Sir William Ramsay), along with Mr. Soddy, separated the niton from a comparatively large quantity of radium. It had all the properties of a gas; it expanded by heat, and altered its volume under pressure, exactly like other gases, such as oxygen and hydrogen. But one of its properties was almost miraculous; on standing, the niton disappeared slowly, and its place was taken by another gas called 'helium,' discovered by the writer in 1895.

"Such a phenomenon was at that time new to chemists; it implied the 'transmutation' of one element into another. It is true that, unlike the attempts of the old alchemists to transmute the 'baser metals' (lead, silver, etc.) into gold, this change took place spontaneously; it could not be controlled; still it was no less revolutionary and striking. *One element may change into another,* for there is no denying that both radium and its product helium are in the ordinary sense of the word elements. Some years later, the present writer, working with Gray, made a balance so sensitive that by its aid the weight of a quantity of niton so small that it would just fill a glass tube no larger or thicker than a very fine needle was determined; and also a much smaller weight, that of the helium, produced by the disintegration of the niton.

"By an extremely clever set of experiments, Rutherford actually counted the number of atoms of helium shot off from radium-C in a given time; and he proved that alpha rays are nothing but a stream of helium atoms in enormously rapid motion, poured out from radium and some of its products of disintegration. This stream goes on as long as there is any of the emitting substance left; each atom of radium, for example, loses an atom of helium, and forms a new element niton.

"But the change of one element into another is not always accompanied by the emission of an atom of helium; sometimes, as when radium-A changes into radium-B, an electron is lost instead, and an electron is nothing but an atom of negative electricity; nevertheless, radium-A is just as different from radium-B as radium is from niton; all four are different kinds of matter, as unlike as iron is to silver.

"Are elements compounds? Yes, in a sense; but they are very stable compounds, much more stable than ordinary compounds such as water, or oxid of iron; when they decompose, one of their products appears to be always helium; and their decomposition is in all the cases which have been followed accompanied by the escape of a prodigious amount of heat; far more, regard being paid to the amount of substance changing, than any ordinary heat change.

"For example, an Atlantic liner gains the power necessary for crossing the ocean from the burning of coal, and the heat produced by its combustion. It is not difficult to calculate that if the energy of a few ounces of radium could be utilized (for it comes off far too slowly to be made use of—it takes thousands of years) it would give all the power and more, than the coal carried in her bunkers. We can control the combustion of coal; we cannot alter the rate of change of radium.

"Radium is a very rare substance; the ore from which it is extracted, pitchblende, is not common; good ore contains one-tenth of its weight of real oxid of uranium; and of such ore, less than one-ten-millionth is radium; moreover, the cost of extraction is considerable. Up to now, its chief use has been in medicine."

(*To be continued*)

SELENIUM CELL DESIGN AND CONSTRUCTION.

(*Continued from page* 332)

or brass plate and a transparent sheet of gold foil on the other side. To construct the cell a sheet of copper or brass of the desired size is covered with a thin film of selenium and while the same is in a molten state, a plate of glass is placed on it and a slight pressure applied. When the selenium has cooled and crystallized the glass is removed and a sheet of transparent gold foil is placed over the selenium. The cell is now ready for annealing. In annealing, a similar piece of copper, coated with selenium, may be placed alongside of the cell to indicate if the temperature is too great and as a check on the condition of the cell. These cells have been made with a ratio as high as 330 to 1; the resistance depends upon the thickness of the film, and the thinner this is the lower the resistance.

It should be clearly understood that a selenium cell requires some care to keep it in good condition. It should be kept in the dark when not in use and will retain its sensitiveness longer if exposed to light every day or so. After some time the dark resistance of the cell will decrease, and when abnormally low may be returned to its original value by subjecting the cell to alternating current till the resistance is regained. If exposed to a bright light for long lengths of time the cell will become fatigued and lose much of its sensitiveness.

A FEW DONT'S.

Don't leave the cell in the dark for weeks at a time.

Don't be afraid of allowing the cell to anneal for several hours, the longer the better.

Don't use a Bunsen burner for annealing; use an alcohol lamp that is large enough so that one filling lasts for five hours.

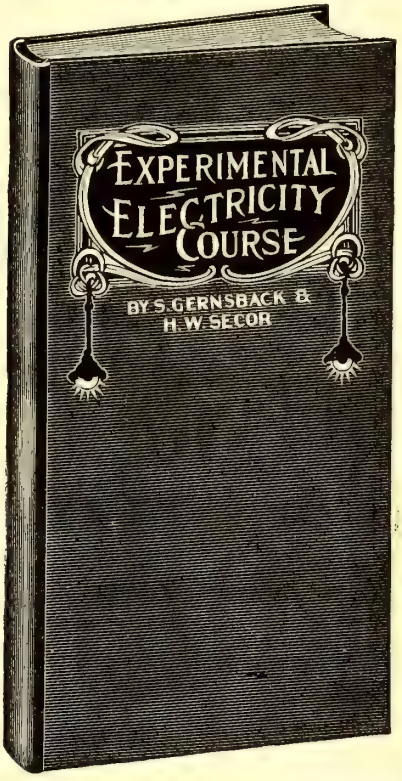
Don't use commercial selenium. Get the chemically pure grade from a reliable chemical supply house.

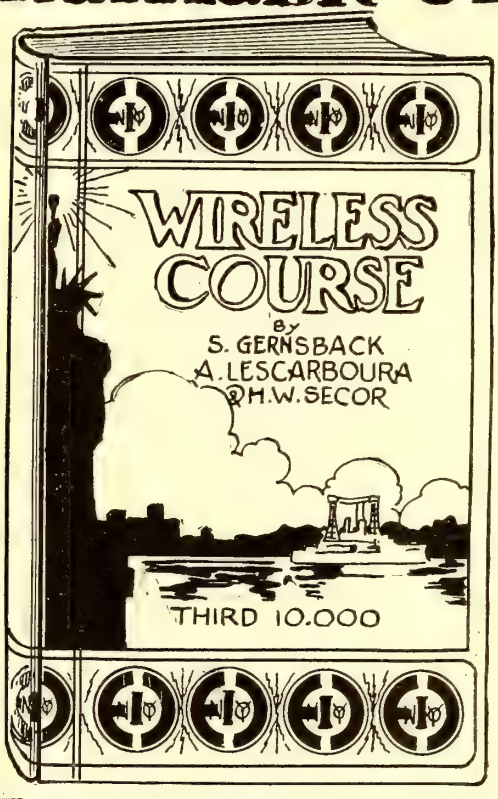
Don't keep the cell in the light too long.

And above all, don't get impatient or disgusted if the first four or five cells you make fail to work. It takes patience, patience and more patience, but perseverance overcomes all obstacles.

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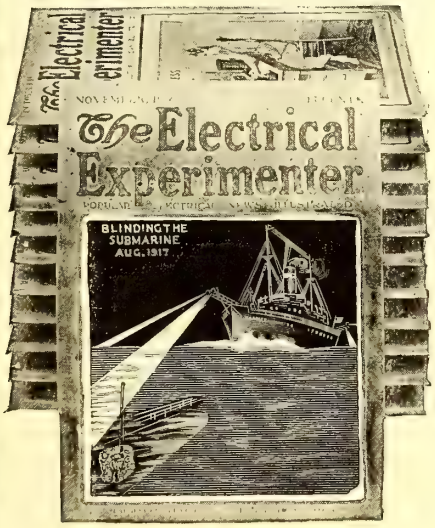


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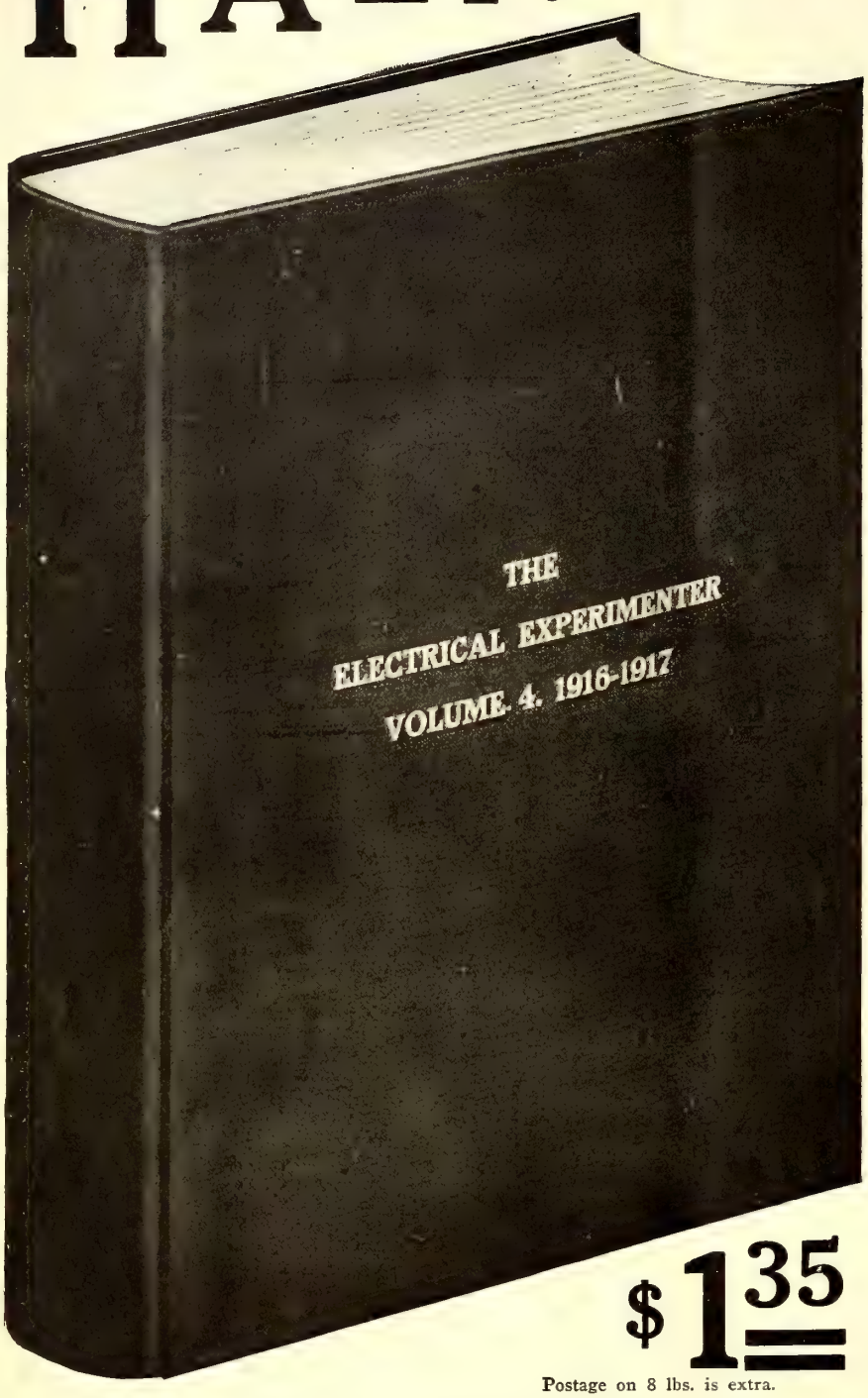
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EXPERIMENTAL CHEMISTRY.

(*Continued from page* 354)

being very careful not to get any acid on the clothing, as it quickly oxidizes and removes the color.

The acid prepared by this method will be very weak, but should at least give the barium chlorid and litmus tests.

EXPERIMENT NO. 91

To ascertain whether we actually have sulfuric acid, it will be necessary to make tests for the *positive* and *negative* parts, in other words, to test for *hydrogen* and then for the *sulfate radical* [SO_4]. Take some of the acid made by either process above and test it with blue litmus paper.

To show that sulfate is present, take about 10 cc. of a solution of barium chlorid [$BaCl_2$] or barium nitrat [$Ba(NO_3)_2$] and pour a few drops of the liquid you prepared or which you wish to test, into it. Observe the color of the precipitat formed, and note results.

Keep the precipitat and add to it 10 cc. of dilute hydrochloric acid, made by mixing one volume of the ordinary acid with three or four parts of water. Shake the mixture well and see whether the precipitat dissolves. If it *does* it shows that you *do not have* sulfate ions or radicals present, and the acid is *not* sulfuric. But if the precipitat *does not* dissolve, *it is* a sulfate, for any salt of barium would have dissolved in dilute hydrochloric acid.

This statement may be verified by making other salts of barium that are insoluble in water, and trying to dissolve them in dilute hydrochloric acid, as barium carbonate [$BaCO_3$] and barium chromat [$BaCrO_4$]. These being insoluble in water, are made by the usual method of preparing insoluble salts. (See June 1917 issue of the ELECTRICAL EXPERIMENTER, p. 155.)

It will thus be seen that the barium chlorid test is a test for the sulfate ion or radical, *and not for the acid alone.* To verify this make a solution of any soluble sulfate, as sodium sulfate [Na_2 SO_4] or ammonium sulfate [$NH_4]_2$ [SO_4], and apply the test.

The carbonization test is one for the acid as a whole. To apply it in four cases, take four small tubes in a test tube rack—into one put a gram or so of sugar, into another a like amount of powdered starch, into a third a wad of paper, and into the last a clean splint. Pour on each of these 5 cc. of commercial sulfuric acid, and let them stand a few minutes. Eventually all will be affected the same way if it is sulfuric acid.

EXPERIMENT NO. 92

Action of sulfuric acid on water.

Measure out in a graduate 10 cc. of cool water from the faucet and pour it into a medium-sized test tube. Immerse a chemical *Centigrade* thermometer in the water, carefully resting the bulb end on the bottom of the tube, as the glass of the latter is thin and mercury is heavy (Fig. 83.) Let it stand a minute, and take the reading and record it. Now take out the thermometer and rest it in another tube in the rack, then measure out 10 cc. of the concentrated commercial sulfuric acid and slowly pour it into the water of the first tube. At once immerse the thermometer in the mixture of acid and water, stirring it gently with the thermometer tube; when the mercury reaches its highest point, take the reading and record it. Remove the thermometer, wash it thoroly by holding it under a jet of water to wash out all the acid, then wipe it dry and replace it in the case.

Compare the difference in the thermometer reading both after placing in the water, and after the acid was added.

(*To be continued.*)

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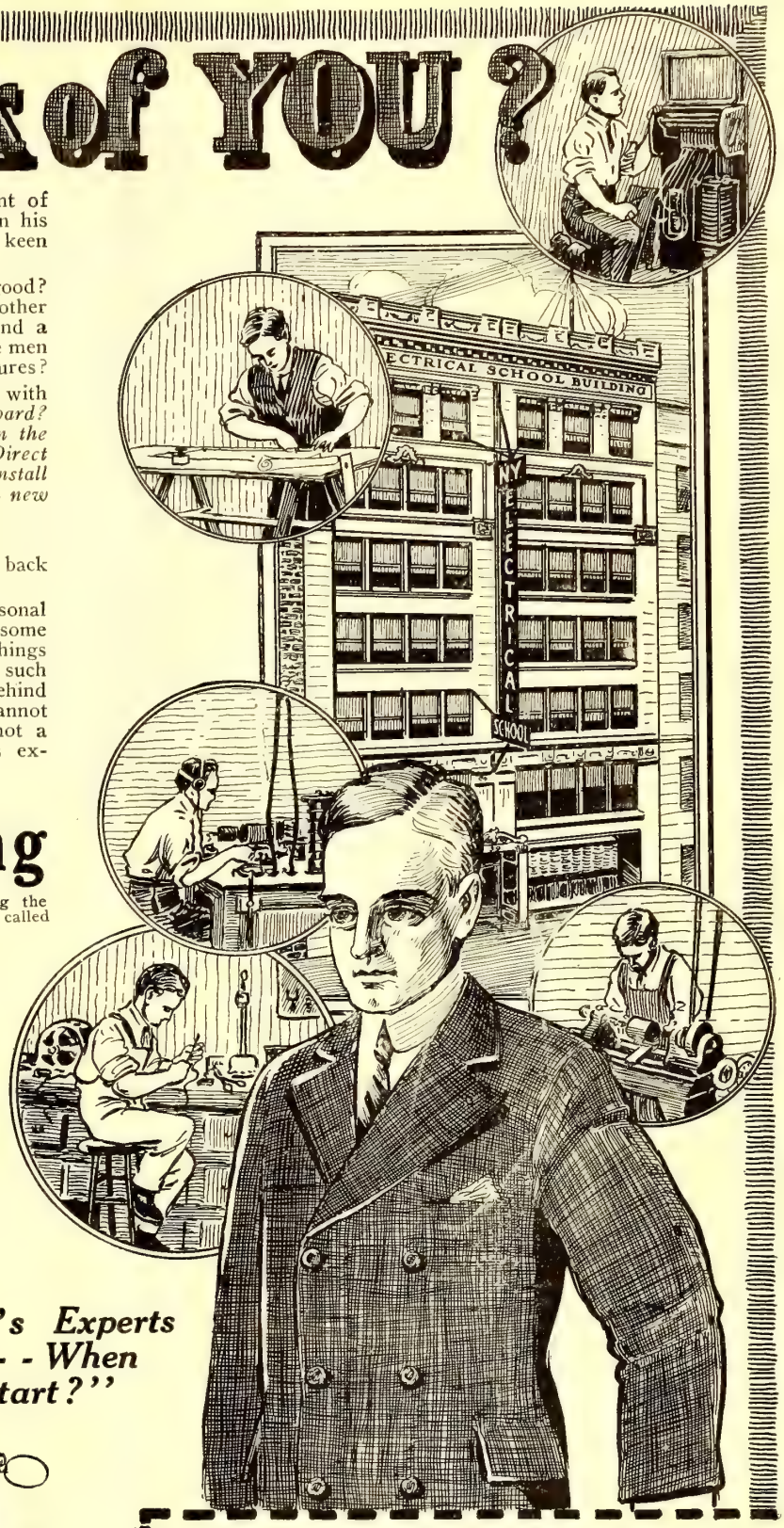
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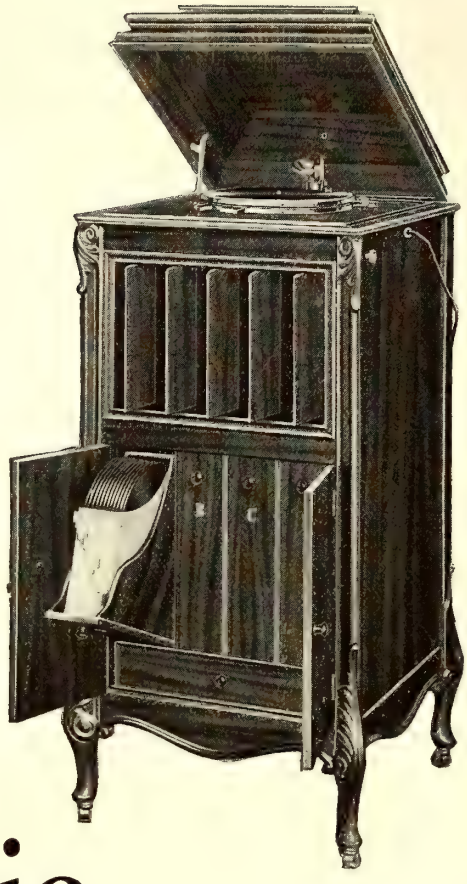
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U. S. PATENT OFFICE SEP 13 1917

Sub-Sea Microphones

WHEN reviewing the various methods which are in use, or which have been proposed to combat the submarine, we invariably are led back to the *microphone*. Indeed our officials are coming to recognize the microphone more and more each day, and just now at least, it seems to be in a fair way towards ultimate success.

Of course, we must admit, the difficulties encountered are enormous, and the ideal microphone for sub-sea work as yet does not exist.

In order to guide workers in this field we will enumerate several points, not well understood by the man, who has never worked with sensitive microphones under water. The information which we publish in the interest of all, and which has not appeared in print before has been secured from experts who have actually worked on the problem for months.

To begin with, a microphone working on dry land is a totally different instrument from the one working under water. Thus it will not do, for instance, to take any sensitive microphone and after waterproofing it, simply sink it into the ocean. A microphone as a rule has a sensitive vibrating diafram. Imagine sinking it fifty feet below water where the pressure is some 21 lbs. per square inch—the diafram would of course cave in. For that reason microphones as a rule are not actually sunk in the water, but are fastened against the inner steel shell of the ships. This naturally is a poor way, as much of the instrument's valuable sensitiveness is lost thereby. However, means have already been found to actually keep the diafram in physical contact with the ocean. Nevertheless improvements are wanting.

If an ordinary super-sensitive microphone is mounted on a ship without special attachments it will be found to be worse than useless. To begin with, the noise of the ship's engine, the walking about of the crew, the noise of the waves pounding against the ship, all make it impossible to hear anything else in the 'phones.

If on the other hand we sink the microphone clear of the ship, only supported by cables, our troubles are far from ended. The first thing we find is that we must sink the sensitive microphone at the very least 35 feet below the ocean level. Failure to do so will bring a constant dull pounding into the ears of the man at the 'phones, due to the noise created by the everbreaking and rolling ocean waves above. Even at 35 feet below, trouble awaits us. If the microphone remained perfectly stationary it would be a fine thing, but if suspended from a moving vessel, the rush of the water against the microphone casing produces a lot of unwelcome noise, hard to get rid of.

Most of these troubles are slowly being mastered, but far too slowly. What is needed are many more investigators who are willing to actually perform experiments under water. Land experience with microphones is valueless.

To cite a few more points. The average microphone works well only if in one position. Incline its face 45° and it will cease operating almost entirely. This of course is due to the shifting carbon grains. Makeshifts, *i. e.*, suspending the instrument in gimbal-rings like a compass, will not always do under water; what is wanted, is a sensitive microphone which is not influenced when turned upside down.

It has also been found, and this is an important point to remember, that using a "sea-diafram" which in turn vibrates a layer of air, the latter acting on the microphone diafram, will not work at all.

Another very interesting point is that when mounting microphones on each side of a vessel, the *loudness* of the incoming sound is equal in both telephone receivers, *i. e.*, if a submarine is on the starboard side of the ship, it will be heard just as loud from the port side. But, the difference can be readily detected and very accurately too, by the *phase difference* as heard in the 'phones. In other words, the sound will be heard a fraction of a second earlier in one ear than in the other. Small as this difference is, even a green operator will detect it at once.

Finally, the motors of a submarine do not give a clear note of a certain frequency in the listener's 'phones. Rather we hear a dull rumbling noise, loud, but without any definite pitch.

H. GERNSBACK.

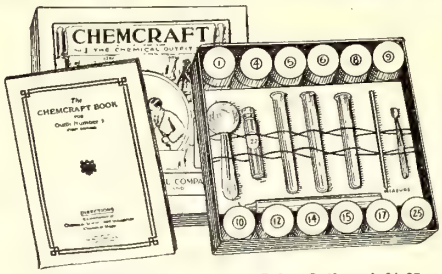
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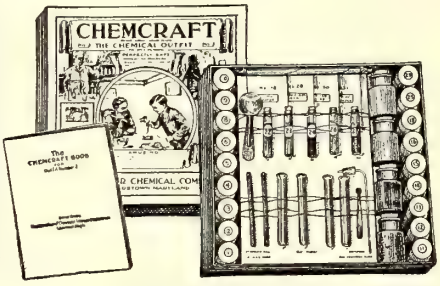
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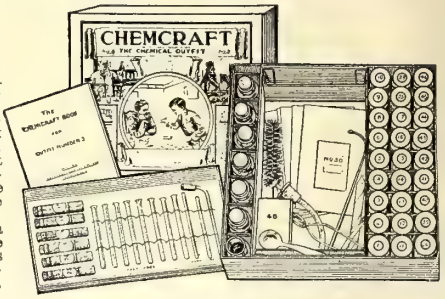
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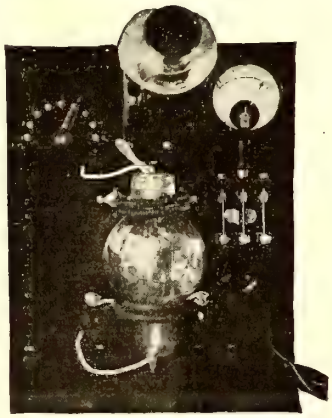
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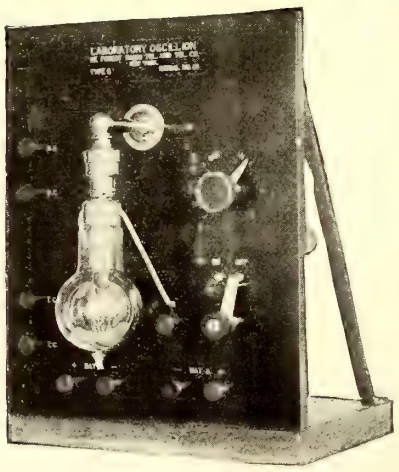
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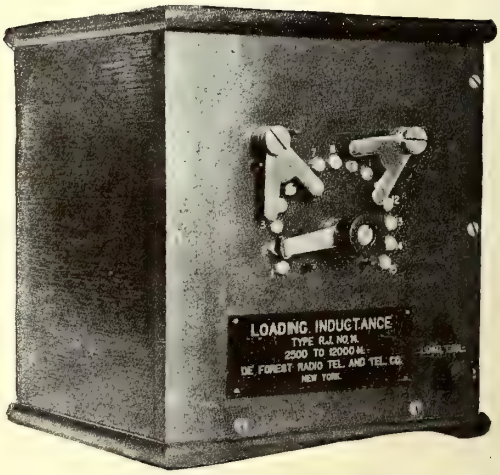


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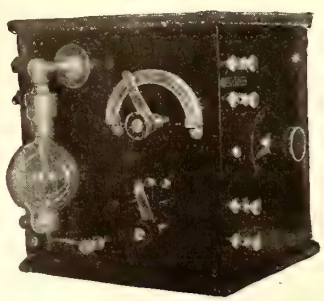
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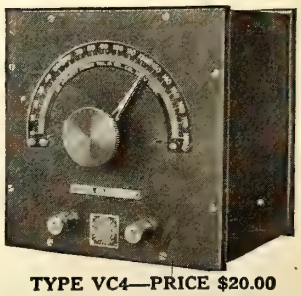
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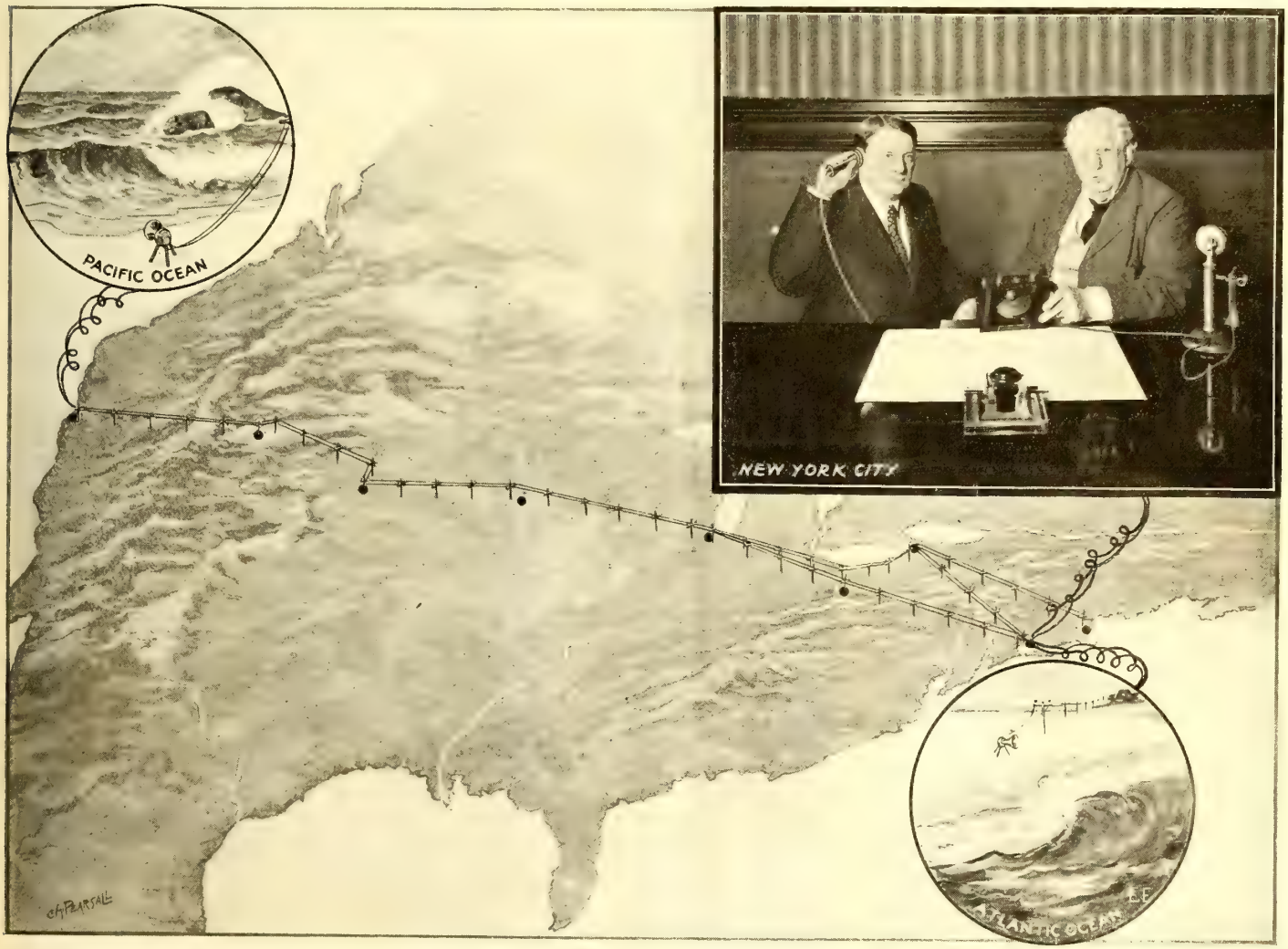
How Lord Northcliffe Heard Two Oceans at the Same Time

A REMARKABLE demonstration of the wonderful telephone network which extends over the entire United States was recently made for the benefit of Lord Northcliffe and his party on the occasion of their visit to the offices of Theodore N. Vail, President of the American Telephone & Telegraph Company, in New York City.

A point of historical interest was the listening by the distinguished visitor to the roar of the Atlantic and Pacific oceans simultaneously. A telephone instrument was connected to the trans-continental line reaching to San Francisco where the line had for the occasion been extended to a telephone transmitter on the shore of the Pacific at the Golden Gate. Another telephone was connected to a line extending to a transmitter on the shore of the Atlantic. Thus by placing his ear to one receiver and then to the other, Lord Northcliffe was able to hear first one ocean and then the other, and by placing a receiver to either ear he was able to hear *both oceans simultaneously.*

In this remarkable telephone line there are two physical and one phantom circuits and in each physical circuit there are two wires and 6,800 miles of hard drawn copper wire. There are 870 pounds of copper wire in each circuit mile and 2,960 tons in the entire line. The line crosses thirteen States and passes thru Salt Lake City, Denver, Omaha, Chicago, and Buffalo, with a branch that runs thru Pittsburgh, Washington and Philadelphia. In the main line there are 130,000 poles.

The power that sends the human voice out over the telephone is scarcely greater than that of a breath, yet it can be picked up by a delicate instrument, conserved over a distance of 3,400 miles, and reproduced perfectly and instantly across the continent.



Lord Northcliffe, During His Recent Visit to the Offices of Theodor e N. Vail, in New York City, Had the Pleasure of Listening to the Atlantic and the Pacific Oceans Simultaneously, Over the Trans-continental Telephone Line, 3,400 Miles in Length.

NOW COMES THE ELECTRO-MAGNETIC RAPID-FIRE AERO GUN.

The accompanying photo shows the latest thing in aeroplane guns from France. It is operated by an electro-magnet thus giving the aviator-marksman instant control of the gun, no matter at what angle it may be mounted.

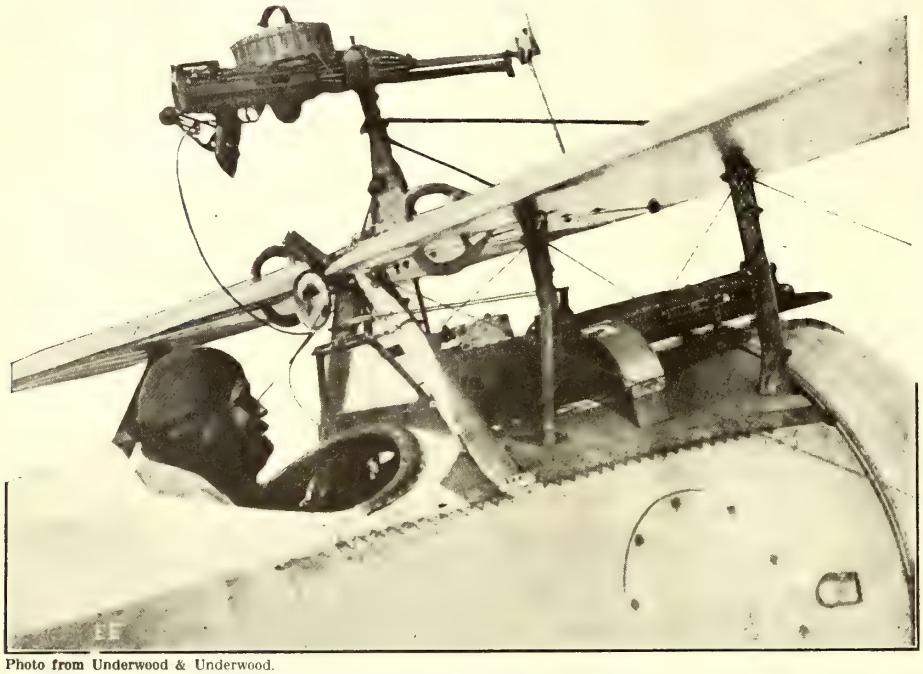


Photo from Underwood & Underwood.

The Machine Gun In This French Aeroplane Is Fired by Means of An Electro-Magnet Controlled From the Aviator's Seat. Great Rapidity of Fire Is Thus Obtainable, As Well As Increased Accuracy.

The little French Nieuport "scout" plane is a great fighting machine and is equipt with an electric rapid fire gun which is worked from the pilot seat by a special switch. The machine is furnisht with all the latest apparatus evolved from three years of intensive air fighting.

With the Nieuport, French airmen have repeatedly shown the German birdmen that there is not room for two brands of fighting men in the air and the Germans have acquired the knack of being "dropt."

THE GREATEST ELECTRIC KITCHEN IN THE WORLD.

By Frank C. Perkins.

THE electrical connections and the general design of the electric cooking, roasting and baking equipment of the largest electric kitchen in the world, in operation at Siemensstadt near Berlin, Germany, may be noted in the accompanying illustration. This remarkable electric kitchen has a capacity for serving three thousand persons in four groups of from seven to eight hundred workmen in each group between the hours of 12 noon and 2 P. M., one-half hour being allowed for each group. The electric cooking installation was decided upon after a careful study of the use of gas, coal and steam cooking in the various plants of the Siemens Schukert Werke, in other cities and other suburbs of Berlin, where the office forces as well as the workmen have been served with meals for a number of years during the noon hour.

This new electric kitchen is the most thoroly equipt kitchen cooking installment in the world, as well as the largest, being provided with a modern cold storage and refrigerating plant operated by electric compressors, electrically driven kitchen utensils of every description, including coffee grinders, knife sharpeners and meat slicers, and vegetable cutters, as well as electric potato paring and slicing machines. The electric cooking apparatus includes novel designed soup kettles and boiling vessels, varying from fifty liters capacity to four hundred liters. These kettles shown in the accompanying photograph have insulating shells for retaining the heat, as well as a clever system of utilizing oil, electrically heated, between the casings, similar to the system of double boilers ordinarily using water for cereal cooking.

It may be stated that these oil-heated vessels have the electric heating element in the bottom arranged with two and three sets of windings providing for twelve kilowatts, twenty-four kilowatts and thirty-six kilowatts as desired. The roasting and baking equipment are of special interest, and may be noted in the background in the accompanying photographs. The baking ovens require a current of eight kilowatts and measure three thousand four hundred millimeters long, one meter wide and one thousand two hundred and fifty millimeters high. The electric broilers are mounted on three tables and measure four hundred mm. by six hundred mm., with a depth of sixty-five mm., each requiring seven kilowatts. The capacity of these broilers is two hundred cutlets per hour, while the total capacity of this kitchen is three hundred portions for each noon-day meal.

The electric coffee vessels have a capacity of five hundred liters and vary in size from seventy-five liters, capable of serving three hundred cups of coffee, to one hundred fifty liters having a capacity of seven hundred cups of coffee per hour. The smaller coffee pots of seventy-five liters require twelve kilowatts, while the larger ones use eighteen kilowatts. The hot water is supplied from electrically heated vessels at three temperatures automatically controlled to forty degrees Celsius, sixty degrees Celsius and one hundred degrees Celsius. The electric water heating boilers vary in size from 1.5 cubic meters to 6.5 cubic meters and the kitchen is equipt with a great variety of other cooking utensils.

The electric dishwashing apparatus is most complete, with electrically operated pumps for circulating the water thru the dishwashing machine, electric conveyors and electric drying oven. It will be seen that the kitchen is well ventilated with electric fans mounted in the wall and window casings conveying the fumes from cooking outside the building.

The cost of electric cooking in this installation is said to be extremely low, not exceeding 2.15 pfennig (1/2 cent) per capita per day, including the total current consumption for all purposes, while for cooking alone the cost does not exceed 1.53 pfennig (1/3 cent) per capita per day.



Remarkable Electric Kitchen In Operation at Siemensstadt, Germany, With a Capacity of 3,000 Persons. The Food Is Prepared by Electrical Machines Besides Being Cooked by This Agency.

PARIS RESIDENT RECEIVES INCOME BY RADIO.

Mrs. Elizabeth K. Baker, of Paris, a daughter of Commodore Norman W. Kittson, is receiving the income from a $175,000 trust fund by wireless because of the war situation.

Electric "Zig-zagger" Aids Ships to Foil U-Boats

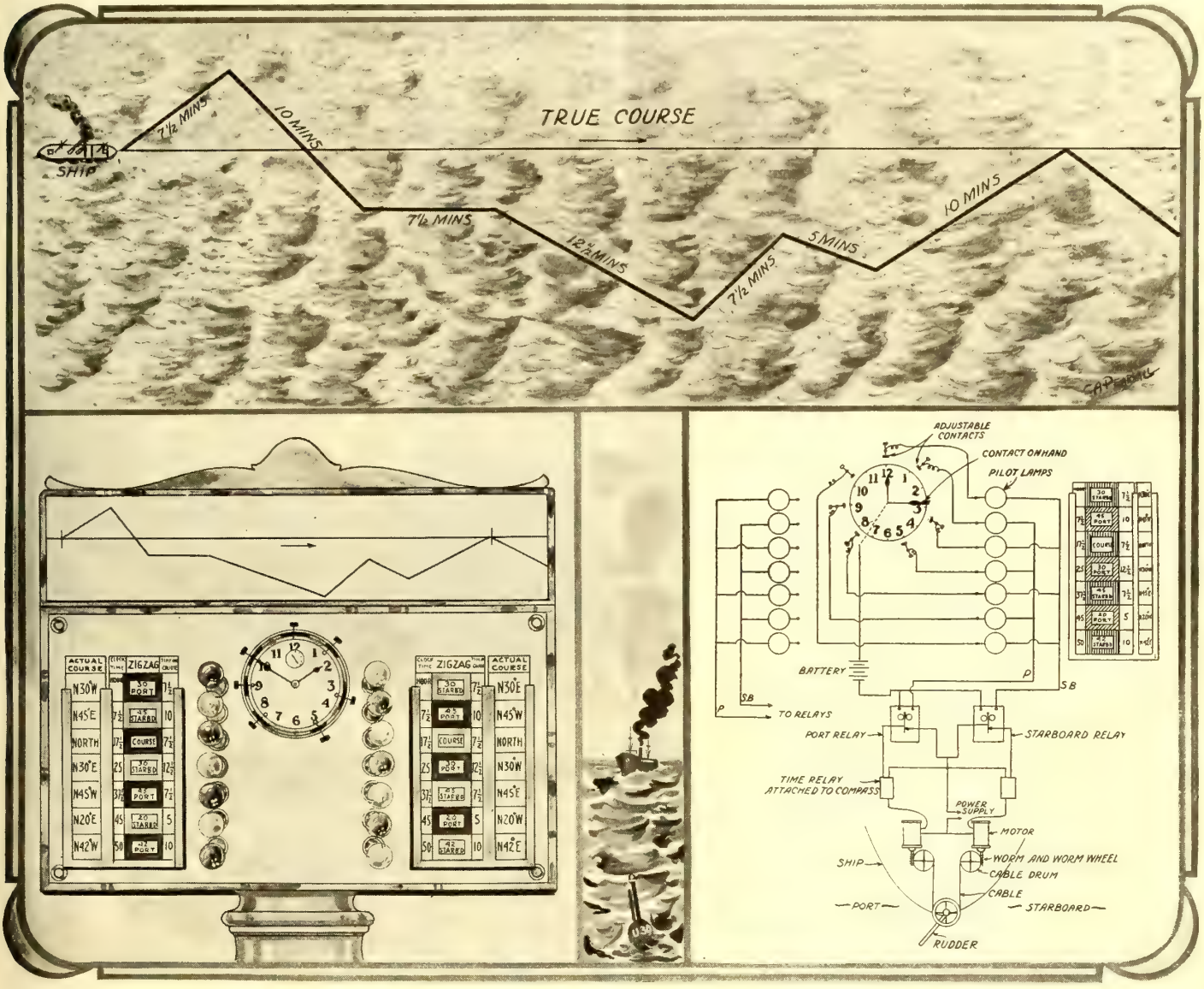
ACTUAL experience in the latest game—"dodging the submarines"—has proved the efficacy of putting a ship over a zig-zag course once a hostile U-boat has been encountered. It has been recommended by marine experts that cargo vessels, whether armed or unarmed, pursue a zig-zag course or better still, a progressive series of such courses. But the captain of such craft is not over fond of following such a procedure ordinarily and would much rather take a chance on "beating it" along a straight course. Also, he is apt to argue, "why should I follow a zig-zag course, which is several miles longer than a straight one, and allow the submersible time to catch up to me?" Again, zig-zagging is rather a nuisance anyway, and liable to get the ship's "log" all out of sorts; unless such courses are accurately sailed there is a chance that the ship's true position will be misjudged.

When all is said and done, however, zig-zagging has a protective value which it did not have before merchant ships were armed. Now that the tramp is apt to carry a rapid-fire gun of from three- to six-inch caliber, the U-boat, once it has come within the effective range of the gun, must stay below. The U-boat commander prefers to get within one thousand yards of a ship before he attacks, and, if he can make it, he will get within five to seven hundred yards. The preferred position for attack is about two points forward of the beam. On sighting an approaching ship, the submarine heads to intercept her course, submerges, and then takes an occasional look at her, bringing its periscope above water for a few seconds only. *The U-boat commander estimates the speed and course of the ship; submerges, and lays his own course by compass while below, so as to bring his boat within torpedo range at a point, preferably forward of the beam.*

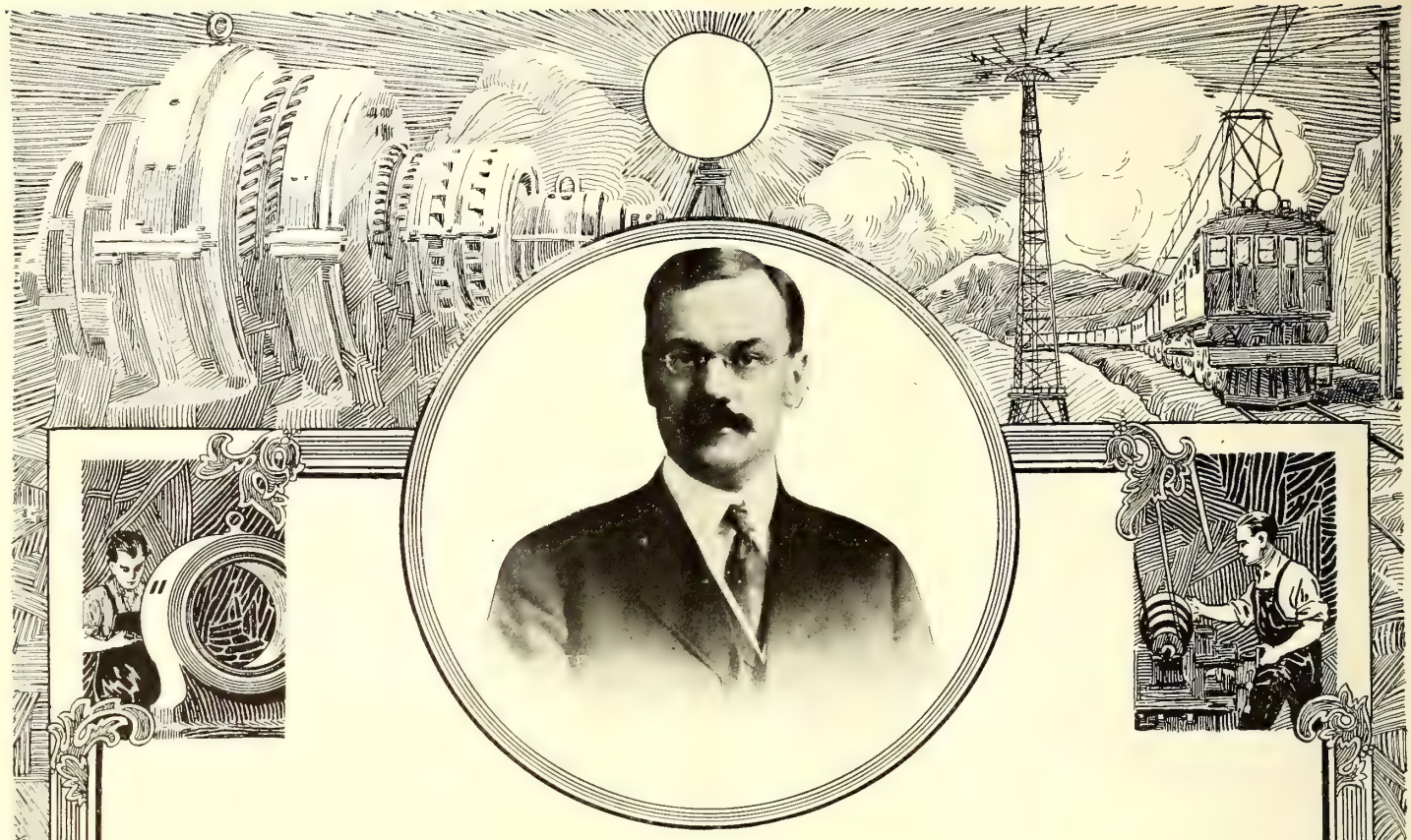
Now consider that while the submarine is below, the merchant ship changes her course, say thru an angle of 45 degrees, the former, on coming up for a few seconds' look at the ship, finds that, instead of converging to meet him, the merchant ship is sailing in a direction *entirely different* from that on which his calculations were based; his maneuver for getting into firing position goes for nothing, and he has to try again. Unless he is satisfied that his guns can greatly outrange the enemy, the U-boat commander does not dare to use his surface speed, and below the surface he has not sufficient speed to overhaul the merchant ship. One or two misjudgments of this kind will lose so much time, that the ship will have a good chance to pass him and steam beyond torpedo range; indeed, it will soon have gained a lead which the U-boat cannot overcome, except by coming up and using his surface speed.

So we come back once more to the zig-zag course problem. Not only is more distance covered, but the navigating officer may forget to make the change of course from one leg to the next at the proper time, and so throw the whole zig-zag into such confusion that the ship will not know where she is with regard to her true course. To circumnavigate this, and with a view to making the running of the zig-zag course popular with ship captains,

(*Continued on page* 414)



Instead of Relying Entirely on the Human Factor in "Zig-Zagging" the Course of a Ship Attacked by a Submarine, the Automatic Electrical "Course Zig-Zagger" Here Shown Is Proposed. Electric Motors Swing the Rudder to Port or Starboard As the Case May Be, These Course Changes Being Made Automatically by a Special Electric Clock Switch.



The Training of the Young Man in Industry

By E. M. Herr, President of the Westinghouse Electric & Mfg. Co.

Written exclusively for the "Electrical Experimenter"

SUCCESS in the electrical industry is attained just as is success in any other industry, primarily by the development of general character and trustworthiness followed by mastery of the details of the particular branch of the industry in which the young man is engaged.

The men who do great deeds are those who have been again and again tried in stress and strain of hardships and difficulties, perhaps in an entirely inconspicuous way, but who have worked thru, never shirking, and have willingly taken up greater and greater burdens as they came to their hands, being most concerned not with the immediate rewards to be gained but with the feeling that progress was being made in the work entrusted to them and that they had succeeded in their immediate task with the result that their character, knowledge, training and, more important still, their courage and tenacity were strengthened for overcoming still greater difficulties and bearing more and larger responsibilities.

Great knowledge and learning will not alone suffice for attainment of success in the industrial world, for if they would, we would see the great scholars bearing the greatest responsibilities. History shows us that its greatest men were generally not men possest of unusual learning, or, if they were, other great qualities of mind and character were present to an even more remarkable extent.

Experience and a broad contact with affairs is not all that is required, for many men of widest experience and who have been in touch with world-wide affairs are ineffective and frequently unable to assume great responsibilities depending on their own efforts and initiative.

Much good effort is often wasted and many a valuable man fails to make good because, to use the old familiar phrase, he is "a round peg in a square hole"—by persevering, possibly, in a most admirable manner, in a position for which he is unfit; whereas, were he placed in a position to which his talents were better suited, his entire source of energy would be devoted to an attainment of a high degree of perfection.

The gradual assumption of more and more difficult work with its attendant troubles, and the successful solution of them by his own efforts all tend to the development of the successful man.

A young man should perform his daily task for the satisfaction of its accomplishment rather than the expectation of an immediate reward. A reward, and a rich one, will surely come to him who can and does excel his fellow in doing things, no matter how burdensome or onerous, provided they are worthy, and especially if such excellence is in work or methods more difficult than is usually encountered. The reward may not come when expected—it may even be delayed until the worker feels great discouragement and can see no prospect of the recognition and reward he has justly earned.

Experience, however, shows that reward for unusual and successful efforts must come and if deferred, as it often is by uncontrollable circumstances, it will ultimately be paid with interest well compounded.

The Westinghouse Electric & Manufacturing Co. employs at the present time approximately 25,000 people. The capital stock is $75,000,000. The gross sales for last year were approximately $90,000,000 and will be considerably in excess of that this year. The plants occupy approximately 100 acres of floor space. The company controls several thousand patents.

WHERE ELECTRICITY CAN BE USED ON THE FARM.

Farmers are constantly hearing of the advantages of electricity on the farm, what it will do for them and its wide application. Some of this has been rather vague and *The Society for Electrical Development* has prepared a list of some 104 applications appended here.

Of course, every farm will not find it economical to install all the equipment listed, but every farm will find profitable use for some of it. Many of the applications can be handled best by a community of interests, for instance, electric threshing and harvesting machinery, hulling machinery, oil concentrating plants, hay balers, etc. High priced machinery used only for short periods during the year is applicable to this community treatment.

Oat Crushers
Alfalfa Mills
Horse Groomers
Horse Clippers
Hay Cutters
Clover Cutters
Corn Shellers
Ensilage Cutters
Corn Crackers
Branding Irons
Currying Machines
Feed Grinders
Failing Machines
Livestock Food Warmers
Sheep Shears
Threshers
Grain Graders
Root Cutters
Bone Grinders
Hay Hoists
Clover Hullers
Rice Threshers
Pea and Bean Hullers
Gas-Electric Harvesters
Hay Balers
Portable Motors for Running Threshers
Fanning Mills
Grain Elevators
Huskers and Shredders
Grain Drying Machines
Binder Motors
Wheat and Corn Grinders
Milking Machines
Sterlizing Milk
Refrigeration
Churns
Cream Separators
Butter Workers
Butter Cutting-Printing
Milk Cooling and Circulating Pumps
Milk Clarifiers
Cream Ripeners
Milk Mixers
Butter Tampers
Milk Shakers
Curd Grinders
Cassin Grinders
Pasteurizers
Bottle Cleaners
Bottle Fillers
Concrete Mixers
Cider Mills
Cider Presses
Spraying Machines
Wood Splitters
Auto Trucks
Incubators
Hoovers
Telephones
Electric Bells
Ice Cutters
Fire Alarms
Electric Vehicles
Electro Cultures
Water Supply
Pumping
Water Sterilizers
Fruit Presses
Blasting Magnetos
Lighting
Interior Telephones
Vulcanizers
Pocket Flash Lights
Ice Breakers
Grindstones
Emery Wheels
Woodsaws
Forge Blowers
Drop Hammers
Soldering Irons
Glue Pots
Cord Wood Saws
Egg Testers
Burglar Alarms
Bell Ringing Transformers
Devices for Killing Insects
Machine Tools
Molasses Heaters
Vacuum Cleaners
Portable Lamps to Attract Insects
Toasters
Hot Plates
Grills
Percolators (Coffee)
Irons
Ranges
Toilette Articles
Water Heaters
Fans
Egg Boilers
Heating Pads
Dish Washers
Washing Machines
Curling Irons

X-RAYING RING NEBULAE.

At the last meeting of the British Astronomical Association at Sion College an application of X-rays to obtain by analogy a test of a theory of the structure of "ring" nebulæ was shown by Mr. W. H. Steavenson. His idea was that the "ring" appearance did not necessarily imply the shape of a ring, but could be produced by a hollow globular form, the suggestion being that the absence of light in the interior of the "ring" is due to the thinness of the shell, which appears much thicker, and, consequently, brighter, just outside the central portion. X-ray photographs of rubber tubes showed a very similar appearance, rubber globes of sufficient thickness not being available.

"Zig-Zag"—A New Thriller for the Sea Shore

By GEORGE HOLMES

WE ALL enjoy going to the seashore, when the summer comes around each year, and all look for thrills, be they young or old, grown-ups as well as kiddies, it's bound to get us all—this beat-it-from-the-city spirit—to get out in the great outdoors and let loose!

The attraction recently invented by an Eastern man, Mr. Hartman, called the "Zig-Zag," will soon be seen by the crowds at pleasure resorts.

The main part of the device is a large steel tower about a hundred feet high, an object of beauty and awe, especially at night, when hundreds of lamps shall blaze forth over the entire structure. At the top of the tower there will be a large ball of revolving lamps and searchlights to enhance the scene.

The passengers are seated in a small car which is drawn by an endless sprocket chain to the top of the tower. When the car reaches the top it is automatically released and begins its descent from the top of the tower with a zig-zag motion, from which the attraction derives its name.

The cars after leaving the top descend by gravity, traveling over a series of inclined rails which are arranged one pair above the other in a vertical zig-zag line in such a manner, that the traveling seats are brought to a stop at the lower ends of each pair of parallel running rails, drop a certain predetermined distance upon the next lower pair of rails and then travel along such rails in the opposite direction downward, until they reach in a zig-zag line the lowest pair of rails. A further swinging movement is obtained at the sudden temporary stops by the living force of the traveling suspended seats.

A close inspection of the illustration will give the reader a good conception of how the mechanism works.

Mr. Hartman does not state how the passenger's "inside mechanism" works during the trip, but we presume people will like it.



The Latest Electrically Operated Thriller for Pleasure Resorts Is Known as the "Zig-Zag." The Passengers Are Hauled to the Top of the Tower by a Motor-driven Cable. They Then Start Their Ziz-Zag Downward Journey by Gravity.

DATE OF ISSUE.—*As many of our readers have recently become unduly agitated as to when they could obtain* THE ELECTRICAL EXPERIMENTER, *we wish to state that the newsstands have the journal on sale between the fifteenth and the eighteenth of the month in the eastern part of the United States and about the twentieth of the month west of the Mississippi River. Our subscribers should be in possession of their copies at these dates. Kindly bear in mind, however, that publications are not handled with the same dispatch by the Post Office as a letter. For this reason delays are frequent, therefore kindly be patient and do not send us complaints as to non-arrival of your copy before the twenty-fifth of the month.*

Firing Bombs by Electricity

By H. Gernsback

MODERN bombs as used in trench warfare are divided in two classes, namely: the "time-fuse" bomb, and the "contact" bomb. The former, which at the beginning of the war was a rather crude affair, has now been greatly improved upon, and as a rule will go off five seconds after its release. This type has a kind of trigger which is presst against the body of the bomb; thus when the latter is released it will take the trigger just five seconds to ignite and consequently explode the bomb.

The second bomb, as its name implies, goes off the moment it strikes a hard body, showering destruction all about it. For trench warfare, bombs are highly effective, and if the enemy's trenches are "bombed" in a systematic manner, the men as a rule become very much demoralized.

Bombs vary in size from the small hand bomb, the size of a baseball and containing from six to ten ounces of high explosive, to the large cylinder-shaped affair containing as much as thirty pounds of Trinitro-Toluol. The latter kind of course cannot be thrown by hand on account of their weight, but are projected thru the air either by a modern spring operated catapult or by a mortar-type *"Minenwerfer,"* first brought out by the Germans.

The chief trouble with the old time fuse type, to quote Captain Ian Hay Beith, is that if the bomb is thrown too soon "the other fellow has plenty of time to pick it up, and throw it back to the sender," incidentally killing him. On the other hand, "if you hold it too long, you jeopardize your own chances of being able to throw it at all."

As mentioned, this refers to the old timers, lit by a match or a cigarette, and does not hold true for the modern type, timed to go off in five seconds.

But the trouble with the modern type is that it is impossible to make it go off the moment it enters the enemy's trench; it either explodes a few seconds too soon or a few seconds too late. In the former case the bomb does not do much harm, but merely sprinkles the trench with steel fragments. In the latter case the men in the trenches find time to run for cover; *i. e.,* dodging the bomb. In both cases not very much harm is done. It is on record that it takes almost *thirty bombs to kill one man!* This certainly is low efficiency. Also not all bombs go off, this being particularly the case with contact bombs; if the latter hit a soft body, such as straw or mud, they often fail to explode. Hence the great waste and low efficiency of the present bombs.

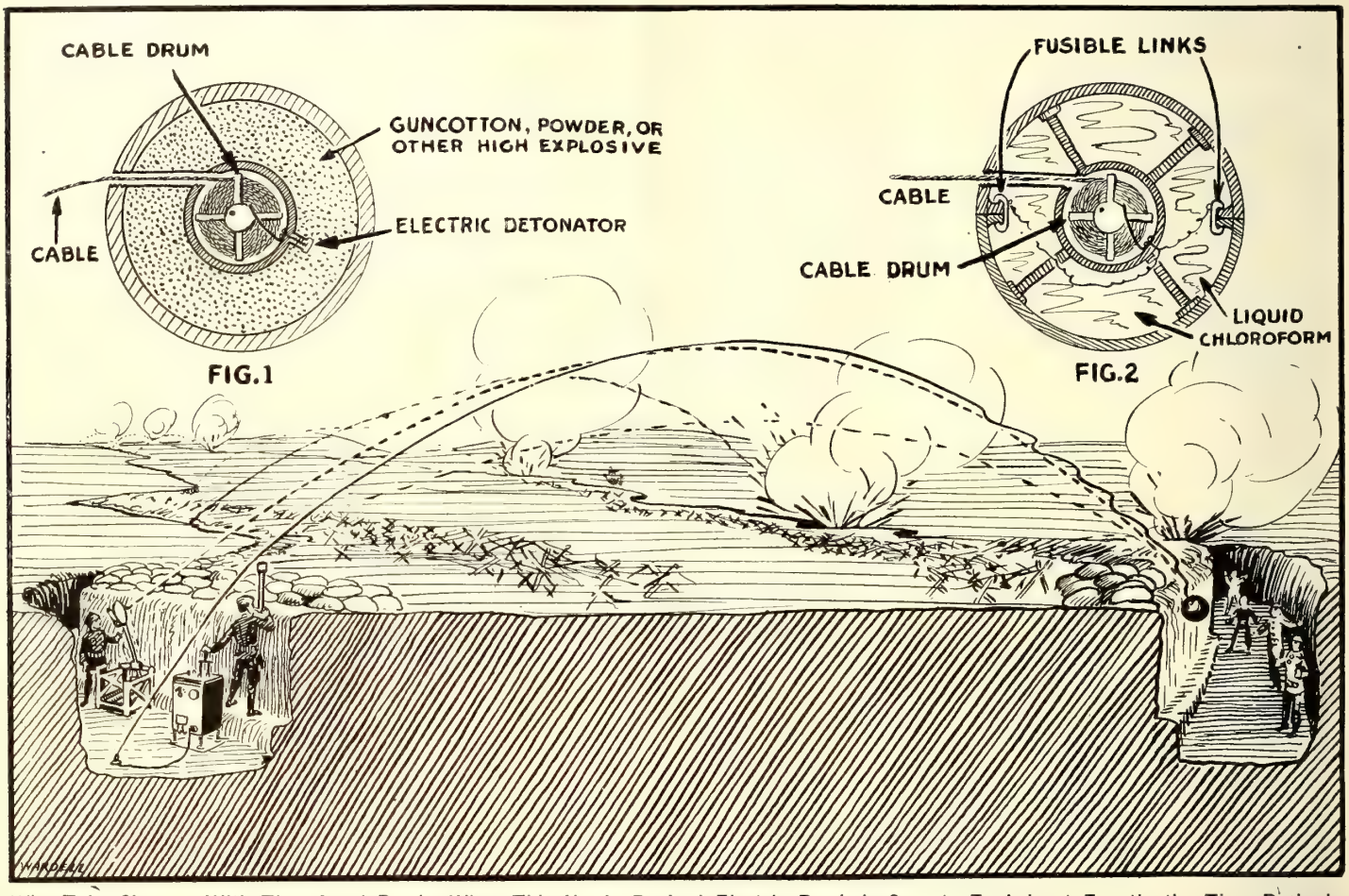
With a view to rectifying several of these defects, as well as gaining certain new important improvements, the electrically fired bomb is suggested. At first blush the idea of putting a "string" on a bomb seems foolish, awkward, as well as troublesome. But if we study the idea, it will be found that the new improvements probably greatly overbalance the imaginary defects, if such there are.

Our front cover illustrates the idea graphically. We have a bomb weighing from five pounds upward, to be thrown in the enemy's trench precisely as any other bomb. It can be thrown by means of catapult or other suitable means. The construction of the bomb is shown in Fig. 1. It has a hollow center which contains in a shell a reel, upon which is wound a thin flexible electric cable. This reel runs free on ball bearings so as to give a minimum of friction. It will thus be seen that as the bomb proceeds in its flight thru the air, the thin electric wire is played out, without in any way retarding or impeding the flight of the bomb. Naturally, the reel must contain a sufficient wire supply to reach from our own to the enemy's trench.

The space between the shell containing the wire reel and the bomb body proper is packed with the usual high explosive. The ends of the wire cable inside of the bomb are inserted into the explosive; the latter can therefore be set off by means of a fine platinum wire electrically heated to incandescence or by any other well-known firing method.

The electric cable being of rubber insulated stranded wire can be quite thin, there being almost no strain whatsoever on the wire cable. This will be understood after a second's reflection, for mechanically the bomb has nothing to do with the cable. The wire reel having ball bearings simply unwinds as the bomb moves on, therefore there can be no strain beyond the *weight*

(*Continued on page* 416)



Why Take Chances With Time-fused Bombs When This Newly Devised Electric Bomb Is Sure to Explode at Exactly the Time Desired. When the Bomb, Filled With Explosive or Chloroform, Reaches the Desired Point, a Switch Is Closed and the Missile Is Detonated. They Are Thrown With a Catapult In the Manner Illustrated.

"BURNELL R. FORD—SCIENTIST ELECTRICAL WIZARD"

THUS do our friends, the theatrical managers, announce the electrical star of theaterdom—he of the flashing sparks and mastodonic Tesla coils. Mr. Ford is one of the most successful scientific lecturers in the country and is now on a Chautauqua tour.

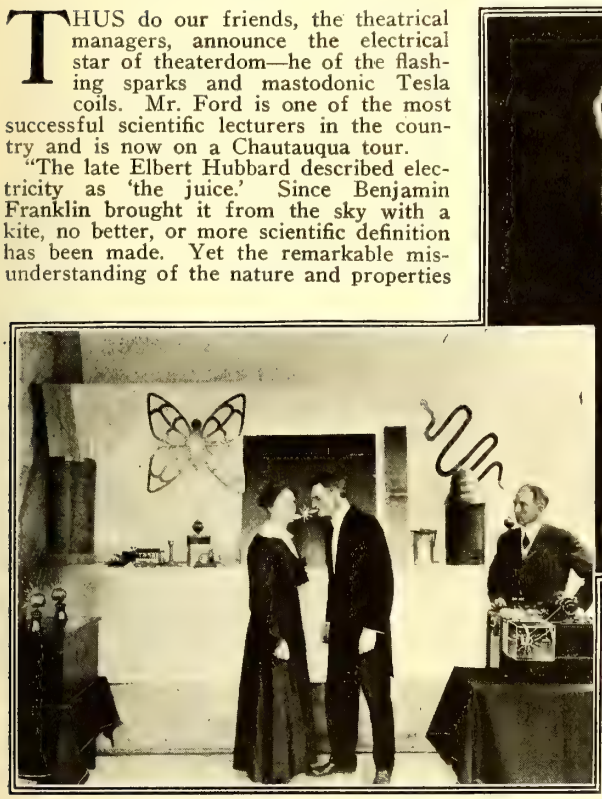
"The late Elbert Hubbard described electricity as 'the juice.' Since Benjamin Franklin brought it from the sky with a kite, no better, or more scientific definition has been made. Yet the remarkable misunderstanding of the nature and properties of electricity seems to be general and permanent. In the entire realm of popular education no one thing can be of more importance than to educate the people on what, to them, are the mysteries of electricity. To do this in a scientific, yet plain and thoroly entertaining way, is no small accomplishment. The management, after much search and many discouragements, has found, in the person of Burnell R. Ford, such a man,"—so reads our program.

One of the startling experiments performed by the lecturer is that of welding by current, which is made to pass thru the human body. Stiff iron wires are solidly welded as shown above, the heavy current flowing from the lecturer's mouth to that of his assistant. The essential thing to be watched in making this experiment is to have metal contact with the mouth (by using a spoon for example) and also to employ a sufficiently high-frequency Tesla current. Such a current, oscillating at say 100,000 cycles per second, will exert no muscular effects and simply passes over the skin of the lecturer.

The interesting effect shown in the center top photograph, is attained by cutting out a cardboard figure and covering it with tinfoil. This may be laid on a photographic plate and charged for a second with a high-frequency electrode. If desired a larger figure may be cut out of thin wood and coated with tinfoil. When this is exhibited against a dead-black background and properly excited by connection to a powerful Oudin or Tesla high-frequency coil the effect on the audience is truly remarkable. The foil-covered figure should be charged, preferably from the live terminal of an Oudin coil.

The right top view shows a mystify-

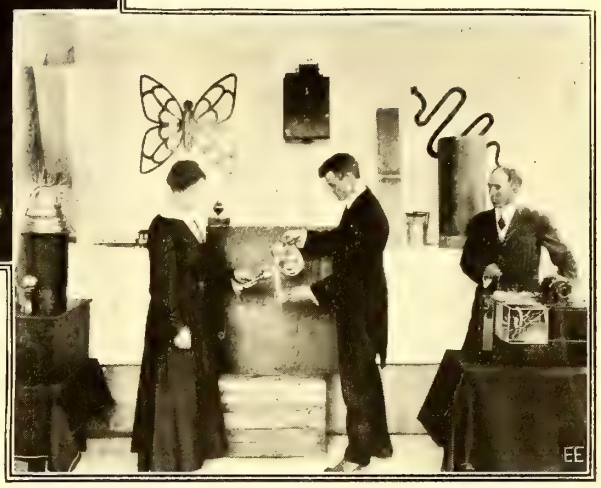
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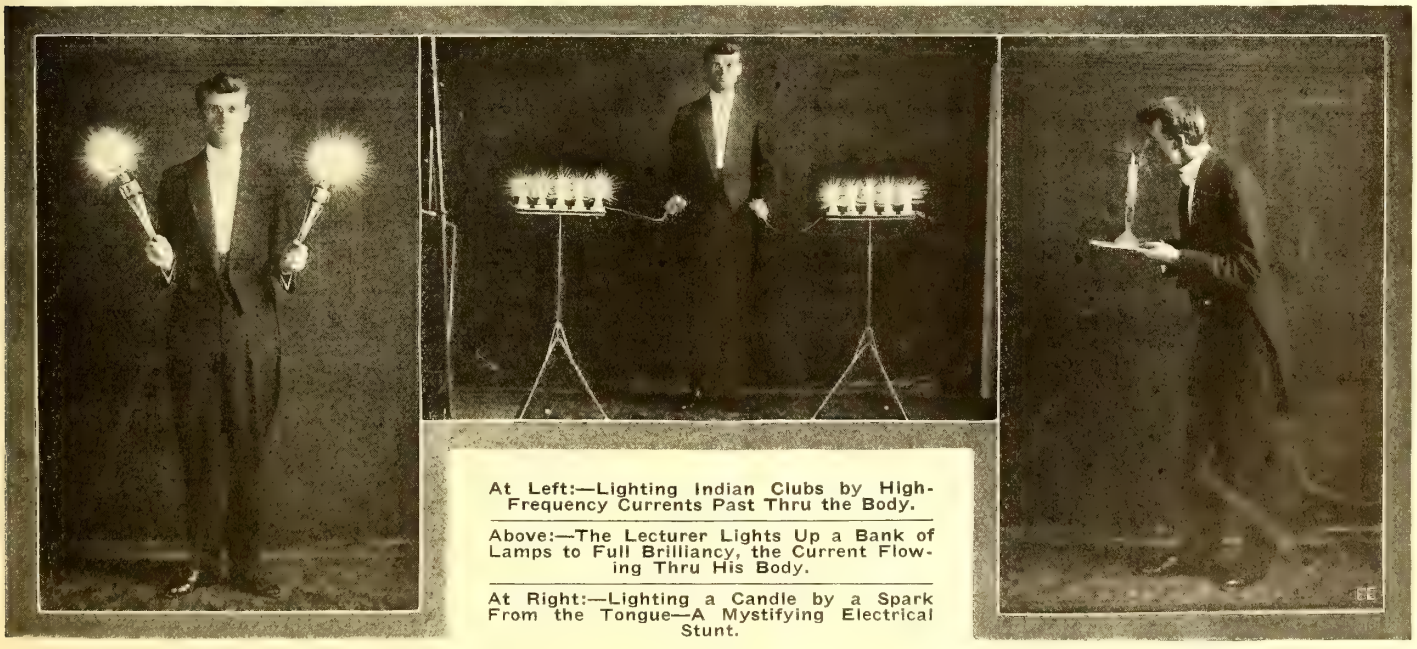
Here Is Shown a Remarkable Demonstration of Electrical Welding Thru Two Human Bodies. Stiff Iron Wires Are Forever Welded, the Current Flowing From the Lecturer to An Assistant. Capable of the Simplest Explanation, This Experiment Is Nevertheless An Awe-Inspiring One.



The Electric "Boogieman" Is Made By Cutting Out a Cardboard Figure of the Desired Shape. When Coated With Tinfoil and Charged by One Terminal of An Oudin Coil This Is What You See.



The Photograph Shows the Lighting of An Ordinary Candle by Means of a Stream of Water. In Connection With This Experiment, the Lecturer Becomes a Human Dynamo, Lighting Arc Lights by Holding the Carbons In His Hands and Handling 3,000,000 Volts of Electricity.



At Left:—Lighting Indian Clubs by High-Frequency Currents Past Thru the Body.

Above:—The Lecturer Lights Up a Bank of Lamps to Full Brilliancy, the Current Flowing Thru His Body.

At Right:—Lighting a Candle by a Spark From the Tongue—A Mystifying Electrical Stunt.

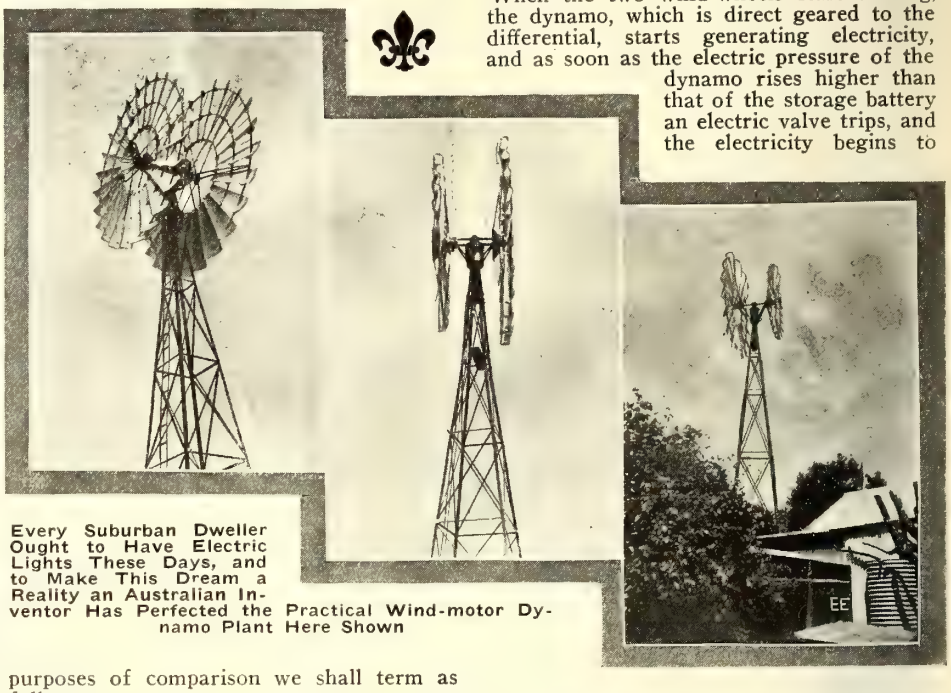
Free Electricity from the Wind

By H. WINFIELD SECOR

WIND pressure as a natural source of power has been in practical use for driving grist mills and pumps for the last six hundred years. The efficiency and utility of the wind-motor has increased along with the development of modern manufacture until the all-steel wind-motor of to-day is a highly efficient machine, giving more power for every dollar of capital invested than either steam, gas, or waterfall. The great drawback to the development and general use of wind power has been the intermittent character of the power. Attempts have been made in the past to generate electricity with wind power and store the electricity for lighting purposes. Theoretically, this combination should be perfect, but many difficulties have been experienced by those who have tried to put this combination into practise. The low speed of the wind-wheels made it difficult to get a satisfactory transmission of power from the wind-wheel to the dynamo. To operate at high efficiency the wind wheel had to run slow and the dynamo at high speed, thus introducing a dangerous element in the way of high speed gearing.

In the new type wind motor plant here illustrated this difficulty is claimed to have been overcome. A special slow-speed dynamo has been designed to couple direct on to the driving axles of the wind-wheels, and a strong gear of simple design connects them together.

The inventor, Mr. M. A. Mulrony, of Australia, has designed two sizes of rural lighting outfits of this type, and which for purposes of comparison we shall term as follows:



Every Suburban Dweller Ought to Have Electric Lights These Days, and to Make This Dream a Reality an Australian Inventor Has Perfected the Practical Wind-motor Dynamo Plant Here Shown

The small plant with a capacity for lighting fifteen 16-candle power lights for a period of four hours per day, and a storage capacity to operate fifteen 16-candle power lights for six days without any wind at all.

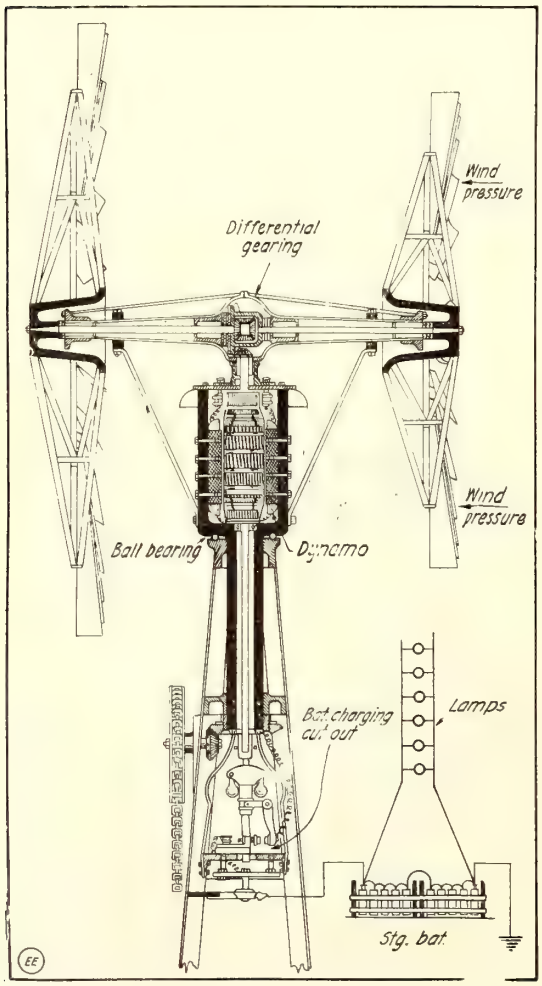
The large plant has the same specification as the small plant except that it has a capacity to light twenty-five 16-candle power lights per day.

The electricity may be used to operate electric fans, electric vacuum cleaners, sewing machine motors, electric pumps, electric toasters, and small electric irons. The inventor has adopted twenty-five volts as standard pressure. The storage battery consists of 14 cells connected in series. This insures easy charging from the dynamo, as there is practically no resistance in the circuit.

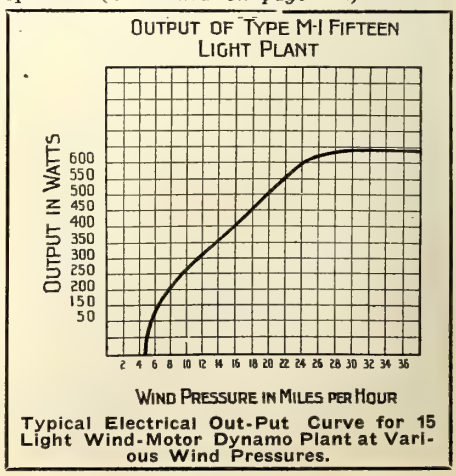
The wind-motor has two wind-wheels as will be observed, one being a little larger than the other. The smaller wheel of the two always faces to the wind, and maintains its position in front of the larger or back wheel. The wind first presses against the vanes of the smaller wheel, and starts this wheel turning in the direction of the hands of a clock. The whole force of the wind, however, is not exhausted on the wheel, but a part of the wind pressure passes thru to the back wheel, and again is turned into rotary motion. The back wheel also turns in the same direction as the hands of a clock. The two wheels are on separated axles, but are coupled together by a *differential gearing* in similar fashion to the back axle of a motor car. This differential allows each wheel to rotate practically as if it had no connection with the other, and in this way brings about an excellent equalizing effect and a balance of power. The two wheels work together, like two horses, in pulling along their common load—the dynamo. When the two wind-wheels start turning, the dynamo, which is direct geared to the differential, starts generating electricity, and as soon as the electric pressure of the dynamo rises higher than that of the storage battery an electric valve trips, and the electricity begins to pour into the storage battery, and continues to do so until the wind pressure fails. When this happens the electric valve immediately trips and disconnects the wire carrying the current, thus preventing the electricity from escaping back thru the dynamo. The above operation can be likened to an ordinary windmill driving a pump, and pumping water from a well into a tank. When the wind fails the valve in the pump closes, and prevents the water from the tank running back into the well.

The operation of this plant is claimed to be absolutely automatic, and a hand is not needed near it for six months at a time. In high winds and low winds alike, all adjustments as to wind direction, speed, turning out of the wind, etc., are made automatically. The application of the gyroscopic principle ensures that the mechanical operation is automatic.

The dynamo is a special and original design, and forms the supporting base for the wind-motor unit. The armature is of peculiar shape, being much longer for its diameter than usual. This feature gives the dynamo its remarkable characteristic of generating electricity at exceptionally slow speed. (*Continued on page* 422)



Sectional View of Newly Perfected Wind-Motor and Dynamo Unit. The Storage Battery Keeps the Voltage Even. The Plant Stands Any Wind Pressure.



Typical Electrical Out-Put Curve for 15 Light Wind-Motor Dynamo Plant at Various Wind Pressures.

New Electro-Therapeutic Apparatus

By H. ROSENTHAL

X-Ray

At the convention of the American Medical Association held at the Hotel Astor in June at New York City, the exhibit of electric apparatus showed many interesting new developments, particularly those to be used

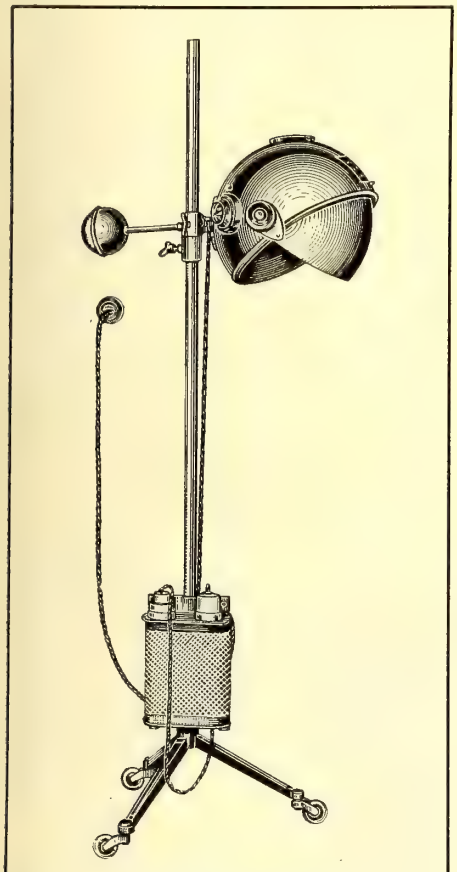


Fig. 4. A New Quartz Mercury Arc Lamp For Treating Skin Diseases.

in connection with hospitals and field hospitals at the front.

One very ingenious X-ray equipment consisted of a portable table for laying the patient upon to be X-rayed; the outfit also included a small gasoline engine generating set, a closed core transformer, this transformer being used in connection with a regulating device to operate a new type of X-ray tube. This tube, about four inches in diameter (see illustration, Fig. 1), had an *anode* terminal of solid tungsten metal supported on a rod of molybdenum and a *cathode* consisting of a tungsten spiral, which was heated electrically from a low voltage circuit from the primary of the transformer. The X-ray tube suppresses any current in the direction that does not make the hot filament cathode. It therefore is capable of rectifying its own current. In order to make the conditions stable a large set of air cooled ventilating vanes are made part of the anode of the tube.

The gasoline engine unit which operates the transformer is so designed with an electrically controlled solenoid that it can be placed some distance from a base hospital or tent, thus eliminating the unpleasant noise. The entire equipment is so arranged as to be portable for immediate transportation.

X-Ray Accessories

Some of the newer developments in the accessories to be used in connection with X-ray work include the Hydrex tube, Fig. 2. This tube operates on the principle of having an auxiliary chamber filled with hydrogen and sealed from the top by a mechanically operated mercury valve. This valve is opened by drawing the mercury past two porous blocks, thereby leaving a passage for a certain amount of hydrogen to enter the tube. To open the valve a small suction pump is provided and is clamped directly on to the glass bowl, or any other convenient place, so the rubber tube can be attached to the hydrogen chamber. To lower the vacuum the plunger is pulled out to its full length and released immediately. To raise the vacuum all that is necessary is to disconnect the anode and connect it to cathode and run a weak current thru the tube.

Very elaborate tables of new development were shown for laying the patient upon and so equipt as to be used either for examination with a fluoroscope or to be used directly in taking X-ray plates.

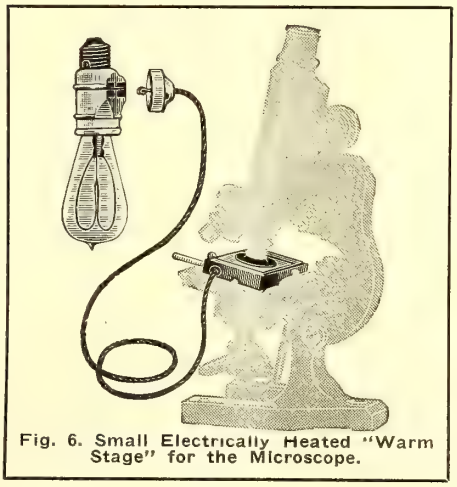


Fig. 6. Small Electrically Heated "Warm Stage" for the Microscope.

One type of table was so nicely counterbalanced that very little effort was needed to obtain almost any position an operator would wish. It was also arranged with a small motor, foot controlled, which would raise the table or lower it in an angular position, according to the will of the operator.

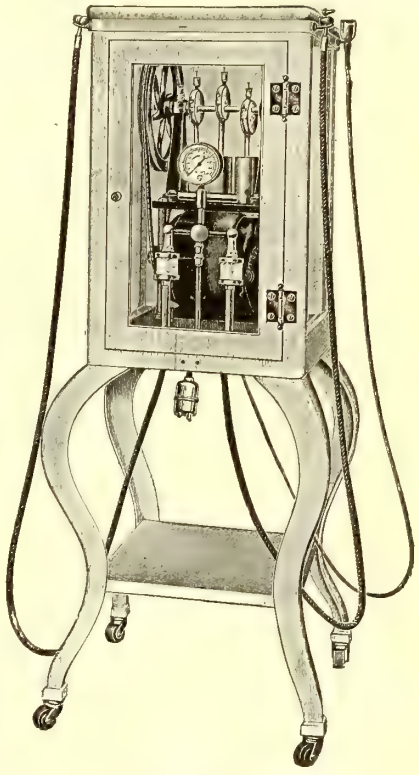


Fig. 5. A Recent Type of Anesthetizing Apparatus, Driven by a Small Electric Motor.

Another type of table was fitted with accessories necessary for making charts of the heart and lungs, these charts or tracings being made directly by examining the patient with a fluoroscope and by means of an automatic device.

A duplicate of the X-ray equipment supplied to the N. Y. Bellevue Hospital was also shown, being the largest X-ray plant in the United States.

(*Continued on page* 421)

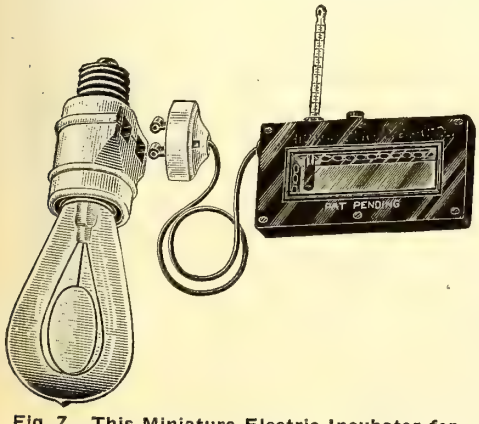
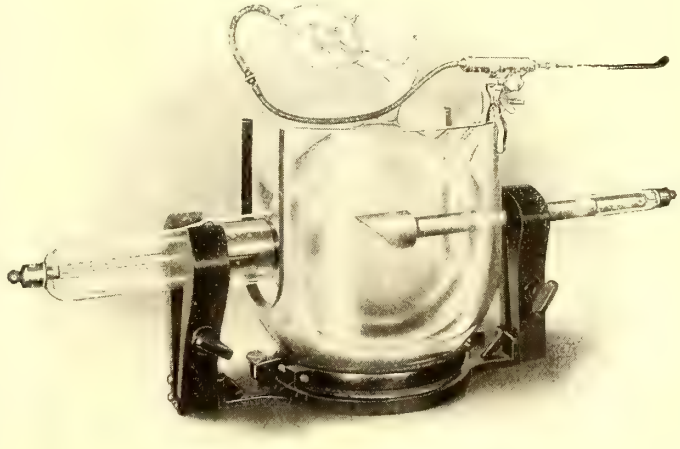


Fig. 7. This Miniature Electric Incubator for Microscope Stages Enables the Physician to Study "Live" Bacteria Organisms.

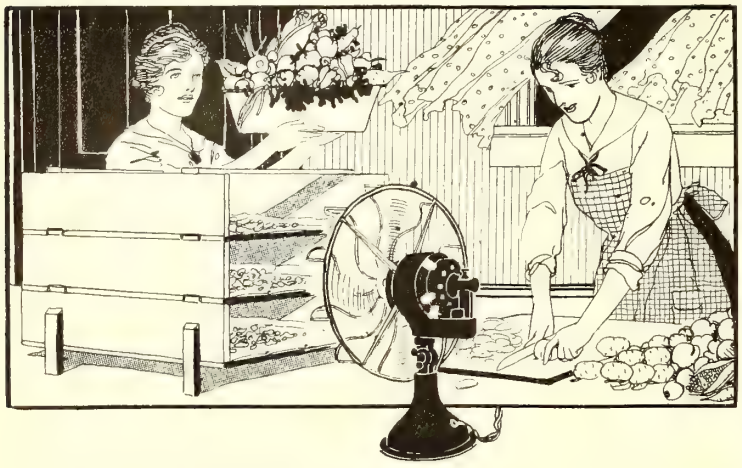


Hydrogen Thru a Mercury Valve. Vacuum Is Adjustable.
Hydrogen Thru a Mercury Valve Vacuum Is Adjustable.

ELECTRIC FAN EXCELLENT FOR DRYING FRUIT.

Cheap living and plenty of it; wide variety; wholesome, clean, nourishing food; prepared quickly with little labor and trouble in your own home—by your own hands!

An electric fan and a kitchen knife are the only "tools" necessary. Drying can be done in home-made box trays, a table top, sheet, strings (apples, pears, etc.), and dozens of other ways. Just like grandmother did, only quicker, cleaner and better tasting!



A New Use for the Electric Fan In Drying Fruit. Another Way In Which to Help Win the War.

The U. S. Department of Agriculture says (Bulletin No. 841): "The fan method has a marked advantage in that the product keeps cool, owing to evaporation while it is being dried, thus tending to retain the color and eliminate spoilage."

Almost all the vegetables and fruits can be treated and stored away—even the most juicy, like tomatoes. And besides—this new way of drying eliminates the biggest part of the work. It does away with a lot of canning—and that's good, for jars and containers are very scarce and mighty high in price.

All summer long, at odd times, the housewife can pick up choice bargains at the markets, prepare them in a few minutes, and the drying goes on while she attends to something else. By cold weather time she can have her home stocked up like a siege fort—for the longest, hardest kind of a cold, long winter.

A THOUSAND AUTOMATIC TELEPHONES ORDERED FOR AUSTRALIA.

Orders aggregating 1,000 lines of automatic central office equipment and 1,000 telephones equipt with the dial, have just been placed to be used as additions to the automatic exchanges in Australia. This is the second such order placed since the beginning of 1917, the first one, for 1,800 lines, being received in February.

The progress of the automatic in Australia has been most rapid. Only five years ago there was a single 1,100-line exchange in operation, at Geelong. Today there are nearly a score of exchanges and a total of practically 35,000 lines of automatic equipment in service thruout the commonwealth. No "central" is required and thus misunderstandings are eliminated.

U. S. TO SPEND $4,000,000 FOR NITRAT PLANT.

Secretary Baker has announced that a plant for the production of nitrats from atmospheric nitrogen would be constructed immediately at a cost of about $4,000,000 and that water power would not be used.

Informally officials explained that the announcement did not mean that the idea of building a water-power nitrat plant had been permanently abandoned, although it would not be pressed at present. Several years would be required to build the enormous plant required for the utilization of water power, and for that reason it was determined that for urgent war purposes it would be necessary to adopt one of other processes of producing nitrats.

HOW TROLLEY MOTORMEN LEARN THEIR DUTIES.

By the time an applicant for the position of motorman or conductor on the Brooklyn Rapid Transit System has past thru their school for employees he has had it brought home to him that a man must have at least the qualifications of good character, a clean record, good health and a presentable appearance before he is even given a trial.

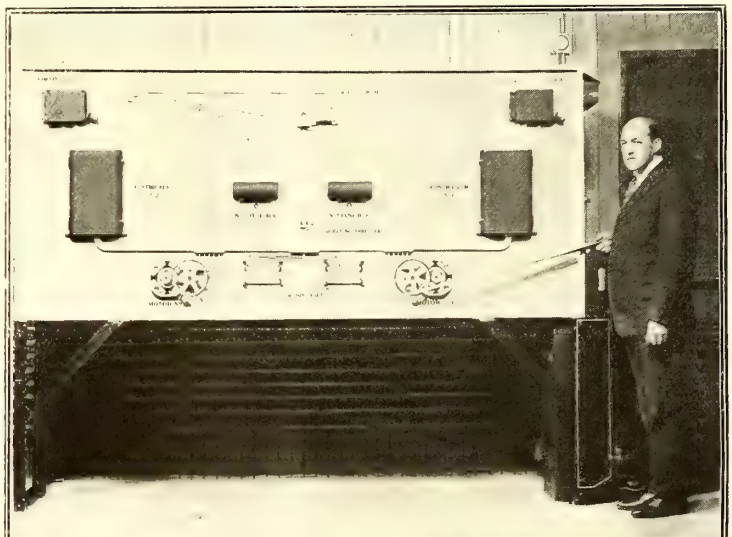
This frame of mind receives a new impulse when the student enters the B. R. T. Surface School Room, for here he finds himself in a place where there is manifestly much to learn—more, perhaps, the average applicant might feel at first glance, than he could ever hope to learn. The intricacy and elaborate detail of the mechanical equipment from which the men receive their instruction, are most impressive; and the entire array of massive and handsome exhibits, while attracting and holding the interest, might seem to defy the layman's understanding.

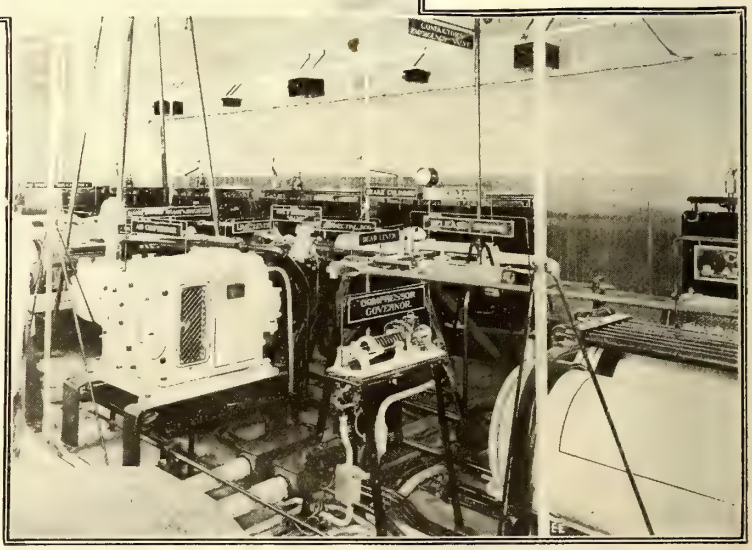
Here spread out before you are the vitals of the trolley car, dissected and labeled. (See accompanying illustrations.) No detail is left in darkness or obscurity. All is revealed. Even the little boy who for years has yearned to crawl under a car to see what it looks like inside would be satisfied. For in very truth he would see one turned upside down, and working just the same in spite of the awkwardness of this position, as a turtle sometimes keeps on working when you turn it over on its back. Be he schoolboy or grown man, any visitor would enjoy a trip around the motormen's room with one of Instructor Duffy's classes.

Emphasis is laid on the regular inspection of his car which a motorman is required to make before going on the road, special attention being called to the life guard, by which about ninety per cent. of persons knocked down by the front of a car have been saved.

Every part of the equipment is in its standard location, many of them bearing metal signs to accustom the men to calling things by their right names. Fare collection, door operation, buzzer signals, thermostat control of heaters, use of switches, replacement of fuses, etc., are also demonstrated. The use of the electric automatic track switch is taught in connection with the center entrance car, switch levers, semaphores and lights all working just as they would in actual service.

Step by step the men in the schoolroom become familiar with the elaborate mechanism that passes into their keeping when hand and controller meet. The "demonstration board," which shows the course of the current and the operation of the control from trolley wire to rail, is a toy which could not fail to fascinate any human being between the ages of six and sixty. When this board has been explained to him the student has a remarkably clear idea of how the electric current operates and how it is controlled.—*Photos courtesy B. R. T. Monthly.*





Two Views of the Brooklyn Rapid Transit Company's School for Motormen. Every Part of a Trolley Car Is Dissected and Demonstrated In Working Condition.

WOMEN AND ELECTRICITY.

When a woman is sulky and will not speak..... *Exciter.*
If she gets too excited..... *Controller.*
If she talks too long..... *Interrupter.*
If her way of thinking is not yours..... *Converter.*
If she is willing to come half way..... *Meter.*
If she will come all the way *Receiver.*
If she wants to go further.. *Conductor.*
If she would go still further *Dispatcher.*
If she wants to be an angel. *Transformer.*
If you think she is unfaithful *Detector.*
If she is unfaithful..... *Lever.*
If she proves your fears are wrong..... *Compensator.*
If she goes up in the air... *Condenser.*
If she wants chocolates.... *Feeder.*
If she sings wrong..... *Tuner.*
If she is in the country..... *Telegrapher.*
If she is a poor cook..... *Discharger.*
If her dress unhooks..... *Connector.*
If she eats too much..... *Reducer.*
If she is wrong..... *Rectifier.*
If she is cold to you..... *Heater.*
If she gossips too much.... *Regulator.*
If she fumes and sputters... *Insulator.*
If she becomes upset..... *Reverser.*

AUTO SCHOOL HAS ELECTRIC DYNAMOMETER.

One of the leading auto schools of the west has installed in its testing laboratory the modern electric dynamometer here illustrated. The students are thus enabled to make very accurate tests on any type of gasoline engine with regard to the horse-power output and other characteristics. The electric dynamometer represents the highest form of prime mover testing device available to-day. The dynamo unit is movably swung in substantial pedestal bearings as shown, the turning effort of the engine connected to it for test being indicated on suitable scales and electrical indicating instruments.

Aeroplane engines are now tested by a similar apparatus. No guess work enters the tests as carried out with the dynamometer, the results being accurate to within a fraction of a per cent. There will be a very large demand for engine drivers and experts this Fall.

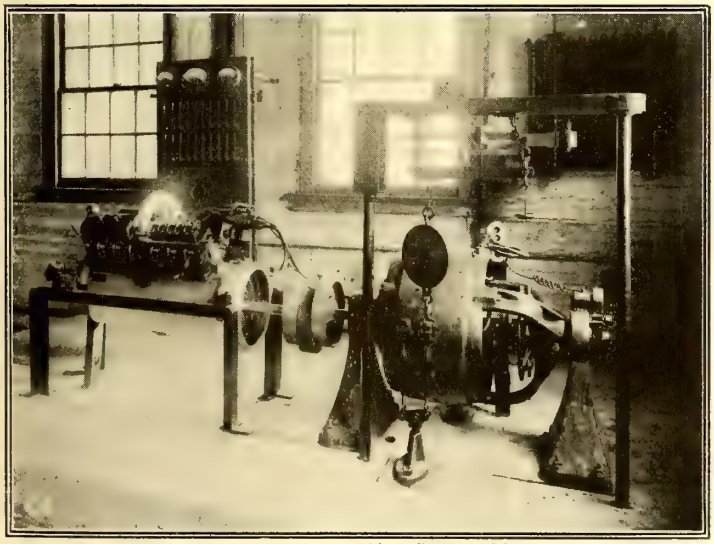


Photo Courtesy of Michigan State Auto School.

The Electric Dynamometer In Use for Testing Horse-power of Gasoline Engine In the Laboratory of Progressive Western Auto School.

TELEGRAPHER LIFTS OVER 20 TONS PER NIGHT.

J. H. Johnson, an Associated Press operator in Boston, while working at Manchester, N. H., a year ago, devised an ingenious method of determining the amount of work performed by him in one night, exprest in mechanical terms says *Telegraph and Telephone Age*. By rigging up a postal scale in a special manner he found it required a pressure of ten ounces on the typewriter keys to print each letter, and in the course of a night, with an average report of 14,000 words, allowing five letters to a word, the total pressure exerted would lift 700,000 ounces, or 21¼ tons.

This computation was the result of a discussion which arose in the office of the Manchester paper as to which man on the paper worked the hardest.

The award was made to another man, but Mr. Johnson, not being satisfied with it, made the investigation of his own work on his own account, with the result that he was declared to be the hardest worker in the office. And yet they do say truck drivers are the only men that do real work!

WIRELESS PLOT IN ARGENTINA.

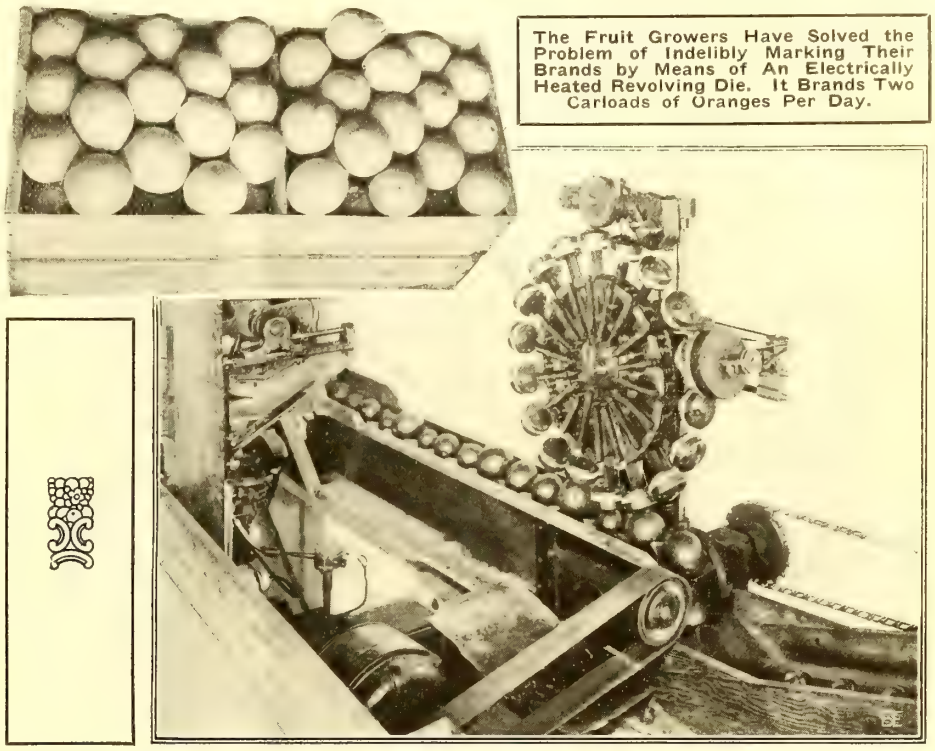
A secret wireless station has been discovered on the coast of the territory of Chubut by the Argentine Navy Department.

The authorities believe the station was to be used in communicating with suspicious vessels.

BRANDING ORANGES BY ELECTRICITY.

By Harold J. Wood.

ONE of the newest wrinkles under the sun is the idea of branding oranges, lemons and apples to protect them from the unscrupulous methods of fruit-stand men in many parts of the country. L. Ahlberg, an Alaskan, has invented a machine which brands fruit by electricity. The California Fruit Growers Exchange has bought an option on the exclusive rights for the use of the machine in connection with shipments of "Sunkist" citrus fruits to all parts of the United States, Canada, England and Ausralia.



The Fruit Growers Have Solved the Problem of Indelibly Marking Their Brands by Means of An Electrically Heated Revolving Die. It Brands Two Carloads of Oranges Per Day.

The machine can be used in branding any fruit that has a waxy skin. It will brand oranges, lemons, apples, pears, watermelons and cucumbers. The device consists of a big wheel with 18 spokes in it. At the end of each spoke is a shoe in which there is a die which stamps the name of the fruit into its cheek. As the wheel revolves, a small nipple at the top drops a little ink upon each die, and a felt wheel distributes it. An automatic device turns on the electricity or shuts it off whenever the temperature of the die rises above or drops below a certain point. The dies are prest down upon the fruits as they are carried along beneath the wheel on an endless belt of metal saucers, and each die makes its hot imprint into the cheek of the fruit.

The heat of the die melts the wax in the skin of the fruit, causing it to flow into the imprint of the die and fill up any breaks which might be made in the skin, at the same time taking up the ink from the face of the die.

Citrus growers in Southern California, where the machine has been operated in packing houses on an experimental basis for twenty months, declare that it gives absolute satisfaction. It is capable of branding two carloads of oranges or lemons per day.

AMONG the hundreds of new devices and appliances publisht monthly in The Electrical Experimenter, there are several, as a rule, which interest you. Full information on these subjects, as well as the name of the manufacturer, will be gladly furnisht to you, free of charge, by addressing our Technical Information Bureau

Unique Revolving Dancing Floor

Do you like to dance? Well, here's a new one in gay New York that has the old-fashioned "barn dance" of our grand-dads beat forty ways.



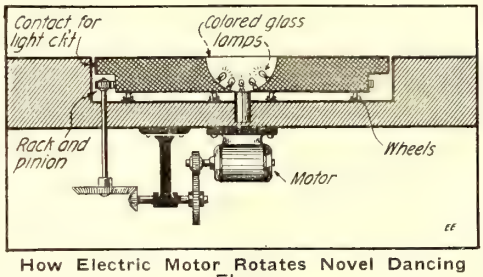
A New York Restaurant Has Provided a Real Novelty for Its Patrons in a Revolving Dancing Floor. An Electric Motor in the Basement Turns It Slowly While the Diners Enjoy the Novel Sensation.

When you are in town don't fail to take a trip to Murray's, one of the city's show places and cabarets, where between courses you may dance, dine and wine with your partner upon a floor that slowly revolves 'neath your feet, giving a pleasing and novel sensation as you whirl to the strains of the Jazz Band.

In the center of the revolving floor is a circle of beautifully colored glass, under which are myriads of lights and as one whirls around, flickering shadows are cast upon the dancers.

The writer, who did not know about the revolving floor feature, one day last month visited this restaurant and took a seat at one of the tables placed at the circumference of the revolving floor. At another table two feet away, but on *terra firma,* he noticed an acquaintance. A few pleasantries were exchanged, whereupon the writer buried his face in the voluminous bill-of-fare. It took several minutes to decipher the French dishes *et al,* after which he addrest a few more words to his acquaintance, not taking the precaution to look at him first. "Sir, how *dare* you!" spoke up an angry looking female, at the spot where the acquaintance was supposed to sit, but alas, sat no more! You see the floor had revolved smoothly and silently some six feet, and the writer's acquaintance was now that far behind! It took the writer a few seconds to realize what had happened, and the expression on his face while apologizing to the insulted damsel, must have been anything but intelligent.

Now to let the reader in on how all this is done—Presto. The floor is on a pivot under which are numerous wheels carefully set and oiled so as not to make any sound when the floor is moving. Along the outer edge of the floor (which is really a large disc twenty-five feet in diameter) is a toothed rack carefully concealed under the flooring. A pinion on a shaft that passes thru the floor to the basement engages this rack. The shaft is connected thru numerous reduction gears and attached to a ¼ horse-power electric motor which slowly revolves the floor; not faster than *one complete revolution every half hour.* By referring to the sectional diagram



How Electric Motor Rotates Novel Dancing Floor.

a good idea of the mechanism may be obtained.

A gasoline engine driven dynamo that is entirely automatic in its action is attracting attention in England.

The United States Bureau of Standards has developed a delicate thermo-electric test for the purity of platinum.

CHROMIUM STEEL PERMANENT MAGNETS.

An investigation into the suitability of chromium steel for permanent magnets has recently been carried out in Germany and reported upon to the Physikalische-Technische Reichsanstadt. Figures are given for five bars of chromium steel, these being compared with five bars made of tungsten steel, the product of remanence and coercive force being taken as a criterion of quality. The remanence of the chrome steel bars was further tested under 20 hours' heating at 100°C., six heatings up to 100°C. and 20 falls from a height of 2½ metres on to a wooden block. It is concluded that carefully prepared chromium steel is a suitable substitute for tungsten steel.

ELECTRICITY FROM THE WIND.

The electrical engineering department of the State Agricultural College of Manhattan, Ks., is at present engaged in conducting a series of experiments with a view to improving the prevailing methods of generating electricity from windmill power. In the present test the generator is mounted on the head of the mill and geared directly to the source of power, instead of being belted to the mill at its base, as is usually the practise. The main need at present seems to be a mill that requires a lower wind velocity to start those now available since the latter are idle for long periods at a stretch, and therefore necessitate the employment of large storage batteries.

NOVEL MEDICAL COIL IS CONTAINED IN HANDLES.

The accompanying illustration shows one of the latest electro-medical coils which is extremely compact as will be evident. The small induction coil, as well as the dry battery and regulating attachment, are all built into the tubular electrode handles which are connected together by a flexible conductor.

To use the apparatus the patient has but to hold the two electrodes in the hands and by pressing a small sliding switch on one of the electrodes, the current is turned on. The strength of the current may be intensified by means of a sliding tube projecting from one of the handles. If it is desired to apply the current by means of a dampened sponge electrode, then this device is inserted in a socket on one of the handles, and the current may then be switched on to the sponge instead of to the handle shell by depressing a switch button provided for the purpose. The complete outfit is very neat in appearance, and a new dry battery can be replaced in a few seconds.



This Latest Idea in Compact Electro-Medical Coils Comprises a Small Induction Coil, Switches and Battery, Which Are All Contained Within the Two Electrode Handles.

SCRUBBING BY ELECTRICITY.

The applications of electricity for relieving both man and woman of tedious work and drudgery are gradually being extended. One of the most irksome duties connected with the keeping tidy of large buildings and institutions, is the scrubbing of floors. Not only is this a laborious and disagreeable task, but it takes a great deal of time to go over a large surface of flooring with scrub brush or even with a mop.

The solution of this problem is the electrically driven *floor scrubbing* machine. A device of this character which has been tried out and found very satisfactory is illustrated herewith. The machine is entirely self-contained and, considering its large capacity, is quite compact. Its dimensions are 28 inches long, 20 inches wide, 16 inches high. The weight of the outfit is 100 pounds. The entire machine is made of metal except the revolving brush. The upper portion of the machine consists of a tank for holding clean water.

The machine wets, sweeps, scrubs and dries the floor at a single operation. It requires only a single attendant who merely pushes the machine forward and guides it. He controls the amount of water distributed on the floor by means of the handle. This water is immediately swept up by the cylindrical brush which is 16 inches wide and has a circumference of 23 inches. This brush is driven by a one-fourth horsepower motor thru a silent chain and sprocket so that the brush revolves at about 600 revolutions per minute. The brush does the actual scrubbing and carries all of the dirt and soiled water over an apron into a separate receiving pan so the scrubbing is always done with clean water from the upper tank. An upright is attached to the machine which carries a cord reel at the top to permit of taking in and letting out the cord by means of which it is connected to any ordinary lighting outlet.



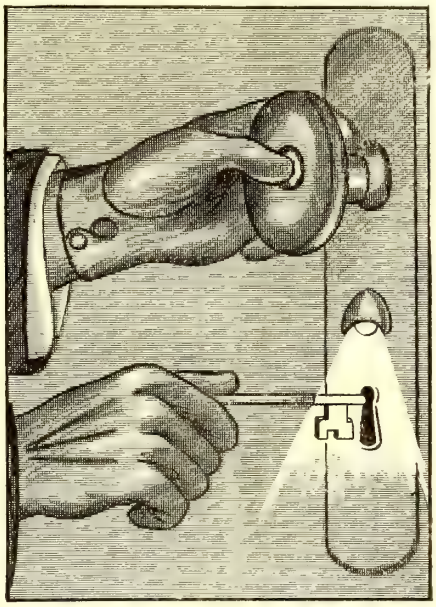
A ¼ H.P. Electric Scrubbing Machine for Use In Large Buildings and Halls. It Reels Up or Unreels Its Electric Supply Cable as It Goes Along.

This machine has an extraordinary capacity. It has been found that if the attendant pushes the outfit forward at a rate of one mile per hour, it will scrub an area of nearly 7,000 square feet per hour. This is about ten times as much floor area as an experienced janitor can scrub clean in the the same length of time. Not only has this machine exceptional capacity, but it leaves the floor much cleaner and more evenly scrubbed than can be done by hand.

Naturally the greatest field for a machine of this type is in cleaning corridors, halls and large rooms in public buildings, office buildings, etc. In such places the janitor work is usually done at night. Because the machine cleans the floors so rapidly, it results also in considerable saving in current used for lighting the premises during cleaning.

LET THE ELECTRIC LIGHTED KEY-HOLE FIND THE WAY.

The annoyance of groping about blindly for the keyhole on cold (or "large sized" evenings) nights will become a thing of the past if the invention illustrated here comes into general use. The device is that of an Ohio man. By pushing a button on the door knob a small electric light just above the keyhole is flashed on and finding the keyhole then is an easy task.



Blank —— Blank —— Where in —— Is That Keyhole?!! Push the Button in This Electric Knob Device and the Keyhole Becomes Instantly Illuminated.

ELECTRIC DRIVE FOR BATTLESHIPS "COLORADO" AND "WASHINGTON."

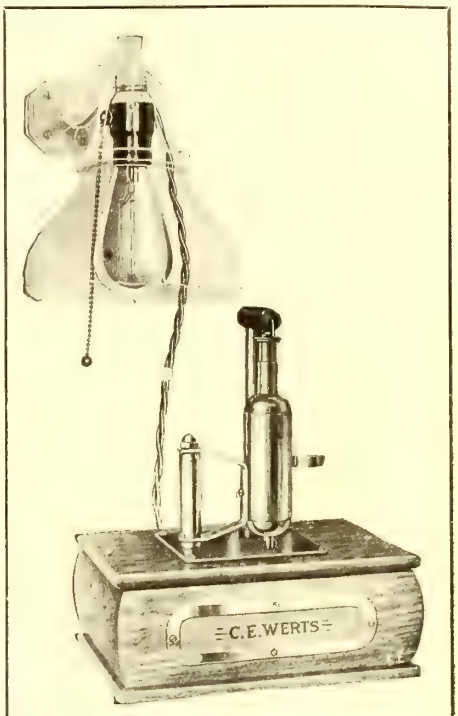
Contracts totaling approximately $2,000,000 have been placed recently with the Westinghouse Electric & Mfg. Company, by the New York Shipbuilding Company, for furnishing the necessary electrical equipments for the propulsion of the new Superdreadnaughts *"Colorado"* and *"Washington."*

The equipments to be furnished are practically duplicates of that contracted for by the Navy Department for the *U. S. S. "Tennessee,"* now building at the New York Navy Yard. The four propellers, as in the case of the *"Tennessee,"* instead of being mechanically connected to driving engines or turbines, are to be driven by individual motors. The current for the motors will be furnished by two turbine generators.

In addition to the main generating equipments and propelling motors, the contracts include auxiliaries for the main turbine generators and smaller auxiliary turbine generators for supplying light and power thruout the ships. A multitude of electric motors will also be utilized for doing nearly all the work on board from raising the anchor to steering.

A NOVEL ELECTRIC CIGAR LIGHTER.

The accompanying illustration shows a new type of electric cigar lighter for use in cigar stores, or for private use. This device can be operated either from a lighting circuit or from batteries placed within the box supporting the lighter. This lighter insures a continuous stream of sparks which flow to the wick until it takes fire. The amount of electrical energy consumed for this purpose is very small. The only operating expense is the cost of 1 gallon of gasoline for feeding the wick. For this purpose 1 gallon of gasoline will last a full year. When used with batteries, a special control lever allows the device to use current only when the lighter is in actual use. This feature reduces the current consumption to a minimum. In case of wear or injury, any part of the lighter can be readily replaced at moderate cost.



An Electric Spark Ignites a Wick Soaked with Gasoline in This Cigar Lighter. It May Be Operated by Batteries or From the Lighting Circuit.

60,000 COPIES "E.E."

are now sold every month on the principal news-stands in the U. S. and Canada; and over 5,000 readers are disappointed every month because the news-dealer says: *"Sold out!"* How often did it happen to you? Why not order a copy from the news-dealer NOW? It costs you nothing to do so, and your copy will be waiting for you next month.

The greatest 15c worth in the U. S.

Intercommunicating telephones, electric lights, call bells, and a complete fire alarm system are installed in modern farm buildings on the estate of a wealthy Long Islander.

AN ELECTRICAL BROACH WRAPPER FOR DENTISTS.

For over fifty years, the treatment of root canals has been a nightmare to careful and conscientious dentists. Recent scientific investigation shows that the danger from the sort of treatment still in vogue among 99 per cent of operators, and the distress and mortality resultant from carelessness, improper methods, crude and inefficient instruments, are little short of appalling and certainly deplorable. To make root-canal operations a success the canal must be adequately enlarged to permit thoro cleansing, which means that every vestige of dead nerve and bacteria, which is liable to be present, must be removed and the canal be perfectly filled, the most difficult part of the entire operation being the removal of debris under aseptic conditions.

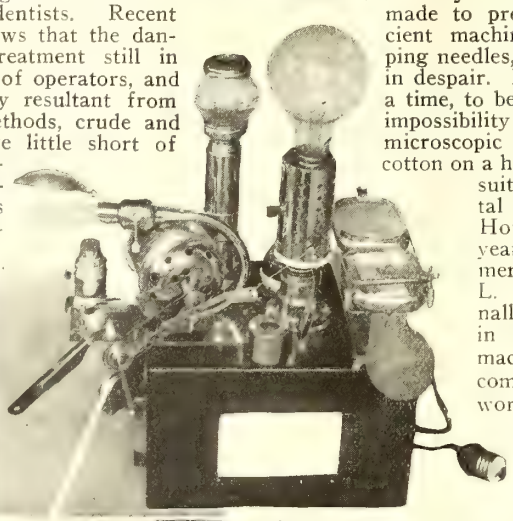


Dr. Funk and His Newly Invented Electrical Broach Wrapper for Dentists which Bids Fair to Save Many Lives Annually by the Antiseptic Conditions It Brings About. It Ensures a Perfectly Clean Broach for Every Patient.

The only method by which root canals can be cleansed is purely mechanical and consists of wrapping cotton on steel needles, which have a fork or notch on the end. The notch is very important, otherwise the cotton would slip up on the shank of the needle and the cleansing cotton would not reach the base of the root, thereby leaving it uncleansed so that putrification would sooner or later take place, subsequently forming an abscess, which is liable to cause distressing, if not fatal disease, such as rheumatism, heart trouble, neuritis, blindness, insanity, and a host of other constitutional ills.

The old method of wrapping treating cotton on dental needles was accomplished by twisting it on the needle with the fingers; this is an uncleanly and dangerous procedure, the cotton being contaminated with dead cuticle, perspiration, and any germs that may have been present on the fingers of the operator.

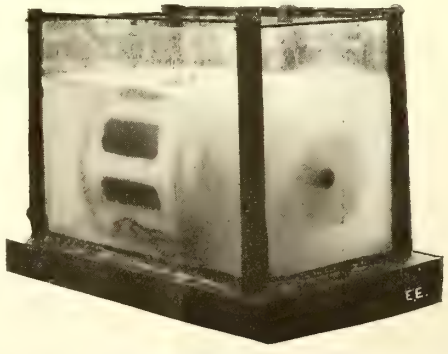
Assuming there are 40,000 dentists in the United States, six patients per dentist per day, 240,000; three hundred days per year, 72,000,000 sittings; five applications per sitting, 360,000,000, to be conservative, divide this by two, 180,000,000. If one cares to be ultra-conservative, halve it again, 90,000,000 and re-halve it if you please, leaving 45,000,000 chances of infection due to digital contamination. This should still be sufficient reason to strive for safer and better methods. Many attempts were made to produce an efficient machine for wrapping needles, and given up in despair. It seemed, for a time, to be a mechanical impossibility to distribute microscopic threads of cotton on a hair-like needle suitable for dental purposes. However, after years of experimenting, Dr. L. L. Funk has finally succeeded in perfecting a machine that accomplishes the work in a most perfect, satisfactory and sanitary manner; the cotton at no time coming in contact with the fingers of the operator. The machine is self sterilizing and there can be no chance of infection due to faulty mechanism, since materials do not come in contact with germs during the process of wrapping, sterilizing would seem unnecessary; however, on the principle of safety first, last, and always, the machine is provided with five sterilizers, practically every method known to science, to be used in conjunction with the wrapper. The machine is simple to operate. A child ten years of age with ordinary intelligence can wrap broaches more quickly and perfectly than it can possibly be done by hand.



In view of the awful carnage now rampant thruout the world, and from a humanitarian standpoint I desire to offer what service I can, consistently, to the United States Government, by donating these Broach Wrappers to be used in Government Infirmaries, says Dr. Funk, with the hope of at least preserving one life for every life destroyed in battle.

A MOTOR THAT RUNS UNDER WATER.

The accompanying photograph shows a sturdy 3½ horsepower electric motor running under water. This motor was first put under water in September, 1909, at a Machinery Exhibition in Cleveland, where it attracted such great attention that it was decided upon as a sort of trade mark for the manufacturers.

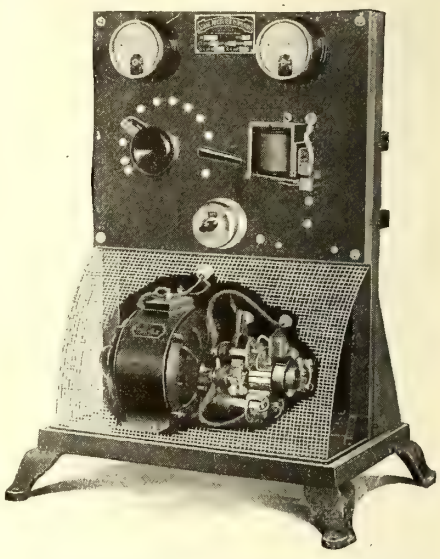


A 3½ H.P. Electric Motor Running Under Water.

The motor has repeatedly been used in installations where it is subject to conditions fully as severe as this. One salt works in Cleveland has had a number of these motors in operation for over ten years, and the wet salt has caked into the windings, until they are scarcely visible: still there has been no motor failure in all this time. It takes a particularly husky and well-built motor to withstand any such treatment as this.

A MOTOR-DRIVEN COMMUTATOR RECTIFIER.

The rectifier shown in the accompanying illustration is designed for the charging of small storage batteries, such as used with automobile ignition, lighting and starting sets. The single-circuit type is a self-contained charging plant that will charge from one to five batteries (or up to a total of fifteen cells). By keeping the rectifier running twenty-four hours a day and taking out each battery as soon as fully charged, on an average, a total of thirteen 3-cell batteries, it is claimed, can be given a full charge in twenty-four hours, allowing for the average amount of residual charge. The rotating commutator principle is employed. Current from the alternating-current supply is brought to two terminals at the back of the switchboard. From these terminals the current passes thru the line switch to a special induction-type motor. On the extended shaft of this motor are two collector rings and beyond them a commutator. The synchronous motor is of such design that no further attention need be given in starting than to simply close the line switch, at which time the motor will start readily and fall into synchronism, remaining so, it is said, even at a great reduction in voltage.



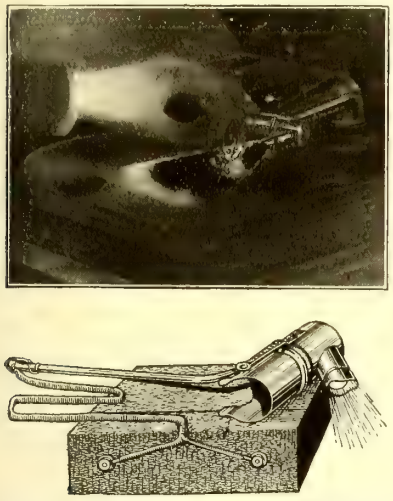
One of the Jobs We All Hate to Tackle Is Charging Storage Batteries. In This Simple Automatic Device a Motor Drives a Commutator in Such a Way that the Alternate + and — A. C. Pulses Are All Rectified or Converted into Direct Current.

EFFECT OF ELECTRICITY ON CROPS.

Important experiments on the application of electricity to agriculture are being made, under government grant, at Huntington, in Hereford, England. As is well known, high-tension discharge accelerates the growth of plants, and may lead to a considerable increase in the yield of crops from a given area. Associated with these experiments are Prof. T. H. Blackman, Mr. W. Duddell and Mr. I. Jorgensen, a Danish expert. Mr. W. J. Kerr, city electrical engineer of Hereford, is also concerned with the movement.

THE RECORD-LITE ILLUMINATES THE VICTROLA NEEDLE.

The miniature electric light for phonographs here shown is a neat, ornamental



Have You Scratched Victrola Records Now and Then While Trying to Adjust the Needle? The Record-lite Was Designed to Obviate This Difficulty. It Works on Batteries.

attachment, that comes complete and ready for use. The installation is simplicity itself—the light is slipt over the end of a taper tube or tone arm, until it snaps into position and is ruggedly and permanently fastened. The battery box is set in the left-hand rear corner of the machine, or may be concealed inside the machine.

The operation is equally as simple. The second finger of the left hand rests naturally on the contact spring when operating the machine and the light illuminates the record, where the needle rests. As soon as the hand is removed, the light automatically goes out. The equipment includes a three-cell dry battery, and a four-volt flashlight battery lamp.

ELECTRIC BINOCULAR MAGNIFIERS.

By Thos. W. Benson.

The binocular magnifier has been designed to enable medical men, zoologists, geologists, botanists, art metal workers, watchmakers, and others called upon to examine small objects with a low magnification, to do so conveniently and with both eyes simultaneously.

Binocular vision in such a device has always been desirable in order to gain perception of depth, but optical means here-



This Binocular Magnifier Is Fitted with a Small Electric Battery Lamp for Illuminating Dark Cavities.

tofore available proved insufficient to provide it. Binocular vision correctly applied not only results in better definition, but allows the operator to observe the object in relief, giving practically a natural perspective.

This condition is fulfilled in the binocular magnifier illustrated herewith by arranging two rhombohedric prisms so as to reduce the distance between the two fields of view and thus place them within comparatively small convergent angles.

The magnifying lens system is arranged so that any desired magnification can be obtained by inserting the proper lenses. The maximum magnification recommended is three diameters, which allows of a large range of working distance.

The eye-piece caps are made of ebonite shaped to fit snugly over the edges of the orbit, the entire instrument being held in place by an adjustable elastic or special fiber head-band fitting around the head. Apertures are provided in the eye-pieces for ventilation and to prevent moisture collecting on the lens surface.

To facilitate the examination of cavities and dark uneven specimens, etc., an illuminating appliance can be fitted to the headband. This consists of a small incandescent lamp operating on dry cells, as shown.

NEW OSCILLATING ELECTRIC WASHER A TIME-SAVER.

The oscillator principle followed in designing the new electric washing machine here shown utilizes both suction and compression force of air within its vacuum chamber. When in use the dasher oscillates in up and down motion something like a child's teeter-totter. It is available in either electric motor drive or gasoline engine drive.

As the dasher raises out of the water the vacuum chambers fill with air—when it goes down into the water the force of



Electricity Has Reduced Wash-day Labors to Child's Play, Thanks to the Motor Which Not Only Rubs the Clothes But Wrings Them as Well.

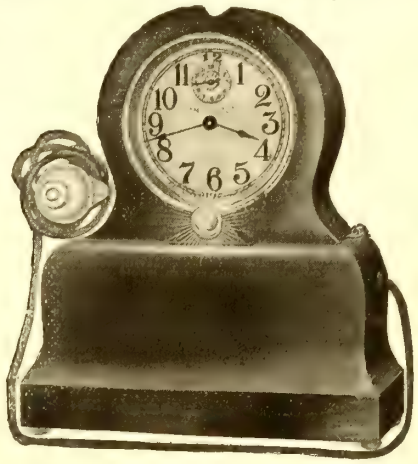
the air compression drives the hot suds thru the clothes—then on its upward swing the air suction draws the suds back thru the clothes. All the washing is therefore done thru the use of air pressure and suction. This eliminates all rubbing, swishing around on pegs and other mechanical action that wears and tears clothes.

The machine is said to wash anything that can be washed with soap and water, cleaner and quicker than by any other method. The most delicate fabrics being washed without perceptible wear. All gearing is enclosed for the protection of the operator.

Included as part of the regular equipment is a swinging wringer—also a special folding bench. Also there is provided quick wringer release, safety hand control, safety foot control—the complete outfit wrings and washes at the same time.

ELECTRICALLY OPERATED AND LIGHTED ALARM CLOCK.

A great convenience in a bedroom is to have a reliable alarm clock to arouse the sleeper in ample time for the day's duties.

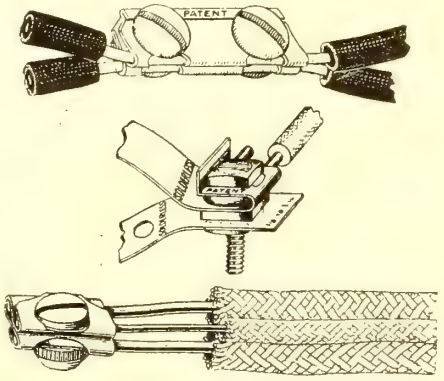


Automatic Electric Alarm Clock with Nite-lite Attachment for Illuminating Dial.

Such a clock, electrically operated and with a special electric-light attachment, has now been made by a New York concern. As shown in the illustration, this is a handsome clock which adds to the appearance of any dresser or other bedroom furniture. The clock is electrically wound. In the bottom of the clock case is a dry cell which furnishes current for operating the clock, for ringing the alarm and for lighting the lamp shown just below the dial. This lamp is controlled by a push-button connected to a cord of considerable length, the button being placed near the bed so that by pressing it the dial is illuminated and the time observed at any period of the night without getting out of bed or other discomfort.

A NEW SOLDER-LESS WIRE CLAMP.

Wire-clamp connectors for circuits, fixtures and grounding purposes which are designed to connect four wires or less of different sizes without the use of heat are now being offered. To connect the wires the screws of the device are loosened slightly and each wire is inserted in one of the four loops and securely connected by tightening the screws. A knurled surface is provided on the nut threaded on each screw so it will grip the wire and not



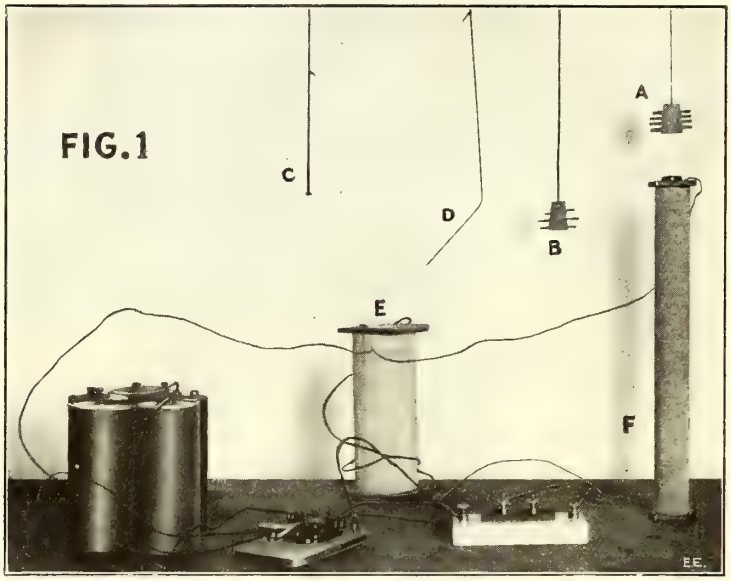
A Clever Wire Clamp Which Requires No Solder. Particularly Useful to Electrical Experimenters for Making Various Circuit Changes Quickly.

turn when the screw is drawn up. These connectors are also made for grounding work. They are very useful to electrical experimenters for making connections in the laboratory and among instruments.

Are There Currents About A Magnet?

By F. F. MACE, Superintendent of Public Schools, Dallas, Texas

IN a previous article in regard to *Magneto-graphs* it was demonstrated beyond controversy that there is actual motion, that there are actual currents, about a magnet, even a *permanent* magnet, and that this motion, these currents, are of sufficient potentiality to affect a photographic plate and to penetrate wood, thin sheets of metal, and other substances. In the present discussion further proofs of these facts will be added and the direction and the character of these currents will be given. (*See May, 1917, issue.*)



Apparatus Used by the Author for Demonstrating that Rotary Motion Is Created in Suspended Magnetic Objects When the Current in a Magnet Coil Below Them Is Suitably Interrupted.

In order to follow the subject in a perfectly logical manner I should begin with an experiment in regard to currents surrounding a charged wire, which experiment will be given later, but that this demonstration may be at once striking and convincing I shall first set out other experiments the conclusions from which are too obvious to be overlooked or denied.

In Figure 1, at "A" is shown a cork thru which are thrust straight, flat pieces of iron or steel. "B" is the same except that round iron wire is used in the place of the flat strips. "C" is an iron wire bent at right angles to its axis when hanging. "D" is an iron wire bent at an obtuse angle to its axis when suspended. When A is suspended by a thread of unspun silk or a hair over the electro-magnet "F" and the current passing thru the coil of the magnet is alternately made and broken by means of a key, A will revolve rapidly. If the direction of the current is such as to make the upper pole a *North* pole the rotation will be counter-clock-wise. If by means of a pole reverser the upper pole is made a *South* pole the revolutions will be clock-wise. This rotation may be checked and reversed at any point by reversing the current so as to reverse the poles; the only precaution necessary being to hold the current for an instant at the point of reversal so that the rotation is stopt. The revolutions may be continued to any length in one direction provided the torsion of the thread does not become too great. With a powerful magnet the rotation may be even continued to the breaking point of the thread. But the revolution is always counter-clock-wise over the *North* pole and clockwise over the *South* pole. B, C, and D may be made to revolve in the same manner and the direction is *always the same*. "E" in the same figure is a helix *without* an iron core. The same result may be obtained with this as with the electro-magnet F.

If A, B, C, and D are suspended as before and a permanent bar magnet is brought underneath and rapidly thrust up and down, they will rotate as before; that is, counter-clock-wise over the *North* pole and clock-wise over the *South* pole.

Here then, if it had not already been proven by the effect of the magnet upon a photographic plate, is proof that there *is motion—that there are currents*—about the poles of a magnet and that these currents are the same about an electro-magnet and a permanent magnet. Moreover, it is plainly indicated that these currents not only move toward the magnet but that they also rotate in their forward progress counter-clock-wise over the *North* pole and clock-wise over the *South* pole. A moment's consideration will show that these currents thus form a continuous spiral about the magnet and that this spiral conforms to the direction of the current about an electro-magnet in both the electro-magnet and in the permanent magnet. No one capable of logical thinking, even if it had not already been proven that there are currents about the magnet, and currents capable of penetrating substances and affecting photographic plates, will doubt that here is motion—currents—and that *these currents are rotary*. Lines of stress, or any other assumption can not account for this motion of the objects. Even a child recognizes the effect of currents in the moving straws and determines the direction of the currents by the path of the straws.

Nor would an assumption that this motion of the objects is produced by an attempt of the partially magnetized iron to set itself tangent to the lines of force about the magnet appear to be tenable. In Fig. 1, A may be made with strips of soft iron or it may be made with steel magnets. The magnets may be arranged in pairs with their poles in the same direction, or they may be arranged in pairs with their poles neutralizing each other. In any arrangement the result is the same, and the direction of rotation is the same. If "D" is used instead of "A," the magnet will temporarily impart to the lower end of the wire a magnetism *opposite* to that of the pole of the magnet. The tendency then is for the lower end of the wire to be strongly attracted to the magnet and to point to the center of the pole, but instead of this it swings in ever-widening circles about the pole of the magnet, the point of the wire becoming further and further from the magnet. Then we may go further. A loose "snarl" of soft iron wire may be suspended in the place of the other objects. The result is the same. Yet it would take quite a stretch of imagination and a decided determination to adhere to "it has been so written," to assume magnetic poles for a snarl of wire or that there would be any tendency to set itself tangent to the lines of force. Go even further. Suspend an iron ring in the same manner. Assume that it becomes magnetized or that it does not become magnetized. If it becomes magnetized the poles correspond to a continuation of the line made by the thread. But in any case the ring revolves as do the other objects.

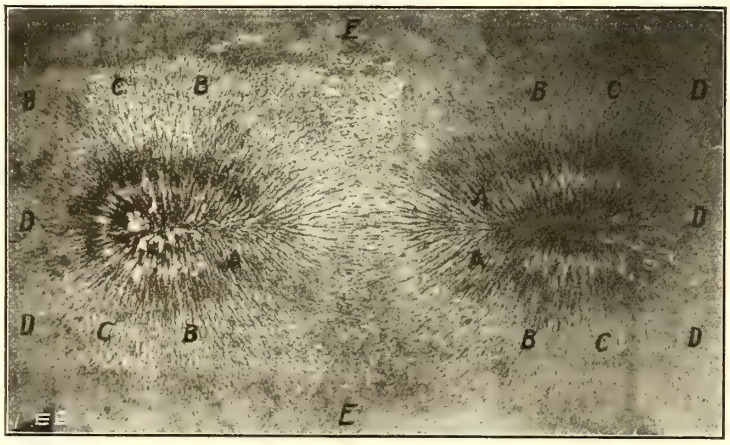


Fig. 2.—Showing the Lines of Force—or Rather a Map of the "Currents" About a Powerful Magnet. Taken by Means of Iron Filings Sprinkled on a Sheet of Glass Under Which the Magnet Is Placed. Then the Current Thru the Coil Was Made and Broken.

It has been customary to "map the lines of force about a magnet" by sprinkling iron filings on a sheet of glass or cardboard placed over a magnet and then tapping the glass or cardboard. Now it is a well known fact that powder or iron filings may be made to arrange themselves in lines on glass or other substance by tapping or by stroking with a fiddle bow, etc. The character and direction of these lines will be determined to a great extent by the nature of the disturbance. The same is true when we tap the glass over the magnet only that here we have a resultant of forces. Tapping the glass just right will produce

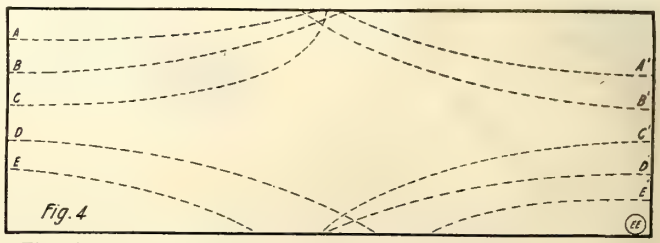


Fig. 4.—Various Paths Taken by an Iron Ball Over a Plane Surface, Such as a Card, Placed Inside a Solenoid.

the conventional lines about a magnet; tho it requires a great stretch of imagination to see the closed curves passing from one pole to another. Aside from this, different tapping, even when the magnet is used, will produce different results. A half score of "fields of force" can be produced in this manner. So easy is this of demonstration by anyone that it is not worth while to reproduce any of these fields here. But Fig. 2 shows a map of the lines of force—or more properly a *map of the currents*—about a magnet produced without jarring or touching the plate in any manner. In this experiment the electro-magnet "F" in Fig. 1, an electro-magnet thirty-eight centimeters in length, was used. This magnet was placed under a sheet of glass on which iron filings were sprinkled and the lines shown in the figure were produced by making and breaking the current in the coil about the magnet. These lines begin to form as soon as the circuit is closed. A little examination will show that the old "conventional" lines were erroneous and that the theories and conventions founded upon them were still more so. *Note carefully the direction and continuity of these lines.* In no place are they continuous from the *North* pole to the *South* pole of the field. At A, A, A, A, the lines actually make a sharp reverse curve and from curving inward toward the magnet show a tendency parallel to the magnet and more in the direction of the poles. At B, B, B, B, the lines are only slightly curved. At C, C, C, C, no curve can be detected. At D, D, D, D, there can be no question in regard to their being straight lines and that under no circumstances would they meet the lines from the other pole. Even at the center of the field, these lines do not form absolutely closed curves. At E, E, they show a tendency to meet each other, the lines from the opposite poles, at an angle. With some lines the angle is quite apparent. Here, then, is proof that the lines of force —currents—do not move in closed curves from the *North* pole to the *South* pole. That these are *currents* and *not lines of tension* will be further emphasized by the next experiment.

Place the electro-magnet under a tank of water (I used a glass bottomed tank placed over a magnetic field already produced by the magnet) and in the water place a small piece of iron attached to a cork. When the cork is placed over a point on the line E, E, and the circuit of the magnet is closed, the cork will remain almost if not quite stationary, or will even exhibit a slight tendency to drift away from the magnet. If placed a few millimeters to the right or left of this line, it at once moves in the direction of the nearest magnetic pole following closely the direction of the line over which it is placed. Note carefully that the cork follows the curves shown in Fig. 2. If a magnetic needle is substituted for the iron the action is the same except that the needle is attracted or repelled along the lines according to its polarity. A magnetic needle placed over one pole so as to be repelled will often move to the center of the field and there stop. If a large bar magnet is substituted for the electro-magnet underneath the water the result is the same. Here, then, is proof of two facts: first, that there is *actually motion* about the magnet, *currents,* and that these currents do not move from one pole to another but that the currents originate near the center of the field (that is, those not entering from the directions of the ends of the poles) and move toward both poles. Also that in the center of the field between the two poles of the magnet is a point of neutrality or of actual repulsion, a point where the currents are outward.

If further proof is needed that there is an outward flow of currents from the center of the magnet it is furnished by the photographic plate. Fig. 3, is such a plate, taken *underneath the "U" bend* of a U-shaped magnet. "A" shows the position of the plate, the objects, and the magnet. "B" shows the result, the plate being taken under the same conditions as those described for the other *Magneto-graphs* (See first paper in May issue.) Now a current flowing upward would affect the photographic plate but would not produce an image of the objects, for the reason that it would be flowing toward them and would pass thru the plate before reaching them. In order to penetrate the objects and thus make their impression on the plate it must be passing downward; that is, must be flowing outward from the bend of the U magnet. The plate speaks for itself.

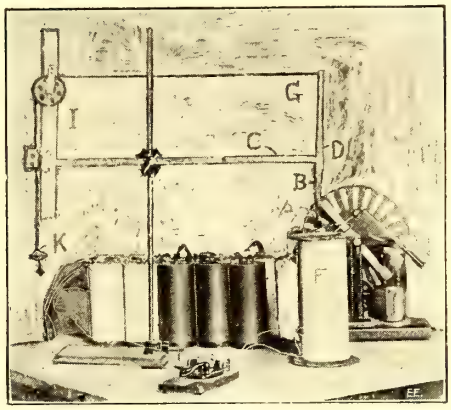


Fig. 5.—Apparatus for Measuring the Strength of the "Interior Current" of a Solenoid.

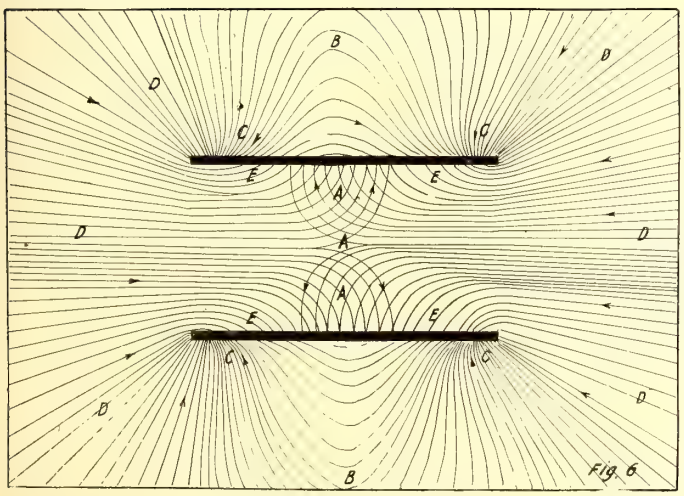
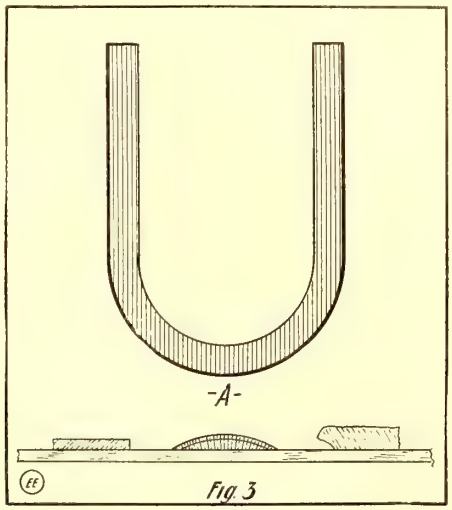


Fig. 6.—Map of the Interior Lines or "Currents" of a Solenoid as Plotted by the Author.

So far only the *exterior currents* of a magnet have been examined. The *interior currents* show equally interesting results. Place the solenoid "E" in Fig. 1, on its side and place a plane of cardboard inside on a line with the diameter. Place a small piece of iron on the end of the cardboard plane and as soon as the circuit is closed the iron will spring to the center of the coil and to one side. Place a piece of iron at both ends and when the circuit is closed



Demonstrating that There Is an Outward Flow of Currents from the Center of a Magnet. To Make a "Magnetograph" Several Objects Are Placed on a Photograph Plate Beneath the "U"-Bend, and Left in the Dark for Several Weeks.



Fig. 3-B.—"Magnetograph" Obtained by Above Arrangement.

they will meet in the center of the coil, but it should be noted that one alone will move to the center. This shows that there are currents moving inside of the solenoid and that the attraction of the solenoid is not at the poles but at the center and toward the sides. This is also proven by the photographic plate for photographic plates exposed inside a helix bearing a current give results similar to the *magneto-graphs* already shown.

Again, place inside the solenoid "E" the cardboard plane as before and cover it with a soft but not rough paper. If an iron ball is placed on the cardboard at "A", Fig. 4, and the circuit is closed the ball is drawn inward and to one side. If the same is repeated by placing balls in succession at "B", "C", "D" and "E", and at "A¹," "B¹," "C¹," "D¹" and "E¹" the result is the same. The balls must be placed on the card one at a time and the circuit closed and opened again before another is put on. If several balls are placed on the card at the same time and the circuit closed, their tendency is to cluster together. If these balls are coated with oil and lamp black they will leave a faint trace of their several paths. Fig. 4 is the reproduction of an actual tracing made on cardboard in this manner.

The existence and strength of these currents is emphasized by another experiment. The solenoid here shown is twenty centimeters in length. Fig. 5 shows apparatus for measuring the strength of the *interior current* of this solenoid. "A" is a small piece of iron of known weight which is fastened to the wooden arm "B". "B" is pivoted to the crossbar arm "C", at "D", and so arranged by means of a set screw as to be lowered or raised inside the sole-

(*Continued on page* 417)

New Portable Electric Lamp For Miners

By F. T. FORSTER
Pittsfield Works, General Electric Company

WITH the advent of coal mining it was discovered that open flames in mines were sometimes dangerous, owing to the fact that explosive mixtures of methane gas frequently occurred. This led to a series of investigations to produce a lamp that would primarily prevent explosions and secondly detect the dangerous gas.



The Latest Safety Electric Lamp for Miners.

The electric incandescent lamp naturally obviates the objections found in the open-flame type miner's lamp. While the electric lamp will not detect gas, this can easily be accomplished by employing a few Davy lamps for this purpose. Special electric gas detectors are now being developed and it will probably only be a matter of a few months before thoroly reliable devices of this type will be on the market.

A glowing lamp filament has been proved by the Bureau of Mines to be dangerous. It is therefore necessary to supply each device with a safety switch that will break, or otherwise discontinue, the current thru the filament when the bulb is broken.

Tests with light and heavy blows in the directions most likely to cause failure are applied to each device and it must not fail on any test in order to pass, for obviously one failure in a mine might mean death to many miners and much damage to property.

Batteries must be proved by test to possess a capacity sufficient to burn the lamp through an entire shift of 8 to 10 hours with a margin of safety.

The first requisite of a mine lamp is to give light for the miner to find his way thru the various unlighted passageways to his work and then to enable him to perform that work in an efficient manner during the entire shift. It is therefore quite necessary that the light should decrease as little as possible in brilliancy during the time the miner is "inside." This is accomplished by using an ironclad storage battery whose voltage characteristic is very even. Except for the sudden small decrease in voltage which takes place in the first few minutes on a freshly charged battery, the change over 9 hours is only 6 per cent, or less than 1 per cent per hour.

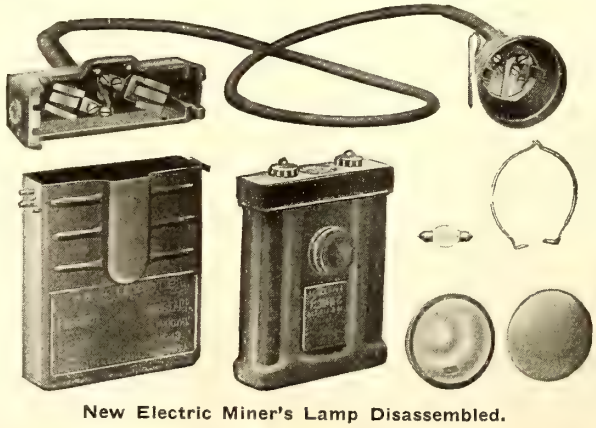
The distribution of light is exceptionally good. A porcelain reflector of irregular shape is used, thereby eliminating those sharp changes in brilliancy that are characteristic of polished metal reflectors.

The cap shell is fitted with hooks for mounting the lamp on the miner's cap at such an inclination forward as to throw the beam of light directly upon the work which the miner is doing.

In this type of miners' lamp, the safety feature consists of two flexible contacts which hold an elliptical-shaped bulb having a contact at either end with the filament extending thru the lamp between its two contacts. The illustration shows this safety device lamp mounting for holding the bulb. Any blow which will break the bulb in any manner will force the lamp out of the contacts.

Much depends upon the battery, of course. If it does not supply current to light the lamp for the full working time the miner will have to stop work sooner than otherwise, thus decreasing the output of coal for the mine owner and causing a loss of pay to the miner. It may also be difficult for him to find his way out of the mine if he does not have assistance from someone who has a lamp. With the ironclad battery, a reliable source of power is assured. The lead battery plates are very rugged and have established a reputation in mine locomotives and heavy trucks for their ability to withstand heavy duty conditions and severe shaking. The plates are contained in a strong, well-designed, semi-hard rubber jar that will stand an unusual amount of abuse. By making the metal containing case of proper design for the conditions under which the equipments are to operate, no trouble has been experienced from cracked or broken jars. The cover is fastened to the jar by a double capillary seal, which is acid-tight.

The filling and venting scheme is very simple and effective. To fill the battery the vent plug is removed, which gives free access to the cell space, and the level of the electrolyte is brought to within a small distance below the edge of the plug opening. The vent plug is very effective in preventing spilling of the electrolyte and is securely sealed in place by a quarter-turn of the plug, which draws it down against a rubber basket in a suitable seated surface on the jar to prevent any leakage of acid. The electrolyte, which is the usual battery acid (sulfuric), is corrosive in its action on metals and will damage all kinds of cloth except *pure wool,* yet on account of the degree of perfection which has been obtained in making a strong non-breakable jar, a perfectly seated vent plug, and a non-spilling vent no acid can escape.



New Electric Miner's Lamp Disassembled.

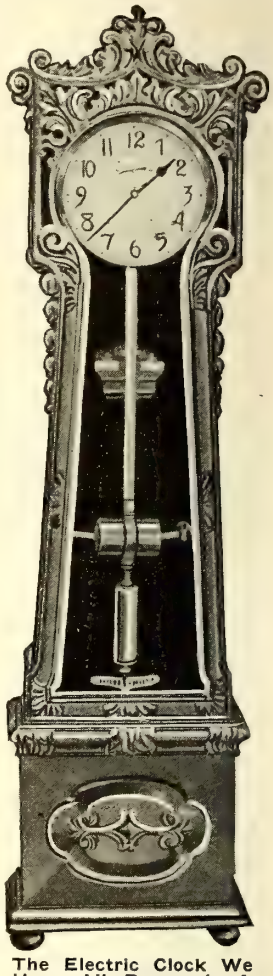
SECRET WIRELESS RAZED.

Costa Rican Government authorities have dismantled a powerful wireless station at Heredia that is supposed to have been used by Germans. It was found on the property of the former Governor of Heredia Province, Dr. Marcos Rodriguez, an intimate friend of the deposed President, Alfredo Gonzales, and of the latter's adviser, J. Kumpel.

ELECTRIC CLOCK DRIVEN BY EARTH CURRENTS.

This clock, unlike an ordinary timepiece, is not actuated by either weights or springs. The motive force is a current of electricity obtained from a pair of plates buried in old Mother Earth, and which are connected with the clock by wires.

The current is applied by means of an electro-magnet direct to the pendulum, so that the pendulum drives the clock, instead of the clock driving the pendulum, as is the case where weights or springs are used.



The Electric Clock We Have All Dreamed of. It operates on Electric Current from the Earth. No Battery Required.

The current is reversed at each swing of the pendulum by an automatic switch, and this switch is so adjusted as to prevent the pendulum being moved in either direction beyond a given point. It is the application of this principle which secures correct time and overcomes any slight variation in the strength of current, and it is this which makes the *Earth - Driven Clock* a distinct advance upon electric clocks as previously made.

An interesting report has been given on this clock by Professor Silvanus P. Thompson, F.R.S., the world-renowned electrical expert, who has minutely examined the clock. The following are extracts from his report:—

"Having had the opportunity—both to see the earth-driven clock at work, and to examine the specifications of patent on this invention, I beg to report as follows:

"The pendulum is both the governing part and the driving part of the clock. I made various simple tests on the clock with a milli-ampere meter attached to the circuit. If I purposely gave the pendulum, by hand, a large impulse so that it swung too far, at once the automatic action of the contact device became evident, and after a few swings the current returned to its normal value, and the pendulum to its normal swing.

"It is, as will appear from the above description, entirely automatic and self-contained.

"I see no reason to doubt that with an earth battery properly laid, it will continue to go for years without stopping.

"I have used earth batteries many years ago, and know them to be extremely constant if they are properly laid down in the earth once for all."

MILK SHAKES BY MOTOR IN 10 SECONDS.

Several new and excellent features are embodied in the new motor-driven mixer here illustrated. The entire base and column is finished in white porcelain enamel. It can be easily kept clean and dispensers will appreciate this sanitary feature.



The Day of the Hand-Made Milk Shake Is Past, Thanks to the Always-Ready Electric Motor.

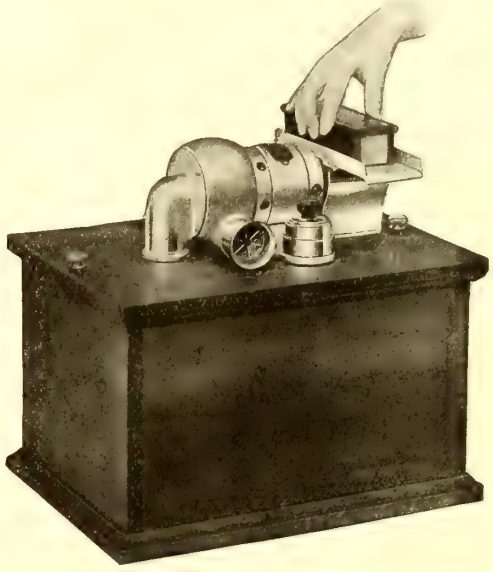
The motor which drives the mixing spindle is stationary on the head of the column, only the mixing spindle moving up and down. The spindle is light and the mixer is very easily operated. The current is automatically turned on when the spindle engages with the driving disk on the motor and is shut off instantly when the spindle is raised. This does away with the splashing of the contents outside of the container as is experienced with other types of mixers.

Another advantage of this mixer is that the spindle raises to a height of 7½ inches, enabling the largest container or mixing glass to be set under the spindle without tipping the container.

ELECTRICITY CLEANS ERASERS RIGHT IN SCHOOL-ROOM.

With the machine here shown erasers are cleaned right in the schoolroom or in the corridor. No need to throw them into a basket and take them outside or into the basement. A small girl can operate the device and get the erasers thoroly clean.

Turning the switch sets a rapidly revolving brush in motion. This loosens the dust and the suction developed by the motor extracts all of the dust from the surface and crevices of the felt. The dust is drawn into a section of the base. The air created by the strong suction is filtered before it comes out of the exhaust. This is one way of solving the black-board and chalk problem, but it's a wonder to us that some genius has not perfected a more cleanly and scientific school-room appurtenance than the "black-board eraser."



Electricity Now Cleans the Germ-Laden Black-Board Eraser In a Thoro and Sanitary Manner.

The Effect of Ultra Violet Rays on Milk and Other Aspects

By DR. HUMBERT BIZZONI

THE actions presented by the ultra violet rays on animal substances, or to state better, the changes produced on infinitesimal life by the ultra violet rays, are such as to leave much doubt and supposition as to their qualities as a friend of man. Still their chemical, physical and biological actions are not as yet known well enough that we might say *à priori* that they are *detrimental* or *beneficial*. The transformations produced by these rays are evident and show their existence, but just how this action forms or develops is yet to be explained, and it would be hazardous to state a fact on a subject which can be clast only in the same category with the undiscovered merits of the X-Ray.

In 1912, Holland had averred that the ultra violet rays were an enormous microbicide on animal substances, and they immediately adopted the ultra violet rays to sterilize their milk by passing it from one container to another in a thin film or stream upon which was projected the ultra violet ray. This was supposed to have the action of sterilization and preservation. The fact of sterilization existed, but while certain microbes were destroyed in this manner, especially those which are injurious to human life, it did not prevent the milk from turning sour; on the contrary the development of the germs under the action of the ultra violet rays was so great, that they seemed to find themselves in a most favorable environment, which was clearly seen under microscopic inspection. In fact, upon projecting an ultra violet ray on a vessel containing milk, it would be seen that the section upon which this ray touched becomes a veritable tumultuous life of multiplication of germs. This clearly indicated that while the microbicide idea of the ultra violet rays exists, its application is on a different principle.

It has always been commonly believed that milk curdles owing to the change of temperature and that by using ice this difficulty would be overcome, but this precaution does not take away the primal cause which, while it remains latent under the unfavorable environment of perhaps zero degree, develops immediately upon being brought in contact with light and a more productive environment, namely, the moment that the ultra violet rays come in contact with the infinitesimal life their development begins, and while it is true that some microbes are destroyed by the ultra violet rays, it has been found that the inferior organisms generally develop more rapidly under the influence of these rays.

The milk of the Bulgarians, well known all over the world for its superior nutritive quality, is made by exposing it to the sun, the rapid development of the germs under the action of the ultra violet rays being such that when it becomes dry they are in highly concentrated form.

The difficulty of transporting milk from one city to another is well known, and I had occasion of demonstrating my beliefs on the action of the ultra violet rays by an experiment at which were present the representative commissioners of milk of Mülhausen, Alsace. It was midsummer (July) and we took milk directly from the cow, without it having had any exposure to the light, and placed it in two cans, one of which had been previously protected against the sun's ultra violet rays; the other canteen was left as it had been. The canteens were then placed on an uncovered freight car without any ice or other protection against the sun and shipt to Colmar, a trip of about four hours. Upon arriving at our destination the cans were then examined; the milk in the can not protected had already turned sour, while the milk in the other can was as sweet and fresh as tho it had been hardly drawn. The fact that the ultra violet rays could not penetrate the protective covering of the canteen prevented any action on the milk.

To substantiate my theory, Dr. Stahel of the Internationale Cellulose Ester Gesellschaft of Sydowsaue had also asked for a patent of a product which was precisely against the action of the ultra violet rays, preventing the decomposition of diverse animal substances influenced by these rays, following several discoveries made from various observations of the action of the ultra violet rays.

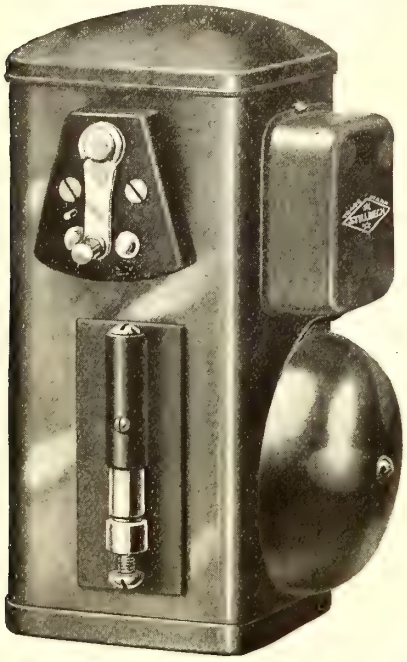
The cerebral substances are decomposed by the ultra violet rays, causing sunstroke, and not by heat as generally believed, and to substantiate this statement it is not thought remarkable that we never hear of cases of so-called heat prostration among the workers in foundries, glass and pottery factories, etc., where an excessive heat temperature equal to mid-summer in the torrid zone is continually preserved, and where the man goes back and forth to and from his labor year after year unaffected. Yet this same man may be taken with a sunstroke in a moment's time upon exposure to the sun, when its rays are sufficiently powerful to react on the body.

In 1913 I had submitted an experiment for the protection of men and horses against the effects of the ultra violet rays by the application of a protective coating against these rays placed in the inside of hats and horse bonnets. Upon the success of the same the French Government used

(*Continued on page* 421)

A NEW PORTABLE ELECTRIC FIRE DETECTOR.

The new electric fire detector is a thermometer constructed of a steel tube for a mercury receptacle, to which is attached the lower contact screw, also the regulating screw by which the detector is set to any given degree from zero up to as high as



An Electric Fire Detector Which Can Be Left at Any Point Desired, Such as in the Kitchen, and as Soon as Blaze Occurs the Alarm Bell Rings. It Utilizes a Fine Mercury Column, Which Expands When Heated, Thus Closing the Bell Circuit. It Will Also Announce a Drop in Temperature.

conditions require. A fiber tube carries the upper contact screw. This fire detector and alarm may be termed almost "super-human," never failing to give an alarm of fire when in its incipiency and which can be extinguished with a pail of water or small portable fire extinguisher and before it has gotten beyond individual control. The detector will not give a false alarm when properly set, it is claimed. The portable outfit shown is for use in kitchens or other localities.

The possibilities of this detector are unlimited, giving a positive alarm of fire at the opportune time; the absolute automatic control and closing of fire-doors and shutters; the announcement of rising temperatures in refrigeration plants and the absolute control of open-head sprinkler systems.

As a valuable equipment for the prevention of disastrous fires, the detector gives an alarm long before the automatic sprinkler will operate; thus not only preventing fire loss, but eliminating the water damage to a very large degree. For warehouses and holds of ships where cotton is stored, an alarm is given when the cotton first begins to smoulder. This also applies to uncured hay and rubbish.

The apparatus is peculiarly adapted for the regulation of temperature in refrigeration plants, being regulated to announce the rise in temperatures on an annunciator in the chief engineer's office, which obviates the necessity of continually making the rounds to read the thermometers.

The detectors can be set to show a rise of a fraction of a degree and a warning of this change given as above described. The detectors for protection in hotels, theaters, homes, apartment houses, office buildings and buildings of like character are set to operate at say 110° and are furnished with ornamental guard of nickel-plated noncorrosive metal, which makes a neat, attractive outfit, but these can be more elaborately decorated to architect's specifications.

Each detector will under ordinary conditions cover an area of 250 square feet of floor space. In a room say 12 by 15 feet, one detector would be sufficient, but if fastened to side walls, two would be required.

RADIO EXPERTS NEEDED FOR NEW MERCHANT MARINE

There is a very great need in the navy just now for radio operators, according to the Buffalo office of the Naval Reserve. These operators are to be used on the giant merchant marine that is shortly to be put in service. The men in this service are well paid. There are several classes in this service so that the beginner has a chance for enlistment.

DON'T MISS THE NOVEMBER "E.E."

We have a great variety of electrical, scientific and radio articles in preparation for the "November" number. You can rest assured that you will find a big 15 cents worth of reading matter in that issue. If you are interested in war-time inventions in this field, you must not miss reading the up-to-date and authoritative articles on these topics, a host of which we publish every month. Here are a few of the "November" features:

"The Use of the Telephone and Telegraph in Battle."

"Action at a Distance as Exhibited in Selenium Crystals," by Prof. F. C. Brown, Ph. D.

"The Marvels of Radio-activity," Part III, by Jerome S. Marcus, B. Sc.

"Forcing the Growth of Plants with High-frequency Currents.

"Historic Electrical Apparatus," by H. Winfield Secor.

A new electrical story, by C. M. Adams.

"A New Military Application of Electricity," by H. Gernsback.

"Are There Electric Currents About a Magnet?" Part III, by F. F. Mace.

"Science and the War"—In the "Movies," They Do It.

"Experimental Physics—Lesson 9," by John J. Furia, A.B., M.A.

"Chemical Action of Storage Batteries," Part II, by Albert W. Wilsdon.

"How to Make an Electrically Played Mandolin," by McClure Albright.

The Construction of a Wheatstone Bridge," by Thomas W. Benson.

Class A is for amateur operators who can send and receive the Continental code at least ten words a minute and can write legibly. Class B is for first-grade commercial or amateur operators, receiving and sending twenty words a minute. Third-class electricians rating are in this class. Class C men must have commercial licenses and must have served at least one year as operator aboard ship and must send and receive at least twenty-seven words a minute in Morse and Continental. They get ratings of electricians, second class. Class E is for men who have worked on ocean-going boats as operators for at least four years and who can repair any break of apparatus. The rating is that of chief electrician. The pay ranges from $33 a month for third-class men to $65 a month for chief electrician. Board, lodging and clothing allowances are given in addition to the regular salary.

GETS 30,000 VOLTS; LIVES.

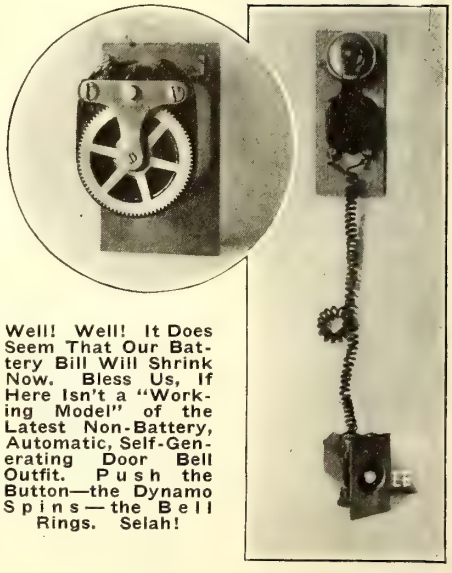
Altho 30,000 volts of electricity past thru the body of Neil Hansen of Trenton, N. J., recently, he will live.

Hansen was cleaning a generator in the distributing station of the Public Service Corporation when he received the full force of the current. His left thumb was burned off, his hands and arms were burned and the top of his head was blistered.

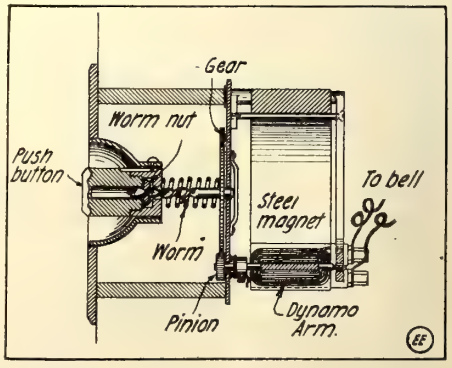
For a time he lay as tho dead. After he was revived he could not remember his name.

PUSH-BUTTON DYNAMO REPLACES BATTERIES.

Something new in push buttons has been invented at last by an eastern man that bids fair to send the old dry batteries now in use to ring your front door bell, to the ash can. It is quite a simple arrangement, and it is strange that no one should have thought of such a simple device. The button itself is connected to a rod that is geared to a small dynamo, and when the button is pushed the dynamo armature rotates in the field of a permanent magnet, thereby generating enough electricity to ring the bell. The whole unit hardly takes up more space than the ordinary push button, and does away with the constant expense of renewing batteries. By referring to the photos a good conception of the principle involved and also the mechanism can be obtained.



Well! Well! It Does Seem That Our Battery Bill Will Shrink Now. Bless Us, If Here Isn't a "Working Model" of the Latest Non-Battery, Automatic, Self-Generating Door Bell Outfit. Push the Button—the Dynamo Spins—the Bell Rings. Selah!



Here's the Secret of the Battery-"less" Bell Ringer. By Means of a Special Nut and Worm, the Dynamo Spins Merrily at Every Push of the Button.

Some Electrical Properties of Silver Sulfide*

By GEORGE W. VINAL

NATIVE silver sulfide is seldom pure but the sulfide may be prepared chemically in the form of a black powder which has a melting point of about 825°C. It was found that the sulfide so melted could be rolled into thin strips or drawn into short wires like a metal. At a temperature of about 200°C. it becomes very malleable and may be hammered out on a hot plate or drawn thru a heated draw plate. Working the sulfide at this temperature changes its electrical properties. In the form of a strip which has been rolled cold this substance is both a metallic and electrolytic conductor at the same time. When drawn hot it acts like a metallic conductor with nearly zero temperature coefficient.

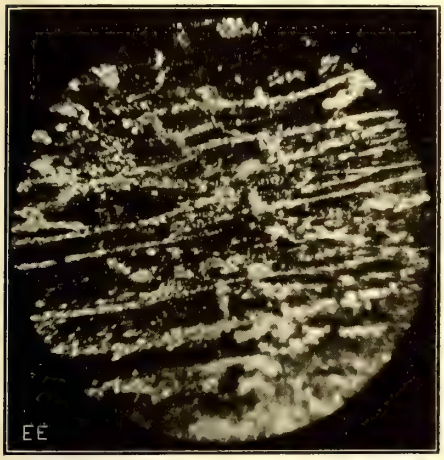


Fig. 1. Outcropping of Silver in Middle of Sulfide Strip. The Direction of the Electric Current Was Approximately Parallel to the Direction of the Lines of the Silver. This Picture Suggests the Possibilities of the Formation of Native Silver in the Earth.

In making experiments with the sulfide it was necessary to find some means of making good electrical contact between it and copper lead wires. It was not found possible to solder to the sulfide directly and brass clamps are not desirable, but it was found possible to silver-plate the ends of a piece in a silver-potassium-cyanide solution. After this is done a copper wire can be soldered on with little difficulty.

When the sulfide is rolled at room temperature it has a large negative temperature coefficient of resistance, similar to an electrolyte. When worked at 200°C the temperature coefficient is approximately zero. It is not easy to explain why the mechanical working makes so great a difference in the electrical properties, but it seems likely that rolling at room temperature may produce minute cracks, whereas wire which is drawn hot is probably homogeneous.

The material rolled at room temperature was found to have different resistance when tested with direct and alternating current. When alternating current is applied the resistance increases, when direct current is applied the resistance decreases but shows a tendency to recover upon standing.

The specific resistance at 25°C was found to be 17,300 microhm-centimeters or about 10,000 times the resistivity of copper.

As resistance measurements indicated electrolytic conduction of the cold-rolled strips, experiments were made to discover any electrochemical decomposition. Direct current was applied to a strip having copper leads soldered to its silver-plated ends. An initial current of 25 milliamperes gave no visible effect. The current was increased at intervals until with 200 milliamperes a discoloration of the plate at the anode end was noticed. A still larger current appeared to destroy the silver plating and finally burned off the terminal, but before this happened a myriad of little shiny silver crystals appeared on the black surface of the sulfide as shown in Fig. 1. The appearance of these crystals was studied under the microscope and it was found that they occurred to within a small fraction of a millimeter of the anode terminal as shown in Fig. 2. The appearance of some of these crystals suggested that they had been expelled from the interior of the strip with considerable force. The strip appeared to be made up of a multitude of tiny electrolytic cells between which metallic conduction occurred. The cross-section of this strip was 0.3 by 0.01 centimeter.



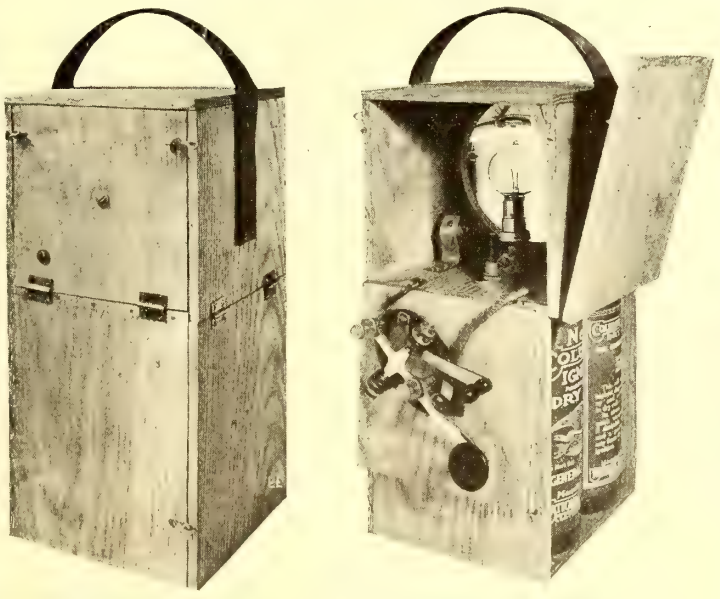
Fig. 2. Anode End Showing Where the Terminal Burnt Off. After the Silver Plating Was Destroyed by the Sulfur, the Outcropping of Silver Took Place. Magnified 50 Diameters.

* Summary of a forthcoming Scientific Paper of the National Bureau of Standards.

A 25-MILE BATTERY LAMP SIGNAL PROJECTOR.

A very simple signal projector having a range of some twenty-five miles is shown in the illustration herewith. It consists of a wooden box 12 in. long and 5 in. square, made of ¼-in. wood. This box contains a 5-in. Mangin mirror.

At the focal point of this mirror is mounted a 6-volt, 1½-ampere Mazda lamp, having a maximum concentration filament. (A 1½ ampere automobile lamp could be used, but the range will not be so great as with the maximum concentration filament lamp.) In the lower compartment of the box are four standard dry batteries connected in series and to the lamp thru a standard telegraph key.—*Photo Courtesy Gen. Elec. Rev.*



A Military Signal Projector Having a Range of 25 Miles. It Is Fitted with 5-In. Mangan Mirror and 6-Volt 12-c.p. Mazda C Lamp. A Telegraph Key Controls the Lamp Circuit.

AS TO THE EFFICIENCY OF OPTICAL PROJECTION.

In a recent paper before the Illuminating Engineering Society, Mr. R. B. Chilas analyzes the conditions affecting the efficiency of optical projection in the cinematograph. He estimates that in the most favorable circumstances the screen does not receive more than 5.8 *per cent.* of the light from the arc, while in many cases it does not exceed 1 *per cent.* Various arrangements of carbons with a view to avoiding the shadow cast by the negative have been tried, but with the present lens systems it is difficult to utilize more than 17 per cent. of the light from the crater. On the other hand, it is suggested, an improvement might be made by reverting to an old idea explained in a Swiss patent by S. Schuckert, as far back as 1889. This involves the use of an ellipsoidal mirror, the crater being at one focus, the objective lens at the other, and the film in between. Theoretically as much as 75 per cent. of the light from the crater can thus be collected.

RUSSIAN SOLDIERS AMAZED AT WIRELESS.

An interesting description is given by a Russian officer of one of the numerous little mobile field wireless outfits operating near the front. The whole wireless station can be unloaded from its auto truck, rigged up and be ready for work in twenty minutes. The seventy-foot masts are hollow and made in sections, which are screwed together when taken off the truck.

The simple peasant soldiers, many of whom come from remote villages where wireless has never been heard of, are greatly fascinated by the station, and like to stand around when they can get a chance and watch the flashing of the spark and listen to its song. "It sounds like butter in a frying pan," they say. They have coined a nickname for the men in the wireless crew, which, as near as possible in English, is "sparkers" or "the spark men."

Experimental Physics

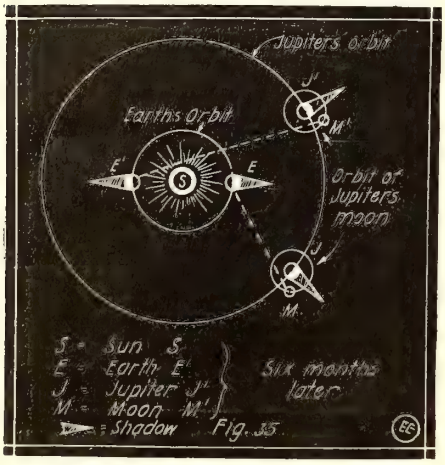
By

JOHN J. FURIA, A. B., M. A. (Columbia University)

LESSON 8.

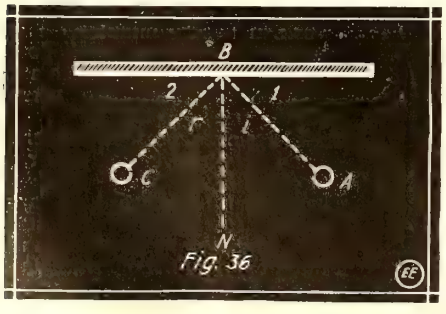
Light.

MOST people have the erroneous idea that light passes instantaneously from the source to the observer. In the year 1675 Olaf Roemer, a Danish astronomer, found that his prediction of an eclipse was



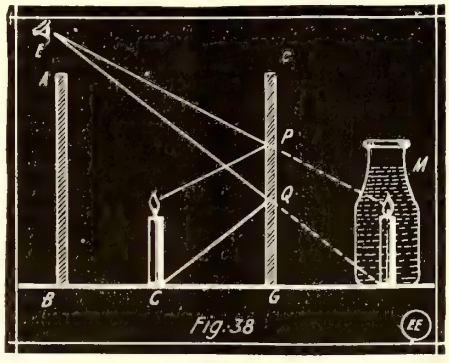
Due to the Difference in Time Elapsed Between the Eclipses of One of Jupiter's Moons, Roemer in 1675 Deduced That This Deviation Was the Time Required for Light to Travel Across the Earth's Orbit.

in error. He had observed and noted carefully the instant when one of Jupiter's moons M (Fig. 35) past into Jupiter's shadow when the earth was at E, and by computation predicted the exact instant when another eclipse should occur six months later when the Earth was at E¹. Actually the eclipse occurred 996 seconds later than at the time predicted, and Roemer concluded that the delay represented the time required for the light to travel across the Earth's orbit, a distance which was known to be about 180,000,000 miles. Thus it was found that light travels about 186,000 miles per second. This speed is so great that it would carry light nearly eight times around the Earth in one second, so it is no wonder that the idea prevails that light travels instantaneously. However to the astronomer who deals with the enormous interstellar distances the speed of light seems as the speed of a 1903 model Ford with only one cylinder in working order. It takes 4 and one-half years for light to travel from the earth to the *nearest* star. If one of us should be up on the Pole star with a telescope powerful enough to see events on the earth, he would not see the battle of Gettysburg, which occurred July, 1863, until January, 1918, the Pole star is so far away.

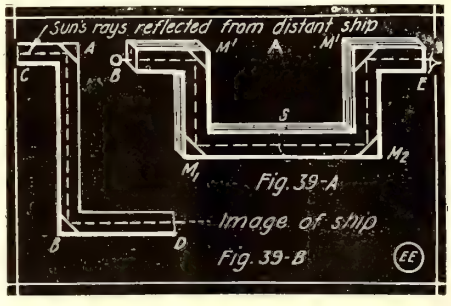


The Principle of Light Reflection; Angle "i", Incident Angle Always Equals "r", the Angle of Reflection.

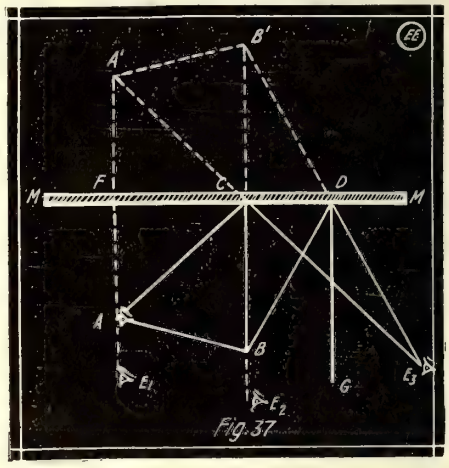
EXPERIMENT 46. One of the most important properties of light is that of *reflection.* When a billiard ball strikes the sides of the table obliquely, it rebounds in such a manner that the angle made by the ball on striking and the angle made on rebounding *are equal.* In Fig. 36, A is the position of ball before being struck by the cue, B is the point on the cushions of the billiard table where the ball strikes, and C is the position of the billiard ball after rebounding. Angle 1 equals angle 2. If BN is a line perpendicular to the cushion, angle i equals angle r. Angle i is called the *incident angle* and angle r the *angle of reflection.* The law of reflection is usually stated THE ANGLE OF INCIDENCE IS EQUAL TO THE ANGLE OF REFLECTION. The fact that the law of reflection holds true for light makes possible the use of many instruments, one of the most important at the present time being the *periscope.* The writer learned the law of reflection at school long ago on those occasions when the sun shone into the room and the teacher pulled down the shades. A beam of sunlight would enter the room from the sides of the shades and the writer by means of a pocket mirror would reflect it so that the angle of incidence being equal to the angle of reflection, and the teacher's face being along the angle of reflection, it would become illuminated, to the extreme discomfort of the teacher and the unbounded pleasure of the pupils. Things would have fared very well had not the teacher also known the law of reflection, and hence been able to locate the innocent culprit. (Innocent according to the pupils, and culprit according to the teacher.) When a surface is smooth as in the case of a mirror each point of an object is regularly reflected, and a sharp image is formed. When the reflector is rough, as in the case of ordinary paper or the walls of a room, each particle of the surface reflects regularly, but since the particles are not all on a level stretch, the reflected light is scattered, and this is known as *diffuse reflection.* Some girls' noses are smooth and shiny (regular reflection) but after an application of face powder, the noses are no longer smooth and shiny but rough (diffused reflection). The Sun, a gas flame, etc., are visible because of the *light they emit,* while ourselves, books, chairs, tables, etc., are visible because of the *light reflected.* All bodies except those emitting light are visible because of the light they reflect diffusely.



How a Person at "E" Can See a Candle, Invisible at "C", and Apparently Burning Inside a Bottle of Water at "M."

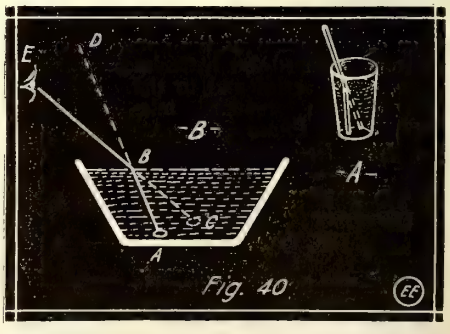


Illustrating the Principle of the Submarine's Periscope. Mirrors Reflect the Image Down the Tube and Around Corners.



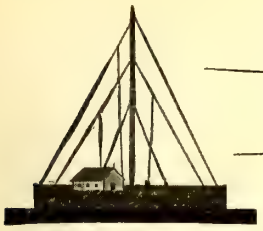
Analysis of the Principle of Mirrors. Each Point of An Image In a Plane Mirror Is As Far Behind the Mirror As the Corresponding Point of the Object Is In Front of the Mirror.

EXPERIMENT 47. To locate the image of an object in a plane mirror. Stand a small rectangular pocket mirror on its side, over a piece of paper. Draw an arrow in front of the mirror MM at AB. If now the eye is placed behind A, behind B and to the right of B respectively, in the positions E_1, E_2, E_3, the image A^1 of the point A, will be found on the straight line E_1A prolonged

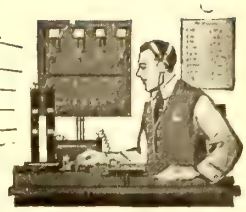


Due to the Change of Velocity of Light Rays Passing Thru a Denser Medium—Water In This Case—An Object Appears As Tho Bent or Misplaced.

(*Continued on page* 424)



RADIO DEPARTMENT



Radio-Controlled Torpedo Devised by California Genius

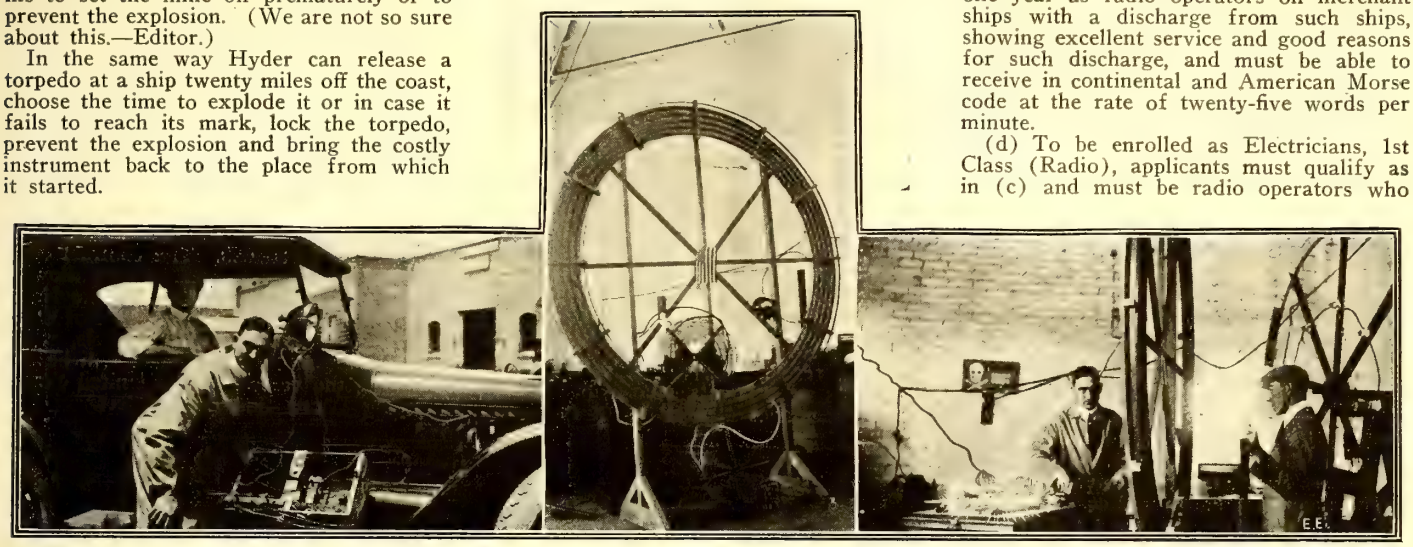
A WIZARD of electricity, whose inventions may revolutionize warfare both on land and sea and win victory for America in the great war against Germany, was discovered in the person of Henry H. Hyder, of Los Angeles, Calif., ostensibly an automobile man, but in reality a miracle worker with wireless and electricity.

Seated in his little workshop several miles away, Hyder can explode any one of a field of mines, either in the ocean or on land. He can choose which mine to explode or he can blow them all up—by wireless. No other wireless can interfere with his to set the mine off prematurely or to prevent the explosion. (We are not so sure about this.—Editor.)

In the same way Hyder can release a torpedo at a ship twenty miles off the coast, choose the time to explode it or in case it fails to reach its mark, lock the torpedo, prevent the explosion and bring the costly instrument back to the place from which it started. It may be the means of dealing the death blow to the submarine menace.

It is possible that it will mean the scrapping of the giant super-dreadnaughts of the world's great navies because of their helplessness when attacked by a torpedo controlled in every way by wireless. It will also mean a great saving in that an expensive torpedo which misses fire can be brought back and used again.

Hyder is only 33 years old and he was born on a farm in Missouri. All of his electrical knowledge has been obtained thru his own efforts, for neither he nor his assistant went to college—but, then, neither did Edison. Study will solve all problems.



Photos from C. W. Geiger

This California Radio and Electrical Inventor Claims to Have Solved Many Problems of Great Value to U. S. War Department. He Has Succeeded In Lighting Lamps by Wireless Power and Has Perfected a Radio-Controlled Torpedo Which Cannot Be Interfered With.

All of these things that he claims to be able to do he demonstrates with working models in his little workshop with the help of his assistant, Arthur H. McClelland.

For more than four months Hyder and his assistant have been working night and day to perfect the invention so that they can take it to Washington to place it before the Naval Advisory Board. Now they are about ready to demonstrate it and expect to leave for Washington within a short time.

The invention for which Hyder claims so much is not, however, the result of only four months' work; it is the culmination of fifteen years of hard study and drudgery, inspired by enthusiasm and hope. Team work has played an important part, for McClelland, Hyder's assistant, has worked with him during all of the fifteen years.

Hyder's torpedo and mine construction have not been his only accomplishment. He has perfected a system of lighting lamps by wireless which he believes will be utilized in the future to prevent ships from colliding in the fog and will eliminate the block system on the railways. By wireless he can light several lamps wired in series and keep part of them lighted when some of them are removed.

What Hyder terms his torpedo and mine construction is most important at this time.

MR. AMATEUR, "I WANT YOU!" SAYS UNCLE SAM.

UNCLE SAM is offering exceptional opportunities to young men who will join the service at this time, states Mr. Fred Mueler, Gunner (R) U. S. N. R. F. At the present time the U. S. Navy Department desires to enroll in the U. S. Naval Reserve Force radio men who are willing to volunteer for general sea service and who possess the following qualifications:

(a) Must be citizens of the United States.

(b) Must be able to pass a physical and mental examination before enrollment.

(c) Must be able to send and receive the continental code and possess some technical knowledge of radio-telegraphy. Radio men are particularly desired and those applying for enrollment as radio operators will be assigned to active duty upon qualifying.

The following is a list of qualifications required for enrollment in the various grades of radio operator:

(a) To be enrolled as landsmen for Radio Electrician, applicants must be able to receive at least ten words per minute in the continental code, write legibly and spell correctly at the rate of twenty-five words per minute, and have a grammar school knowledge of arithmetic.

(b) To be enrolled as Electricians 3d Class (Radio), applicants must qualify as in (a) and must be competent first grade commercial and amateur operators who can receive twenty words per minute in the continental code.

(c) To be enrolled as Electricians 2nd Class (Radio), applicants must have commercial licenses, must have served at least one year as radio operators on merchant ships with a discharge from such ships, showing excellent service and good reasons for such discharge, and must be able to receive in continental and American Morse code at the rate of twenty-five words per minute.

(d) To be enrolled as Electricians, 1st Class (Radio), applicants must qualify as in (c) and must be radio operators who have served at least two years on a merchant ship and possess a considerable knowledge and acquaintance with radio plants.

(e) To be enrolled as Chief Electrician (Radio) applicants must qualify as in (d), must have a broad knowledge of radio-telegraphy, must have served on ocean-going steamers for at least four years, and must pass an examination by a board of at least three officers, of which two shall be radio operators.

The rates of pay for the above grades of radio operator are as follows:

Chief Electrician (radio)	$72.00
Electrician (radio) 1st class	61.00
Electrician (radio) 2nd class	52.00
Electrician (radio) 3rd class	41.00
Electrician (radio) Landsman (for training)	32.00

Men who are enrolled in any of the above grades will be assigned to active duty under instruction at one of the U. S. Naval Reserve Radio Schools, where they will be given a course under experienced Navy in-

(*Continued on page* 417)

Brown University Trains Radio Experts

Brown University has helped to train radio experts during the past summer, conducting a radio class under the direction of Professor Arthur E. Watson, instructor of electrical engineering. More than half a hundred amateurs have been studying one and two nights a week under Prof. Watson, who is the father of wireless at Brown. Almost wholly with his own hands he built the plant on the hill and put the college on the wireless map.



Radio Students At Brown University, Providence, R. I., Studying the Ins and Outs of Wireless Transmitting Apparatus.

Up to the beginning of the war Brown had one of the best college wireless plants in the East. Prof. Watson and his students placed the apparatus, strung the wires; in short, did everything except build the towers on Maxcy and University Halls.

The apparatus had a radius of between 200 and 300 miles, and from the time of its installation "listening in" was a sport that attracted many students who previously had shown little interest in electricity in general and wireless in particular. For them the wires far above the middle campus hummed a lively and engaging tune. To listen to it once was to come again and again.

The closing of the plant did not greatly interfere with the training of future operators. Prof. Watson is too much of an enthusiast to let such a trivial matter upset his efforts. In his new quarters in the Engineering Building he straightway set up all necessary apparatus, rigged dummy aerials and kept going as if nothing had happened.

His night class caught this enthusiasm. Its students have been eager and industrious. A few started as fair amateur operators. Some had only dabbled in the art. The larger number knew nothing at all about it. But in the 10 weeks everybody added to his practical knowledge of radio.

Of all the instruments in the room the omnigraph sender is of the greatest interest. It is a small mechanical device having metal discs—a whole series of them fitting one on top of the other—that show peculiar, irregular edges. These edges are nothing more or less than the dots and dashes of the code. As the discs revolve the listeners pick out the dots and dashes and write them down, as correctly as they can, in letters.

Other students practise with telephone head sets operating on dummy aerials. Prof. Watson has strung wires from one room to another in the building and by means of them the more advanced students send and receive messages. The visitor always finds it interesting to adjust the headgear and listen in on what may be coming from a distant corner.

"We hope to encourage," said Prof. Watson, in a recent interview, "the formation of groups of students who will train in sending messages as well as in receiving. Our time is all too short for full training, but we shall try to give every student a good grounding in the first principles and to advance the real amateurs, the ones who have worked with home sets, to a fair degree of proficiency."



Evening Radio Class at Brown University. Ev en the Young Women Have Caught the Fever, As This Picture Shows.

HOW RADIO SAVED 46 LIVES OF TORPEDOED VESSEL.

The fortitude of a wireless operator in sticking to his instrument made possible the rescue of forty-six men out of fifty, on the American steamship Orleans when she was torpedoed unawares by a German submarine, according to Capt. Allen Tucker, commanding.

"We saw nothing and heard nothing," Capt. Tucker said, "until the torpedo struck us amidships and burst with such force that it seemed to tear the ship asunder. It was a fairly clear night, but the water was very black. I gave orders to launch the boats immediately, and we got all but one, which had been smashed by the explosion, into the water in record time.

"Meanwhile L. F. Larson, our wireless operator, was sitting up in his cabin and sending off S O S calls as coolly as tho they were merely commercial messages. He finally got into radio touch just as the stern began sliding under the water. I ran in, pulled him out on deck and practically threw him overboard, knowing he could swim. Then I followed and we both swam like hell to get away from being dragged under the sinking ship.

"The Orleans sank within ten minutes."

KILBOURNE & CLARKE CO. GET U. S. RADIO ORDER.

This concern has been given a contract by the United States Navy Department for the construction and delivery within nine months of 250 additional radio transmission telegraph sets, at $988,000, which with the other contracts from the Government held by the company makes a total of 315 sets, at a cost of $1,112,000. The contract calls for 200 one-kilowatt and 50 two-kilowatt transmission sets for the use of the Navy Department. It is understood some of these are to be installed on naval vessels, while probably the most of the order will be for equipping the vessels of the United States Shipping Board Emergency Fleet.

A wireless station with a night range of 700 miles has been installed at Cape May, N. J., by E. M. Murray, a Philadelphia Marconi engineer, and E. M. Hartley of the Miami station will be superintendent.

The RADIO LEAGUE of AMERICA

HONORARY MEMBERS
CAPT. W.H.G. BULLARD, U.S.N. NIKOLA TESLA.
PROF. REGINALD FESSENDEN. DR. LEE DE FOREST.

H. Gernsback, Manager W. H. Kirwan, Master of Radio Relays

The Amateur's Opportunity

By the EDITOR

THE letter which we publish herewith is one of the many that come to the editor's desk during the course of a week.

It clearly illustrates one of the strangest situations created by the war, and it likewise has a very pointed moral. The closing of America's radio stations by our Government has had the unfortunate result in bringing to life several hundred thousand "sore heads," who in peace times were fond of calling themselves *Radio Amateurs.*

These good people, whose patriotism has suddenly gone bankrupt, always forget that the same government that granted our radio amateurs greater liberties than any other nation on the face of the earth certainly has some rights of its own.

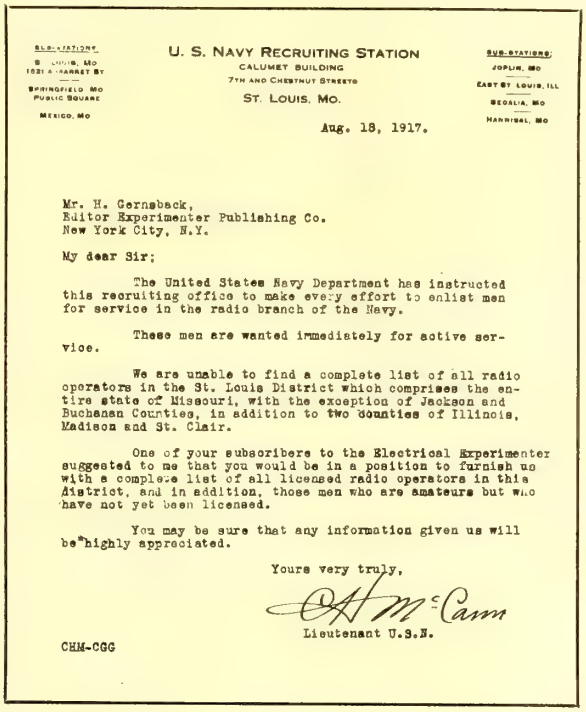
Where, Oh! where, is our far-famed American patriotism? Where is our highly lauded fair-play? Where is our gratefulness? Sore-headedness seems to be one of our latest acquired national diseases—at least in our American radio amateurs. And we cannot but condemn it in the harshest possible terms.

Why not make the best of it, particularly as the present radio situation is of course only temporary? Sore-headedness and bitter remarks about the Government do not in the least improve matters, but rather tend to make them worse. We all want our stations back after the war; we all want the ether free for all. But the way amateurs are acting now certainly tends to bring the whole fraternity into bad repute at Washington. As if amateurs had not been disliked enough before the war, with all the Q.R.M. nuisance going on in the ether continuously! Why make ourselves disliked still more? What's the matter with the American amateur anyway? Where is his logic? Where is his common sense?

And last, but not least, where does the amateur come in with his silly, nonsensical kicks? What about the wireless manufacturers who have been put out of business — wiped off the map? Are they going about the land lamenting their cruel, cruel fate? Not much. They know that war is *synonymous* with sacrifice. They are doing their bit—their big bit, rather.

What about the radio and technical magazines, which lost 99% of their wireless advertising? Take this magazine for instance, which since its start never made any money. When war was declared it lost $1,200 worth of radio advertising in a heap, and it will be losing this amount *every month* as long as the war lasts. Have these magazines, the EXPERIMENTER included, ever as much as raised their voices against the Government? Indeed not, they gladly do *their* "bit" for their country.

Then amateurs, *where do you come in?* Now, we realize that this is rather plain talk, and it is not pleasant to write it, but truth as a rule is never pleasant and we hope that our amateurs will see that we are working in their very best interest.



U. S. NAVY RECRUITING STATION
CALUMET BUILDING
7TH AND CHESTNUT STREETS
ST. LOUIS, MO.

SUB-STATIONS: JOPLIN, MO; EAST ST. LOUIS, ILL; SEDALIA, MO; HANNIBAL, MO

Aug. 18, 1917.

Mr. H. Gernsback,
Editor Experimenter Publishing Co.
New York City, N.Y.

My dear Sir:

The United States Navy Department has instructed this recruiting office to make every effort to enlist men for service in the radio branch of the Navy.

These men are wanted immediately for active service.

We are unable to find a complete list of all radio operators in the St. Louis District which comprises the entire state of Missouri, with the exception of Jackson and Buchanan Counties, in addition to two counties of Illinois, Madison and St. Clair.

One of your subscribers to the Electrical Experimenter suggested to me that you would be in a position to furnish us with a complete list of all licensed radio operators in this District, and in addition, those men who are amateurs but who have not yet been licensed.

You may be sure that any information given us will be highly appreciated.

Yours very truly,

H. McCann

Lieutenant U.S.N.

CHM-CGG

The Editor of this journal has a record of having championed the amateur's cause ever since 1908. It was due solely to his efforts that the American amateur was officially recognized, and that a law was framed for the amateur's benefit, giving him the free use of the ether.

The Editor will continue to work in the interest of the American amateur, but he cannot do so without the latter's undivided interest and his full enthusiasm. It is not pleasant to work for a lot of sore-heads, and the amateurs certainly do not wish the Editor to wash his hands of the whole matter, and "chuck up the job" in disgust.

What we want is ENTHUSIASM and plenty of it!!! Let's pull ourselves together and let us show the world what stuff we are made of. Let's all do our bit in this war, to make the world free and safe forever. To do it Uncle Sam, besides his soldiers and sailors, needs operators—operators and then some. We have them. Thousands of them. The country's full of 'em. The order of the day is to get them out into the open. And we'll do our best, or perhaps our worst, to get them to come out.

Uncle Sam just now does not require radio experts so much who can send and receive 50,000 words a minute; rather he wants boys who have a fair knowledge of radio and who like the work. Your Uncle Samuel will make an expert out of you in no time, *and he will pay you while he is doing it.* Radio work in the army and navy is comparatively safe, and while we do not in the least wish to imply that radio amateurs are cowards, we do wish to go on record with the statement that as a rule the radio man stands on a higher plane of intelligence than the average plain soldier or sailor.

Recognizing this, Uncle Sam pays the radio operators and signal corps men more money than to the soldier or sailor of the rank and file. Now if this does not spell opportunity for you, we'll eat a 5-K.W. transformer, spark gap, wires and all!

Amateurs, again we'll tell you, *you don't realize how really valuable you are to your country.* So why hide yourselves away?

Now then, here is our plan, and we expect *full* co-operation from every one of you, even if you can't send or receive more than five dots and six dashes per minute!

We are going to compile the most complete file of Radio Amateurs in the country, *who are willing to do their "bit."* The files of the "Radio League of America" now contain some 16,600 names—a pitiful amount compared to the total of some 300,000 amateurs.

We want this list so that when Uncle Sam writes to the Editor asking him for names of radio operators, we will be in a position to send him thousands, where we send him dozens now. Take for instance the letter publisht here; all we could send to L't. C. H. McCann was forty names. A fine showing, that—not! **Now to make it interesting for you, amateurs, beginning**

(*Continued on page* 415)

AMATEURS OF AMERICA!
I Herewith Propose
"THE RADIO ROLL OF HONOR"

I call upon every radio amateur in America to do his "bit" in this war. Amateurs, this is the most important message to you I have ever written. I consider it more important than my Editorial in the November, 1908, issue of "Modern Electrics," which was the direct cause of placing the American Radio Amateur into the Radio Law of 1912, thereby giving you the free use of the ether. Amateur Wireless owes a large debt to America. Now is the time to repay that debt with interest. Will you do it?

H. Gernsback

A Radio Controlled Model Boat

By H. C. Van Benthuysen and Max I. Black

FROM time to time in the ELECTRICAL EXPERIMENTER we have read articles on wireless control. We have taken much interest in publications along this line, having constructed a selective control set in the summer of 1916 ourselves; yet we have not run across a set

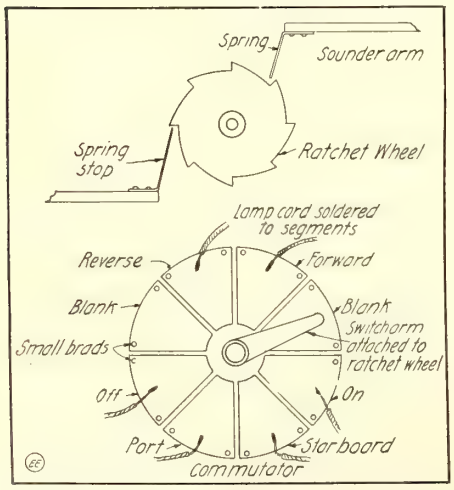


Appearance of Model Boat Fitted With Wireless Control Apparatus. This Kind of Work Is Bound to be Highly Remunerative and Radio Experimenters Will Do Well to Investigate the Many Unsolved Problems In This Field.

that has mentioned as great a range of use, this set having been used in a small demonstration wireless controlled boat, controlling toy reversible electric trains, shooting fireworks—in fact it can be used with any machine which is controllable by electricity.

In July, 1916, this apparatus was installed in a six-foot electrically propelled boat and on the 4th of that month a demonstration of "The Wireless Control of a Boat" was given at Riverside Park, on the James River, at Mitchell, S. D. In April, 1917, the same apparatus was used for a demonstration and talk on the "Science of Telautomatics," given before the Mitchell Science Club, a branch of the South Dakota Academy of Science.

This selective set is simple and easily constructed. The controlling apparatus is an ordinary coherer set, the relay of which actuates a sounder to which is attached a ratchet wheel control for a second sounder. This second sounder operates an eight-point rotary switch of the commutator type. When used in the boat two segments of this switch are blank. The other six operate two solenoid reversing switches and one solenoid cut-off, which controls the helm motor only. It is possible to use the two blank segments for a solenoid cut-off for the propeller motor altho we did not find it necessary. The order of the points are:—*"reverse," "forward," "on," "starboard," "port"* and *"off."* The *"on"* and *"off"* control the helm motor so it will not be in operation continuously. The helm motor is geared down by means of a worm drive which also keeps the rudder rigid. This also gives the operator a chance to skip over the starboard and port *without altering the course of the boat.* With this arrangement the operator has complete control over the boat.

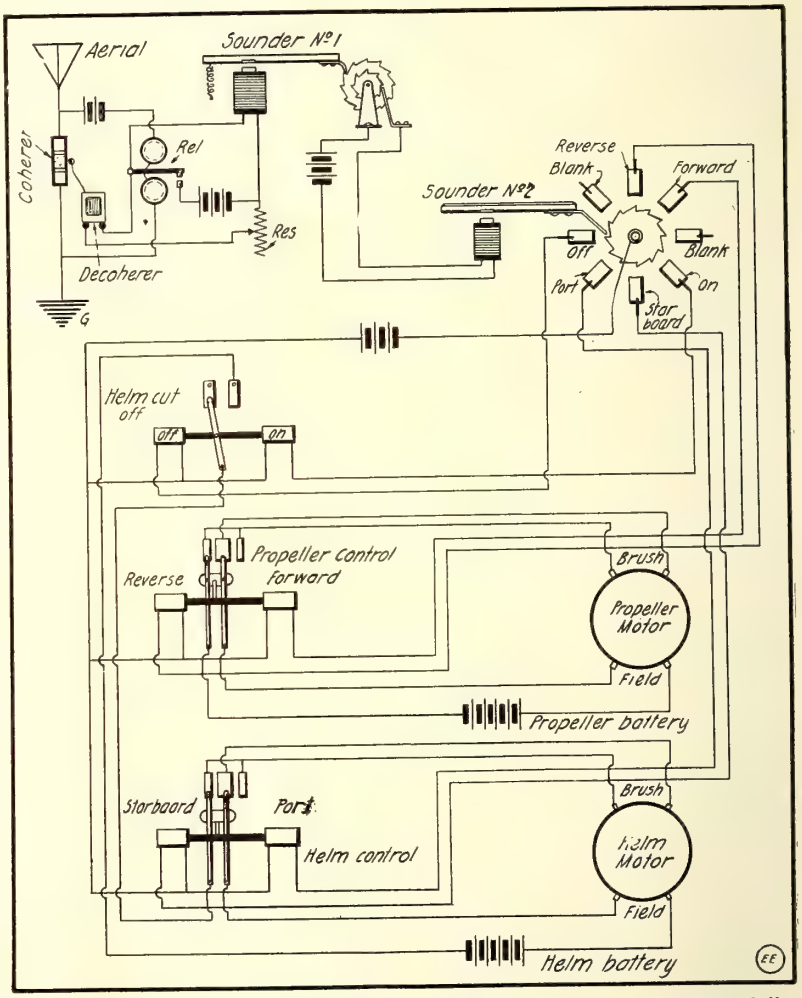


Detail of Sounder and Ratchet Wheel Mechanism for Successively Switching In and Out of Circuit the Rudder Control Magnets, Propeller Control, Etc.

For the selective control of a miniature electric train a four-rail track is used (two rails for the field and two for the brushes so the train may be reversed). With only one reversing switch being necessary, thus giving four blank points on the eight-point rotary switch, instead of two, as in the case of the boat. With these connections switching can be demonstrated with a toy electric train.

The radio apparatus is made up of a precision coherer, and a fifty ohm pony relay with an ordinary bell decoherer. The sounder switches are any ordinary fifty ohm sounders with an extension arm which operates a ratchet wheel. (See diagram.)

The solenoid magnets for the reversing switches and the cut-off switch are made of a core consisting of one layer of zinc (wound on a pencil for uniform diameter). Each core is about three inches long. The ends are split and folded out to hold on the fiber ends of the coil. When the core and ends are assembled wind on three layers of No. 24 D.C.C. magnet wire. Wrap the whole coil with a layer of tape. The armature is an iron rod about five inches long and just large enough to slide easily in the core of the solenoid. The solenoids are placed in such a position on a suitable base that when the armature is clear in, the end will be about one-half inch from the outside end of the core.



Lay-Out of Circuits, Including Coherer and Sensitive Relay, As Successfully Used In the Radio Control of the Model Boat Illustrated and Described In the Present Article.

IOWA STATE UNIV. WILL TRAIN ARMY TELEGRAPHERS.

In response to a request from the central department signal office of the United States Army, the Iowa State University will give during the next school year a course of training for telegraphers and wireless telegraphers. The work will be in charge of the head of the electrical engineering department and will be open to young men of the state, without regard to entrance requirements usually made of students by the University. The course for the individual will last only until he has mastered the art of telegraphy sufficiently to pass the government's examination in the subject.

"The need of telegraphers in the signal corps is serious," declared Lieut. Col. Wildman in a letter to President Jessup. "The available supply has been exhausted and new men must be trained to complete the present organization and prepare for all future increase."

Measurements of Radio Antenna on Shipboard and Some Interesting Comparisons

By F. A. HART

Variations of capacity, inductance and fundamental wave-length have been selected by the author from measurements taken on a large number of vessels, and covering at the same time as broad a range as possible. These data should be of interest to marine engineers and advanced experimenters, especially in the case of aerials erected on roofs, such aerials being under very similar conditions as regards effect from near-by metal, stays, etc., which materially affect the capacity of the aerial.

In connection with ship stations a great deal has been said about compass troubles, generally attributed by masters to the nearness of the aerial lead-in wires in each specific case. It might be well to point out that exhaustive tests have been made from time to time, and absolutely no disturbance noticed, says F. A. Hart in *The Electrician*, London. On the other hand, the proximity of a motor-generator or other large mass of iron to the compass would tend to have some effect.

The lengths used in the table are given in feet, capacity in micro-farads, inductance in centimetres and natural wave-length in meters.

For simplicity, each type is designated by a number. The overall or total length of wire from apparatus of the "L" aerials is taken as the horizontal plus the vertical, and in the "T" aerials half the horizontal plus the vertical. All these aerials are comparatively small in actual amount of wire compared with aerials in coast stations, and a good many should compare very nearly with many amateur receiving aerials, some of which are of even greater length.

Aerials such as Nos. 6, 9 and 28 are the least efficient for 200 and 300 metre waves, as the fundamental is very large, the capacity low, the radiation resistance high; and in order to reduce the aerial to small wave-lengths the series condenser would have to be less than 0.0004 mfd. As both capacities are so small, the radiation from any set less than one kilowatt would probably not be greater than one-half ampere. Judging by the results, for those who wish to transmit efficiently on 200 or 300 meters, the aerial should be made a "T" where the horizontal length is 120 ft. or over. As a rule, the most efficient working wave-length where a series condenser is not used is about 0.9 of the natural wave-length. For instance, in the case of No. 23 the natural is 230; taking 0.9 of this value and adding it to 230 we get 437, which should give the greatest radiation for that particular size of aerial.

In the case of Nos. 15 and 16, these measurements are identical, with the exception of a trifle greater height and 55 ft. more wire in the horizontal length of No. 16. Everything being equal in both cases, except the relation of the vertical wires to the bridge railings and metal stay in No. 15, this apparently makes up for the 55 ft. of extra length in No. 16.

The most marked of deck and work effects is in Nos. 38 and 39, the vertical length in No. 39 running parallel with three stays from the top of the mast to the wireless cabin. In No. 38 they run practically the same, also considerably increased by the nearness of the funnel. The "T" type aerial has been found as a whole to give the best all-round results, and is less likely to be affected by foreign matters. The spring stay should be removed and all other stays either grounded or broken up with insulators to ensure against induction and the most effective work from the radio apparatus.

Aerials in which stays, decks or other metal work figure largely are Nos. 18, 19, 20, 21, 22, 30, 33, 34, 35, 36 and 37, in every case affecting the vertical length. The ground lead in all examples given does not average over 3 ft., and is sometimes less.

No. 1 is a very good type of aerial for amateurs who wish to transmit. No. 40 is also in line with No. 1; the capacity runs higher, altho the lengths are very small, and the nearness to all metal work and the large number of wires has helped to increase this.

One can readily see from the table how important it is to keep the overall lengths as small as possible where there is any possibility of metal increasing the capacity.

Two-wire Aerials.

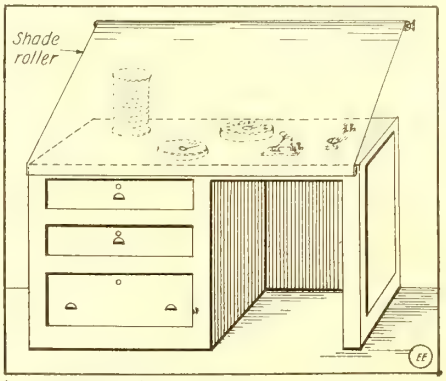
No.	Type of Aerial.	Height.	Lengths. Horizontal.	Vertical.	Total.	Capacity.	Inductance.	Natural Wave Length
1	T	92	130	50	115	0.00075	22,000	232
2	T	110	151	85	160	0.00090	26,363	290
3	T	90	210	50	155	0.00092	29,860	312
4	T	91	208	64	168	0.00096	30,975	325
5	L	86	216	65	281	0.00101	34,217	350
6	L	135	238	80	318	0.00095	61,434	455
7	T	100	240	80	200	0.00140	30,603	390
			Four-wire Aerials.					
8	L	68	127	90	217	0.00082	49,621	380
9	T	150	250	90	215	0.00096	53,210	426
10	L	70	90	90	180	0.00099	23,600	295
11	L	125	112	75	187	0.00105	41,932	395
12	T	128	178	100	189	0.00108	34,215	362
13	L	90	100	60	160	0.00110	30,100	340
14	L	80	120	50	170	0.00115	20,188	287
15	T	110	170	70	155	0.00115	28,333	340
16	T	100	225	70	182	0.00115	28,333	340
17	T	115	170	88	173	0.00116	22,184	320
18	L	112	220	105	325	0.00130	30,854	380
19	L	100	120	80	200	0.00135	30,784	384
20	T	100	260	58	188	0.00136	23,933	340
21	L	100	150	50	200	0.00140	26,952	366
22	L	105	204	64	268	0.00145	28,038	380
			Six-wire Aerials.					
23	L	55	125	50	175	0.00085	17,532	230
24	L	80	98	50	148	0.00100	33,246	345
25	T	135	150	90	165	0.00102	25,690	305
26	L	125	155	85	240	0.00109	36,272	376
27	T	96	200	85	185	0.00118	21,192	298
28	L	105	270	70	340	0.00120	55,902	488
29	L	94	138	50	188	0.00120	30,085	358
30	L	98	104	90	194	0.00120	20,428	295
31	L	125	225	80	305	0.00124	46,615	453
32	L	115	141	84	225	0.00125	30,335	367
33	T	60	165	35	118	0.00126	20,134	300
34	L	95	150	70	220	0.00128	30,946	375
35	L	115	190	95	285	0.00140	32,200	400
36	L	100	150	60	210	0.00145	38,451	445
37	L	120	200	70	270	0.00150	34,272	424
38	L	145	225	100	325	0.00180	27,343	418
39	L	98	200	60	260	0.00240	21,200	425
			Ten-wire Aerial.					
40	L	50	80	30	110	0.00068	16,639	200

L = mean standard inverted "T".

A DUSTPROOF COVER FOR RADIO SETS.

Having an open desk on which my radio set was mounted, and being greatly troubled with dust, I hit upon the following simple but efficient method of protecting it from dust. A shade roller, three feet long in my case was mounted on the wall about six inches above the desk. A cloth three feet wide and long enough to cover the entire set when fully extended was nailed to the shade roller. It operates as follows: When ready to use set, take hold of cloth and pull away from the roller and then let go. The cloth will wind itself about the roller. An ordinary shade will do, but I use a cloth because it presents a neater appearance and is besides more flexible than the ordinary shade. Rollers can be obtained of any length for a nominal price.

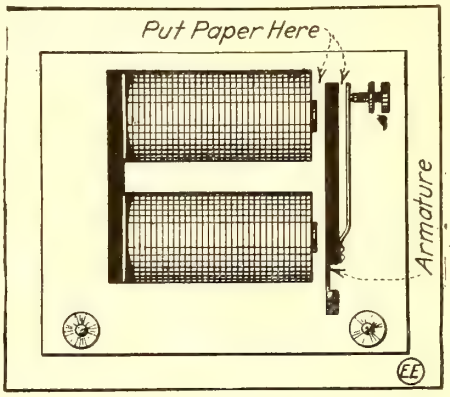
Contributed by CARL BERNHARDT.



A Convenient Way In Which to Protect Your Apparatus Table From Dust, Utilizing a Common Window Shade.

MAKING THE BUZZER "HY-TONE"

The great trouble with ordinary buzzers used for detector tests, is that they do not emit a high tone. I found that if tightly folded pieces of paper were placed between the magnet and armature and between the armature and spring that carries the contact, the tone was thereby raised. The best thickness of the paper must be found by experiment. Also, the contact screw must be regulated to get the highest tone. Rubber bands may also be used. These are snapt around the buzzer in such a way as to pass thru the same points as occupied by the paper.

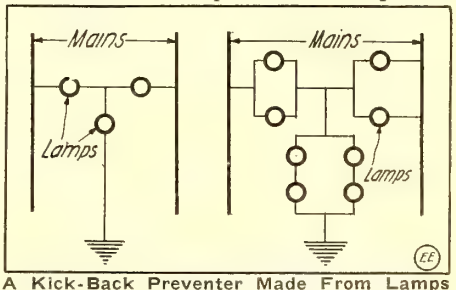


Any Buzzer Can Be Made to Give a High Tone By Placing Paper on Either Side of the Armature, As Shown.

Contributed by E. D. PAPKEE.

A LAMP "KICKBACK PREVENTER."

Two lamps are connected across the line, the wire between the lamps being grounded thru the third lamp. With low powers there will be little danger of the lamps being burned out, and in the case of higher powers, two lamps may be connected in parallel in place of only one lamp. Carbon lamps are capable of carrying heavy overloads and are good for the purpose.



A Kick-Back Preventer Made From Lamps Properly Connected.

Contributed by THOS. W. BENSON.

A Key That Will Handle 1 K.W. for $1.00

Following is a description of a wireless key that is easily made. With a wooden base it costs about $1.00.

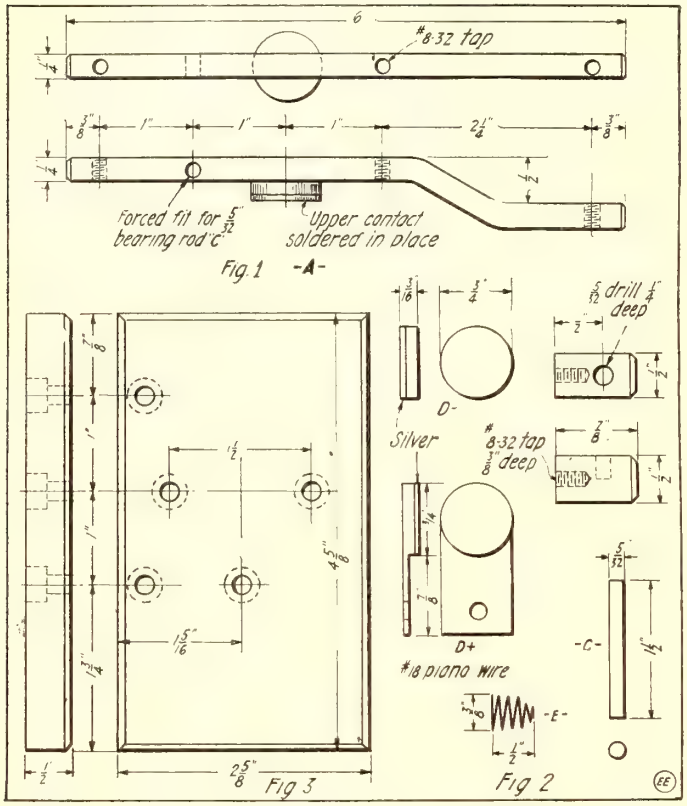
The lever, shown in detail in Fig. 1, is made of a ¼ inch brass slider rod about 7 inches long, bent as in the drawing. This can be done by placing it in a vise and carefully tapping it with a hammer. The bearing rod (Fig. 2-c) is made of a short piece of 5/32 inch brass or steel rod. This is forced thru a hole in the lever 1⅜ inches from the end. A little solder will hold this in place or it may be pinned in position. The bearing posts are of ½ inch square brass rod, see Fig. 2-b. The contacts D— D+, Fig. 2, consist of two pennies and two dimes soldered together. The upper contact D— is then soldered to the lever, Fig. 1. The lower contact is then soldered to a short piece of copper or brass bar with a binding post mounted on the end. Binding post G, Fig. 4, may be connected to the lever in numerous ways.

A well-known wireless key makes use of a bronze spring pressing up against the lever. Another way is to connect to the bearing post. The tension spring "E" requires no explanation, except that it may be made of brass spring wire instead of piano wire. This spring may be adjusted before the final assembling of the key by cutting off a small piece or stretching it, until it is the right length, thus eliminating the thumb nut "F."

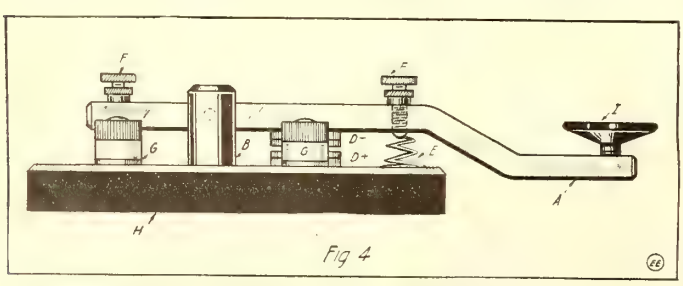
The binding posts G, G, the thumb nuts F, F, and the key knob I, may be purchased from any electrical supply house for about 6 cents each.

The base may be made of wood, fiber, hard rubber or marble. The latter improves the looks of the key considerably, but it comes rather high and does not improve the working of the key. Nickel plating improves the appearance also. This key will take care of a 1 K.W. set, and if carefully made will equal a $6.50 key.

Contributed by ALBERT PARDEE.



Details for Making a First-Class Radio Key Suitable for Transformers Up to 1 K. W. Capacity.



View of Assembled Radio Transmitting Key.

The "What to do with your Radio Set" Contest Concluded

When the Navy Department declared all radio stations closed, it seemed as if I would have to pack my instruments away for about six months or more, as there seemed to be no further use for them.

However, I decided to use my instruments in some other way than ascribed for them in their original use. Finally I evolved the idea of building a very sensitive microphone.

The following instruments are used: A wireless telephone transmitter (or an ordinary telephone transmitter), an Audion amplifier set and phones. The wire from the aerial is used to connect the different instruments. Where one wire crosses another, the insulators can be used to insulate them. If this set is to be put up between two buildings, a return wire can be used by the ground usually used in wireless. —JACOB FEIGENBAUM.

Radio Instruments Useful in Electro-Chemistry

Any up-to-date wireless outfit may be used in the study of "electro-chemistry." The amateur can make use of nearly all his instruments. The transformer and spark gap will make a fine little electric furnace or open arc. Electrolysis, electroplating, and electrotyping are easy. Delicate indicators and variable instruments will be of use in electromotive force tests. The effects of magnetism and various waves on chemical actions is interesting. Battery jars and electrodes come in handy. The resourceful American amateur would need only glass-ware, some common chemicals, and a text-book, to make a complete laboratory. The EXPERIMENTER might take the place of the text-book. I have made a good chemical laboratory of my wireless room, and am teaching some grammar school boys the mysteries of chemistry. Electro-chemistry is as instructive and interesting as wireless itself, and I recommend it to all other amateurs. —J. FRANKLIN STYER.

Miscellaneous Experiments for the "Radio-Bug"

Imagine yourself to be an amateur who has been presented with an efficient sending and receiving outfit; time—Xmas. Time flies as you persevere over the code. Feb. 3, 1917, U. S. breaks relations with Germany. You are able to hear NAA give out reports and gossip over the war. April 6, 1917, U. S. declares war on the German Imperial Government. April 7, 8, 9, Radio inspectors are around sealing stations. This happens just when you were on the road to Radio fame. Wouldn't it jar you?

Cheer up! Perhaps this will help you. These ideas of mine enable the "Radio-Bug" to use his apparatus in war time without evading the Federal law.

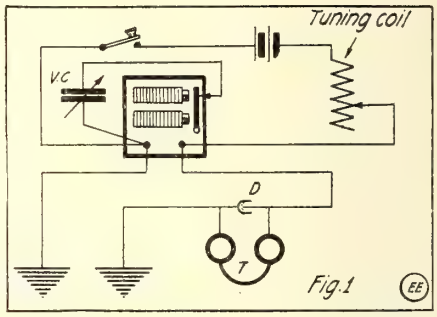
The apparatus used is as follows:

Key, batteries, coil or transformer, gap, condenser and helix.

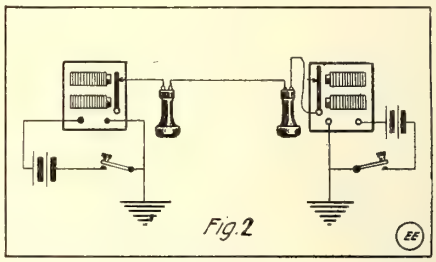
Variable or fixt condenser, loose coupler, detector, 'phones, and buzzer, perhaps a tuning coil and potentiometer.

Idea No. 1 enables you to learn the code or gives you practise so that you won't get out of trim. Uncover that soap box and get out a key, some batteries, a buzzer, 'phones and detector, and the tuning coil or potentiometer. Connect up according to diagram 1. The tuning coil or potentiometer act as rheostats and increase or decrease the pitch of the buzzer. The condensers absorb the spark usually present at the contact point of the buzzer. This is a modified buzzer test. A two station buzzer line has been installed in our high school and we certainly have fun. Here, a key, batteries, buzzer and 'phones are used. (Fig. 2.)

High frequency experiments may be tried and currents obtained by using a transformer or spark coil, batteries, gap and helix. The transformer takes the part of the Tesla coil or Oudin resonator. Look up your old E. E.'s for H. F. experiments. Then get to work, persevere and enjoy yourself.—GEO. KRUEGER.



A Simple Buzzer Set for Practising the Code.



An Efficient Buzzer Telegraph System Good for Several Miles.

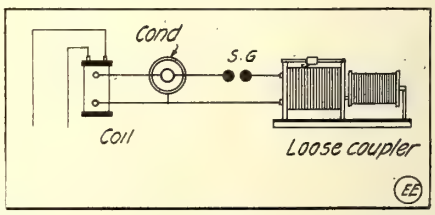


Fig. 3. Old Tuning Coils or Loose Couplers Can Be Used As High-Frequency Oudin Resonators.

RADIO WRITERS — ATTENTION!!!

Can you write radio articles dealing with the practical problems of wireless operating? We can use some good papers on such subjects as "the tuning of radio transmitters"; "the use of the wave meter, including its application to measuring the frequency, wave length and decrement"; "operation of commercial transmitting and receiving sets"; "the operation of army trunk sets"; "improved ways of receiving undamped wave signals," also new ideas and short-cuts for learning the codes. We pay well for all articles accepted. Help yourself, your magazine and your country.

A Simplified Variable Condenser

By R. U. CLARK, 3rd

ALTHOUGH there are a great many forms of variable condensers on the market today, there are few types which can be readily constructed by the average experimenter, which will approach the compactness, and good appearance embodied in many stock articles of this nature.

A condenser constructed on the general lines of the one described herein should comply with the above requirements, and as can be seen from the sketches will require but few materials and little work for its completion.

As various capacities will be desired by the different amateurs who may decide to make this instrument, no definite dimensions will be specified in the following notes, except to show the general relation, in regard to size between the different parts which enter into the construction.

Very few parts are necessary for the work in hand, the complete list of materials is as advised at this point. 1 round tubular fiber or composition case. 1 round top, of metal, fiber, or hard rubber, etc. A small quantity of lead. A few feet of thin brass or copper ribbon, about one inch wide, preferably of soft metal. Several pieces of paper tape, about three-fourths of an inch wide, by about one sixty-fourth thick. 2 short lengths of 1 inch half round fiber. Brass screws, about one-quarter inch long, two small brass screw-eyes, 2 binding posts, a short round brass rod and small composition knob, complete the list with the exception of a short length of flexible copper ribbon.

In order to construct the condenser it is necessary to cut the brass or copper ribbon into two equal lengths, each one inch wide, and with a few of the small brass screws mentioned, fix one end of each piece to the flat surfaces of the half round fiber, one piece of brass to one of fiber. This should be done in such a manner that the end of each brass strip comes to within about 1/8th inch of the center of the fiber, on the flat surface, both brass strips also being positioned near the center of the fiber, in regard to the distance from each end.

The two flat surfaces of the fiber are now fitted together in such a manner that the two pieces form one round rod, with a brass ribbon apparently passing thru the center. One of the pieces of brass should now be wound part way around the rod, till it comes into contact with the other piece.

When the above steps have been taken,

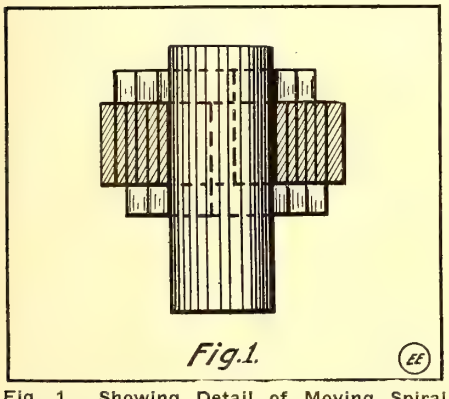


Fig. 1. Showing Detail of Moving Spiral Plate Member of Variable Condenser; the Brass Ribbon Spiral Is Held by Molded Lad.

the fiber rods should be slid along on each other, so that if the metal ribbon is wound around the rods, the pieces will overlap at each end 1/4th of an inch, thus forming a winding 1-1/2 inches wide. Before the winding is commenced however, two pieces of paper tape should be placed between the brass strips, and two additional pieces made fast to the outside surface of the second metal ribbon, in such a position that when the several layers of metal and paper have been wound into a tight coil, there will be an empty annular space ¼th of an inch deep between the brass strips at each end of the coil, the remaining ¾ths inch near the center being filled with the paper tape, as shown in Fig. 1.

In order to wind the paper and metal in the manner specified, it will first be necessary to clamp both ends of the fiber together. After the coil has been completely wound, it should be bound with paper tape, until the outside diameter of the paper ring thus formed is equal to the inside diameter of the tubular condenser case. Both ends of the fiber can now be sawed off flush with each other, one end being sawed off about ⅛th of an inch from the end of the coil. The other end should extend about ¾ths inch beyond the end of the coil; see Fig. 1.

The clamps can now be removed from the fiber ends, and the condenser case split over the coil, which should be pushed into position, so that the short end of the fiber comes to within about ⅛th inch of the top end of the case. Molten lead should now be poured in to fill the remaining space to the top of the case, after a short strip of very thin copper ribbon, about one-fourth inch wide, has been inserted in the space betwen the pieces of fiber. This piece should be bent over once at the lower end before being inserted, so that when the lead has been poured, the copper ribbon cannot be withdrawn.

The condenser case should now be moved along over the coil of metal and paper tape, until the other exposed ends of the fiber pieces extend beyond the case about 1/8th of an inch. This should cause the upper lead casting to move down about 1 inch.

Several layers of paper tape should next be wound around the lower end of the case to form a mould for the lead base which is integral with the metal portion which holds the lower set of spiral plates as shown in Fig. 2.

The various parts are now removed from the case, and the two sets of spiral plates are carefully pulled apart, the paper tape being removed at the same time. If these parts are now placed in their original positions in the case they should slide freely in and out of each other. In the event of the friction being too great to allow free movement, the lead and fiber on the movable portion of the plates can be filed down a little to permit unobstructed movement.

The top piece for the condenser should now be slotted to allow the copper ribbon to pass thru, the latter being then attached to the round brass rod, mentioned in the list of materials.

The top is next fastened to the case by means of a brass screw eye on one side, and a small screw binding post on the other. The brass rod mentioned above is then put into place, being slipt thru the screw eye on the right hand side, as in Fig. 2, and using for its other support a second screw eye held in the binding post as shown.

A composition or rubber knob placed on one end of the brass rod, and a small binding post fitted to the lead base, complete the construction of the condenser.

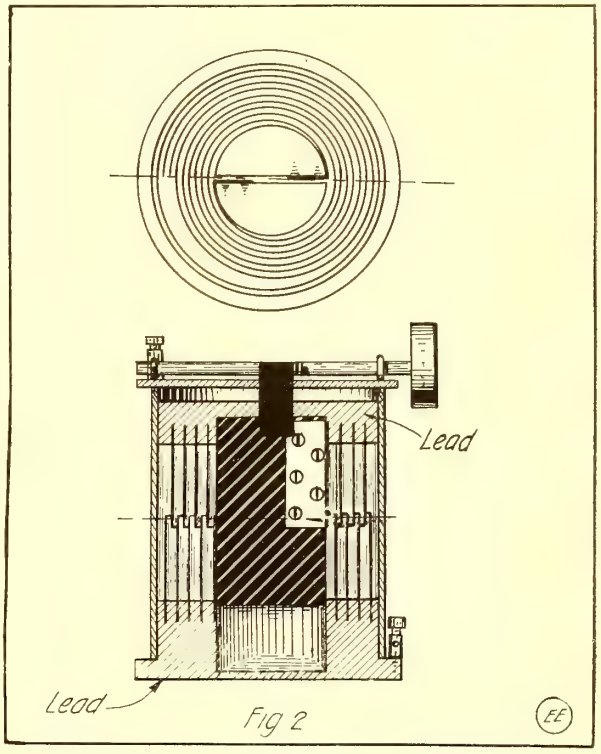


Fig. 2. Unique Variable Condenser, Suitable for Radio and Other Circuits. The Movable and Stationary Plates (Spirals of Brass Ribbon) Are Both Held by Molded Lead at Top and Bottom of the Condenser, As Shown. Oil Dielectric Can Be Used, Giving As High As Five Times the Capacity With Air.

In operation the plates are separated by turning the knob, the weight of the movable plates causing them to sink into place between the fixt plates, when the knob is turned in the proper direction, and the friction on the rod, brought about by compressing the bearings, prevents the plates from moving on their own account.

This condenser can be shellacked around the bottom joint and filled with oil to increase its capacity, and in this maner a very compact and simple instrument will be obtained which will give excellent results.

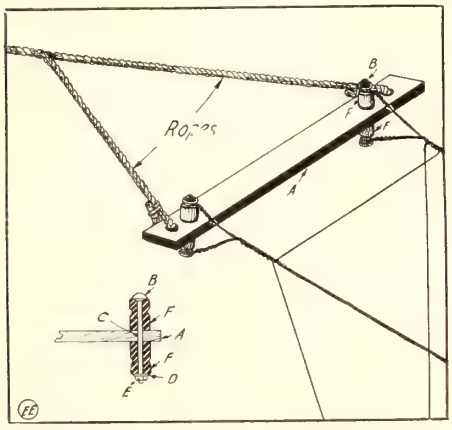
MAKES RESERVATION IN "ENGINEERS" BY WIRELESS.

Fearing that he would arrive too late to enlist in the Eighteenth engineers, railway, United States Army, Warren A. Taylor, a railroad man of Cordova, Alaska, recently wirelessed Col. J. B. Cavanaugh, commander of the regiment, to hold a place for him. Taylor arrived in time to enlist at the Eighteenth's emergency recruiting office.

For the last seven years Taylor has been an engine man on the Cooper River Northwestern. On learning that the United States was organizing nine railway regiments to send to France, he began preparations for the trip to Seattle to enlist. He was delayed, but decided to take a chance on getting into the regiment on the eve of its departure for Europe. When the steamship Alaska was two days out he sent the wireless asking for a "reservation."

PORCELAIN KNOBS AS ANTENNA INSULATORS.

The drawing is that of an aerial which is insulated with material which is commonly found around any work shop. By looking at the illustration you will see that it comprises merely two porcelain knob



Clever Way of Utilizing Porcelain Knobs In Supporting Antenna or Other Line Spans. The Knobs Are Bolted to the Spar in Pairs as Shown.

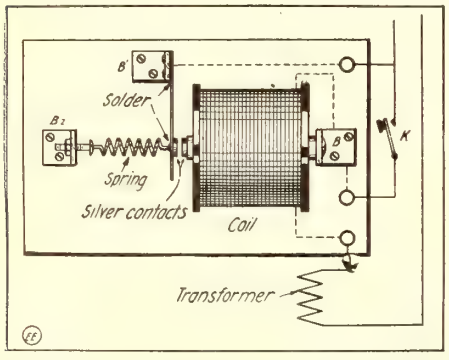
insulators, fastened on the spreader by a bolt of sufficient length. This is a cheap but neat insulator and will work very nicely for receiving or small sending stations.

Contributed by
BENJAMIN L. TEAM.

AN ARCLESS MAGNETIC RADIO-RELAY.

To make this key first take an electromagnet that has a tapt hole in one end and rewind with wire that is heavy enough to stand full load current of the transformer, grounding one end firmly to the core. (Allow 800 circular mils per ampere for cross-section of wire.) Then rivet a piece of silver on the end of the core opposite the hole and mount on a suitable base by a bracket B, formed by bending a piece of heavy sheet iron into the shape of an L, but before bending drill three holes in it, two to hold it to the base and one to accommodate a screw to support the coil, as shown. Then make two more brackets, B_1 and B_2, similar to B, of heavy sheet brass. To B^1 (see drawing) is soldered the armature, which is made of a piece of thin sheet steel. On to this is soldered the other silver contact which corresponds to the one on the end of the coil.

The third bracket may be made exactly like B, and will be used to hold the helical spring and its means of adjustment, as



Due to the Fact that the Alternating Current from the Transformer Line Flows Thru the Key Magnet Coil, the Final "Break" of the Circuit Occurs at the Zero Part of the Cycle.

shown. The other end of the spring is soldered on to the armature, as soon. Three binding posts should be provided and connected, as indicated by dotted lines. The external connections are also shown.

Now, if the key is deprest, current will flow thru the key, transformer and relay coil, the current thru the latter causing it to attract its armature, which will alternately open and close the silver contacts, which are shunted across the key, due to the alternating character of the current flowing in it, the armature flying back when current approaches zero, to be attracted again when it increases again, etc.

Now, if the key is releast when the value of the current is great enough at that instance to attract the relay armature, the circuit will not be opened by the key, therefore no spark occurs at its contacts; nor will the circuit be opened until the value of the alternating current has reached a value so low that it can no longer hold the armature, which then flies open, opening the circuit when there is very little current flowing, which means practically no spark at the relay contacts.

The difference in time between the opening of the key is so short that it is unnoticeable, being less than 1-1/120 part of a second when 60 cycle current is used.

Contributed by LOREN ANSLOW.

MAKING SWITCHBOARD AND INSTRUMENT BASES OF SLATE.

Owing to the high cost of hard rubber, vulcanized fiber and other suitable materials, many amateurs use wood, with the result that the instruments are not efficient, due to the fact that wood easily absorbs moisture. I would suggest that greater use be made of ordinary roofing slate instead of wood, as it can be worked almost as easily as the latter.

The slate is cheap and can be easily procured. It is cut to the desired size with an ordinary wood saw (lubricate with water), preferably one having about ten teeth to the inch. A hack saw will make a very clean cut but will cut very slowly. I would suggest using a cheap saw such as can be procured in a five and ten cent store, as a good saw would be ruined, or would, to say the least, need "some" re-filing. After the slate has been cut the edges are smoothed and beveled with a file and the whole well rubbed down with fine sandpaper and a block. If the slate is not thick enough, two pieces may be cemented together with thick shellac or may be held together by means of the screws holding the instruments. Holes for binding posts, switches or instruments can be drilled easily with a diamond point or twist drill. Before fastening on the instruments the slate is again well rubbed down with fine sand paper or emery cloth and given a coat of varnish or shellac. The finished base will look very much like hard rubber. Many slate switchboards are simply rubbed up thoroly with linseed oil. Others are given a coat of some good insulating varnish such as black armalac.

Contributed by JOSEPH BACKERT.

SECRET "WIRELESS" IS FOUND ON APPAM.

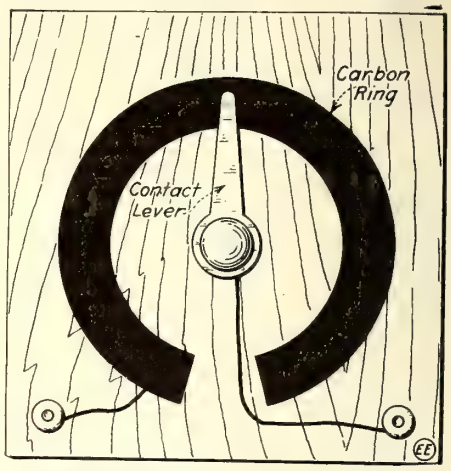
Federal authorities recently found a secret wireless plant aboard the interned steamship Appam, which was taken possession of by United States Marshal Saunders at Newport News, soon after the severance of relations with Germany.

A fine wire was found strung beneath the pipe leading to the whistle on the smokestack of the Appam and extending above it as do the antennae of wireless plants. The wire led to the interior of the vessel where the lighting plant dynamos were kept running. When the Appam was first brought into port, the dynamo in the wireless room was removed by the Federal authorities. Later, however, Lieutenant Berg ran a wire to the wireless apparatus from the dynamo in the boiler room of the steamship and connected it so that he could either send or receive messages.

From the wireless room another wire led to Lieutenant Berg's private room in Norfolk. Messages were flashed to him in the Morse code on his electric light bulb by the simple process used in flashing messages between battleships at sea.

A SIMPLE POTENTIOMETER CONTROL.

The carbon ring used in making this potentiometer may be sawed off the bottom of an old wet cell carbon cylinder. It should be about ⅜" or ½" in thick-



An Efficient and Finely Adjustable Potentiometer Constructed from a Ring of Battery Carbon and a Switch Blade.

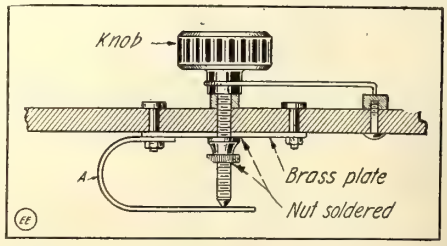
ness. After filing and sand-papering the top smooth, it then should be glued to a base with a wire connecting to one binding post. In the center of the carbon circle so formed, mount a hard rubber knob and switch lever so as to make contact with the ring.

This potentiometer is very easily and cheaply constructed. A large number of them may be made from one carbon cylinder. They will prove useful in controlling the current in radio and electrical circuits.

Contributed by BURT CLARK.

HOW TO IMPROVE ROTARY SWITCHES.

After having trouble with the connections to the moving member of a rotary switch on a loose coupler, I adopted the following scheme:



Effective Arrangement of Rotary Switch Blade to Ensure Positive Contact at All Times.

In figure "A" is a phosphor bronze spring, bent as shown, so as to bear on the pointed end of the threaded rod of the switch knob. The contact is kept bright by the constant turning of the switch.

Contributed by ASA S. KELLER.

THE CONSTRUCTOR

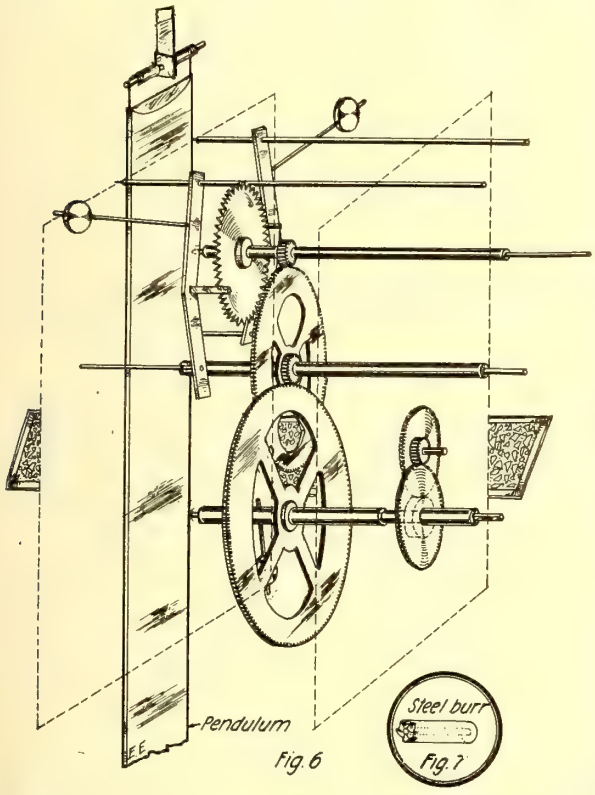


Making An Electric Clock

By THOMAS REED

Part II.—Wheels.

I MEAN clock-wheels, not the ones in your head. Clock works are pretty hard to make unless you have a lathe, but you can fudge up something that will do out of the works of a kitchen clock. I mean the old-fashioned wooden-case clock with the peaked top, whose works are simple and rugged. You discard, of course, the power-wheel (spring or weight) and any other wheels which occur on the power-side of the minute-hand arbor.

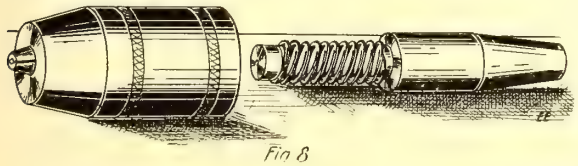


Phantom View of the Modified Clock Movement As Adapted to Be Driven by Electricity. Fig. 7 Shows Detail of Steel Burr for Milling Ends of Arbors.

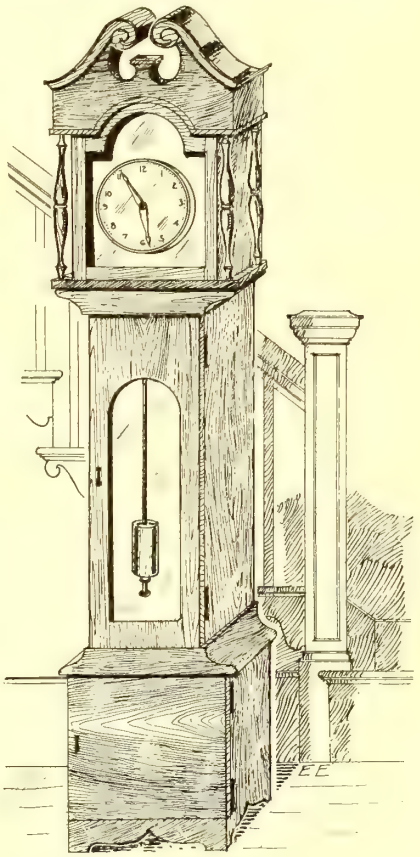
If you were going to use a pendulum of the same short length as the kitchen clock, you would have pretty plain sailing; but I assume you want a *seconds-pendulum* (see Sept. issue), and that makes it hard. In the first place, the works must have been designed so that one of the wheels revolves in just one minute. In the old-fashioned clocks this was apt to be the fact, and that wheel was the one just preceding the 'scape-wheel. So the thing to do is to take the 'scape-wheel off its arbor and put it in place of the gear on the preceding arbor. That isn't so hard, but you can't have a second-hand on, unless you want one running backward. If you have a lot of old clock-wheels, perhaps you can pick out two that are exactly alike, and transfer the motion equally but in opposite directions from your minute-arbor to your old 'scape-wheel arbor, in which case it will run right and come thru fairly symmetrically on your main dial. To extend the arbor in order to carry the second-hand, you can buy some very, very small brass tube (it's made, I assure you) and tuck a piece of it over the end of the arbor, reaming the front hole out to correspond; or you can make up a little tube yourself if you're careful. I made an entire new arbor by filing while rotating in the lathe.

Also, the 'scape-wheel you use must have 30 teeth. Perhaps it seems too much to expect of an old clock to satisfy so many requirements, but lots of them *do* have 30-tooth 'scape-wheels. Junk-stores usually have several of these old clocks for sale cheap, and you're pretty apt to meet up with one that passes the test. If worse comes to worst, you can use an odd gear-reduction, and make up an odd-length pendulum, experimentally, to match it.

Now about the escapement. A plain ratchet-and-pawl is what one first thinks of, with an extra click to prevent its dragging backward; but that isn't satisfactory, as occasionally the pawl will ride over a tooth, or fail to catch it—you can't tell why. Fig. 1 shows a reliable construction, which is a reversal of the so-called *gravity escapement*. When the pendulum lifts the lever on the right, the one on the left drops, forcing the pallet P between the teeth A and B, with a sliding motion into the space C, and moving the wheel ½ tooth ahead. On the return swing, the right-hand pallet P^1, drops between teeth D and E, but can't move the wheel until the left-hand pallet P is lifted an instant later; then pallet P^1 drops into space F, moving the wheel another ½ tooth in the same direction as before. The pallets have to be adjusted to each other to work coincidently, but you only have to make one of them adjustable, of course (see Fig. 2). It isn't vitally important what part of the circumference the pallets meet. The pallets are made of steel, and as highly polished as possible. The size varies with the 'scape-wheel teeth; the base of the wedge should be quite a bit wider than the space between the teeth.



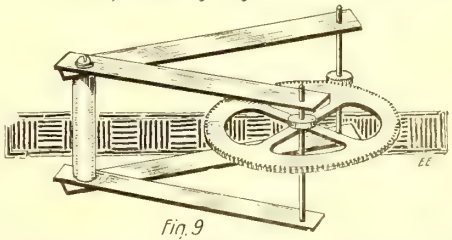
Special Tapered Stud to Hold Hand-drill Chuck In Lathe. The Arbor Burr, Fig. 7, Is Then Held In This Chuck.



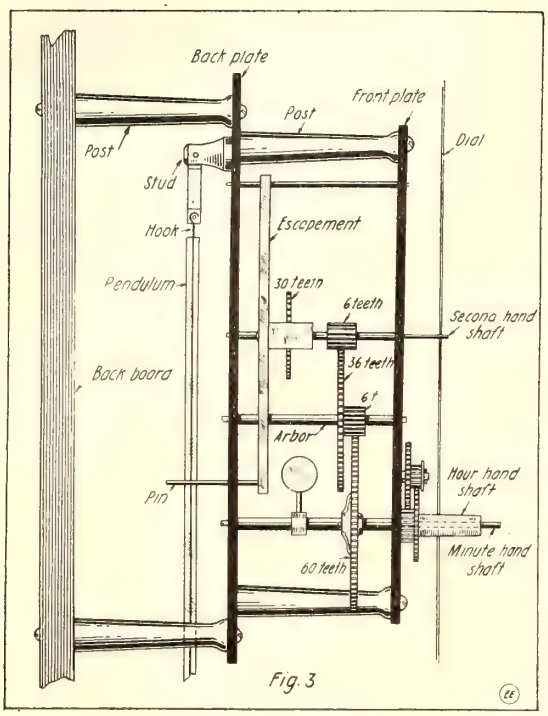
Electrical Experimenters Take Our Advice, Build a Home-Made Electric Clock. You Will Always Be Proud of It.

In Fig. 1, the escapement bars are hung from arbors, and the impulses are given by the little weights—W, W. The same result could probably be accomplisht by mounting the escapement bars on springs, which would be an easier construction for some.

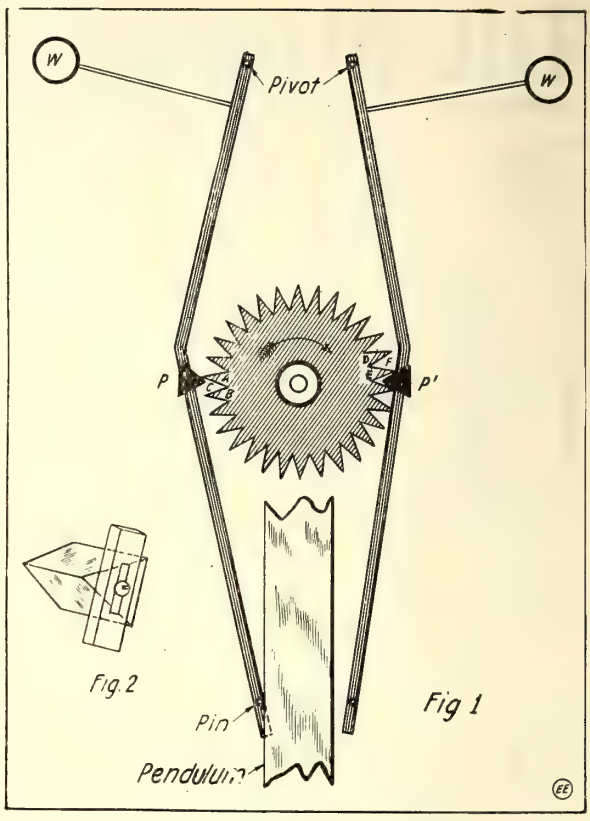
Recess now for a "wrinkle." It's about oiling clocks. Use *toilet vaseline*. I know all the old clockmakers will howl in unison at this, for they say use the "runniest"



Handy Jig For Matching Up Gears and Determining Their Correct Spacing Between Arbor Centers Before Drilling the Main Frame.



Side View of Complete Electric Clock Movement, Illustrating Suspension of Pallet Levers, Escape Wheel and Pendulum.



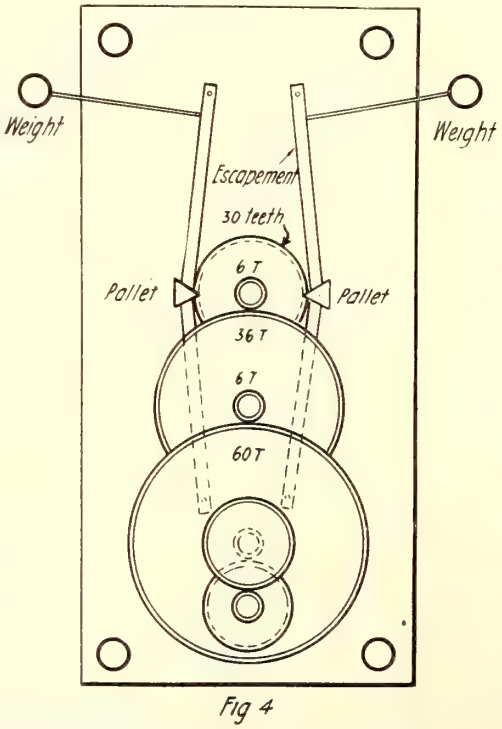
Details of Escapment Mechanism Showing How the Pallet's P and P¹ Rotate the Star Wheel, As the Weighted Levers Are Moved Alternately by the Swinging Pendulum Bar.

oil there is; but I've tried vaseline and I know. Thin oil tends to run out of the bearings and spread on the plates. My clock was deficient in depth of the countersinkings, which are supposed to hold the oil by capillarity, and I had to re-oil it every 6 months or so; but now, with a little daub of vaseline on each arbor-end and on the pallets, I never have to touch it. I added a little grafite scraped from a hard lead-pencil, but really I don't know whether that improved it or not. Vaseline stays where you put it, and doesn't gum. I'd laugh if it should prove a popular lubricant for clocks on my recommendation. I remember I used it on my bicycle years ago, when all the wiseacres said it was the worst thing you could do, and would bring down on the patient tin steed some mysterious calamity resembling the Curse of Muldoon in direness. Everybody's doing it now.

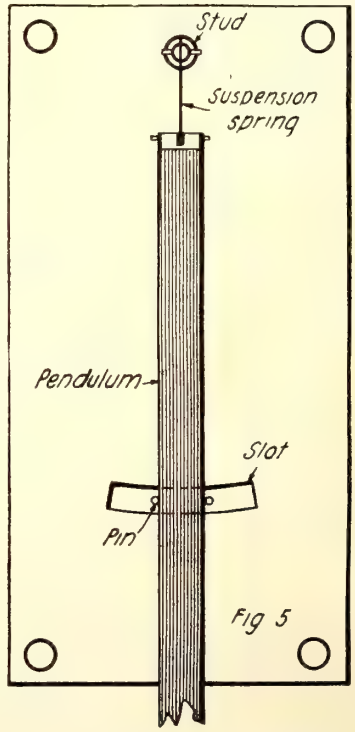
If you have a lathe with a self-centering chuck, you'll want to make your own works, so I give you the detail drawings of mine (Figs. 3, 4, 5, 6). As to the gears—you buy 'em. The various gear companies publish nice illustrated catalogs from which you can select gears and pinions with the proper sizes and numbers of teeth. I could tell you here the name of one good Gear Works, but I won't, because I think they ought to advertise in "E. E."! It's up to the Editor to go get 'em. By the "ads" he already has, I judge he has some irresistible method of pulling 'em in, so I shouldn't be surprised if we heard a peep or two from that quarter shortly. (Voice from the deep: In 1915-16 four gear people advertised in the "E. E." They all quit, because "E. E." readers did not buy any gears, it seems. Moral: "E. E." readers support advertisers! Editor.)

Wrinkle:—The pinions, or small gears, come in rods, which you have to cut up and drill concentrically; so if your chuck has three jaws you can practically only use a 6-toothed pinion, otherwise it won't center right. If you are adept in lathe work, however, you can drill any pitch gear, concentrically by placing a piece of steel or brass strip around it and then tightening up the chuck. A piece of thin sheet lead is excellent, as there is less chance of damaging the teeth. But this is no obstacle, as you can apportion the teeth of the larger gears to obtain the proper reduction. A good proportion (60-6 and 36-6) is shown in the drawings.

Of course the gears referred to are not the broad-faced kind, but the thin clock-gears. The Gear Works sell them and if there's any choice, get the thinnest and tiniest ones you can, as there's no power on them. You can also buy 30-tooth 'scape-wheels — "star-wheels" — with the teeth radiating from the centre (Fig. 1) instead of inclined like those of mechanical clocks. Just as good either way.



Here, "Bugs," We See the Arrangement of the Electric Clock Gear Train. It's Simple We Assure You.



Rear View of Clock Plate. The Pallet Levers Are Moved by Pins on Either Side of Pendulum.

One thing you can't buy, tho, and that's the hand-wheels—those re-entering gears which reduce the minute to the hour speed. You'll have to bone them from some existing clock.

About reducing the ends of the arbors to the size of the bearing-holes, you can do this in the lathe with a file all right, and then, after polishing, ream out your holes to fit. The holes ought to be drilled small and reamed (broached) anyway, as a plain drill-hole is pretty rough. A little young reamer for such small holes costs only 10 cents or so. Any watch or clock-maker will sell you one of these tapered reamers —called *broaches*. If you want to take the trouble, instead of filing you can make yourself a small steel "burr" (Fig. 7) which isn't difficult, and then your arbor-ends will all be the same size, and true. Only you have to hold the burr in a drill-chuck set in the tail-stock. Wrinkle: I use the little chuck off of my hand-drill, having made for it a tapered stub with the proper thread (Fig. 8). It's the handiest thing there is about the house, and if I lost it I'd give way to despair and get me to a nunnery — well, you know what I mean, the other kind.

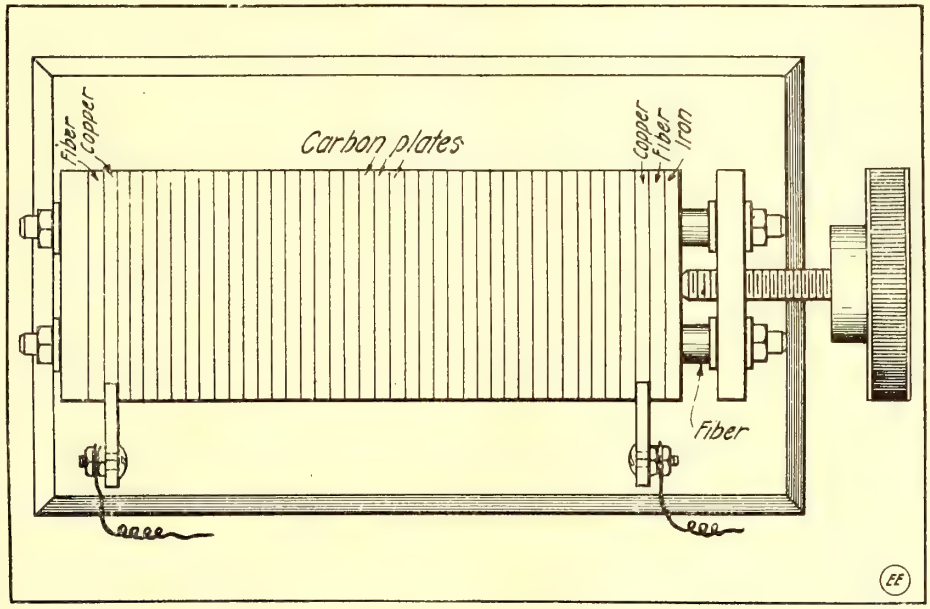
To mill your clock-arbor, you hold it in the head-stock chuck, and while in motion run the burr up on one end at a time, till the distance between the shoulders is the same as that between the front and back plates—with an allowance for ease.

(*Continued on page* 425)

Building a Good Carbon Compression Rheostat

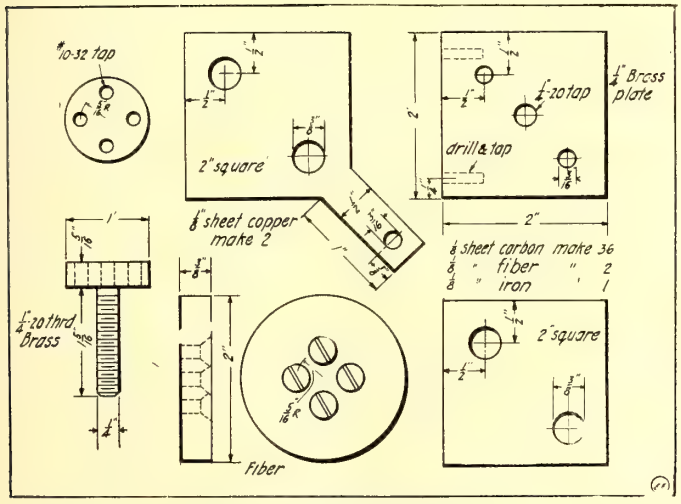
A rheostat that will serve over a wide range of uses may be made from a number of pieces of sheet carbon. Anyone who has tried water rheostats knows that it is very difficult for these rheostats to keep a constant resistance, owing to the fact that particles of the electrodes either float in the electrolyte or settle at the bottom of the container, and thus increase the conductivity. The longer they are used the lower their resistance becomes, and often considerable damage is done due to this fact. Rheostats made of resistance wire, besides being rather expensive, require some time and trouble in order to make suitable contacts and a more or less elaborate contact arm to swing over them.

A carbon rheostat is cheap and easy to make, will keep a practically constant resistance and is not likely to burn out when overloaded. The one to be described has a range from about ½ to a few hundred amperes at a pressure of 1½ volts, tho the details of construction may be varied to suit the purpose for which it is to be used.



Plan View of a Compression Type Carbon Plate Rheostat of Many Uses. It Will Handle Currents of From .5 Ampere to 200 Amperes. The Resistance Is Lowered by Compressing the Carbon Plates and Vice Versa.

The materials needed are a piece of ⅛" sheet carbon 12" by 12", 2 brass rods 3/16" in diameter and 6¾" long, 2 pieces of 2" by 2" sheet fiber, about a foot of 5/16" fiber tubing (outside diameter), some ⅛" sheet steel or copper, a fiber wheel 2" in diameter and ⅜" thick, a heavy brass screw (see illustration), some washers, 4 nuts and 4 flat-headed No. 10-32 brass machine screws. Two pieces of 2" by 2" brass, ¼" (iron or copper ¼ inch thick will do) thick will also be needed.



Dimensions of Carbon Plate Units, Compression Screw, Etc., for Rheostat Illustrated Above.

Secure a suitable baseboard about 7" by 4" by ½". A piece of marble, slate or asbestos board will be excellent but any hard wood will do. For high amperage, it is advisable, if the base is to be of wood, to fasten some heavy asbestos sheeting to the top of the base. A slate base is good.

Lay off the sheet carbon in 2 inch squares, and drill holes in each piece as indicated. After the holes are drilled, the squares should be cut out, making 36 of them in all. This may be done by carefully cutting the carbon with a hack saw, or a sharp pointed scriber may be run along the guide lines a few times and the carbon will then break quite easily.

The brass rods should be threaded with a No. 10-32 die which fits them exactly. The two brass plates which are ¼" thick must have holes drilled in them so as to permit the brass rods to pass thru them. Holes thru their ends also are drilled and tapt to facilitate screwing into the base. All the other square pieces, whether of copper, fiber or carbon, have ⅜" holes drilled in them in the position indicated.

Securely fasten one of the ¼" brass plates on end, to the base. Slip the rods thru it and fasten with washers and nuts. Then slip a piece of fiber tubing 5⅜" long on to each rod. The square pieces are then slipt over the fiber tubing and rods in the following order: First a piece of fiber, then a piece of copper with an ear on it, then the 36 carbon plates, then the other copper plate with the ear on it, then the other piece of fiber, then the piece of sheet iron. (See assembly drawing.) The fiber tubing should now project ¼" above all the plates and the rods should project thru the tubing. Slip washers on the rods, then put on the last pieces of ¼" brass plate. This last piece has a ¼" hole drilled and tapt thru its center to receive the heavy brass screw. Now slip another washer on each of the rods and screw down with nuts. Then securely fasten the ¼" brass plate to the base.

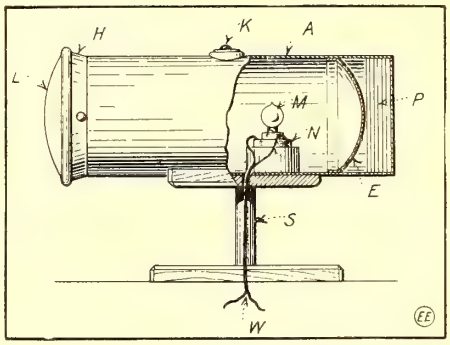
The fiber compression wheel is fastened to the heavy brass screw with machine screws which are countersunk in the fiber. The head of the brass screw has 4 holes drilled and tapt in it for this purpose. The threads are No. 10-32.

Binding posts are fastened to the holes of the projections of the copper plates, and serve as the terminals of the rheostat. The resistance of the rheostat decreases the more the fiber wheel is screwed down, and vice versa. For smaller loads the rheostats may be made more sensitive by using more carbon plates. Carbon rheostats are used for many purposes and in a great many places. They are used by standardizing laboratories such as the Governmental laboratories and in the Universities. They are used by testing departments of practically all kinds of electrical supply companies, whether electric railway or electric lighting, and provide a simple and satisfactory method of regulating direct current for test purposes, if they are properly made. This rheostat provides as indicated in the article, statisfactory control for currents from .5 to a few hundred amperes at battery potential of 1.5 volts. (40 *to* 50 *amperes per square inch of carbon plate surface is a fair value for a steady load; 75 to 80 amperes may be past for short periods.*—Ed.)

Contributed by ALBERT H. BEILER.

A NOVEL WINDOW ATTRACTION.

This display is to be used chiefly as a flash-light window decoration. It is to represent a large flash-light. A, is a piece of stove-pipe. P, is a piece of wood cut circular to fit end of stove-pipe. M, is a 40-watt electric lamp. N, is socket to hold lamp. E, is a reflector. K, is an imitation push-button. S, is stand to support display. W, is concealed wiring. L, is the lens and H is a front glass taken from an automobile. The drawing will explain itself. A flasher can be put into the circuit, to give a more novel effect.



This Nifty Electrical Window Attraction Comprises a Large Dummy Flash-Light, the Lamp Within It Being Winked On and Off By a Flasher.

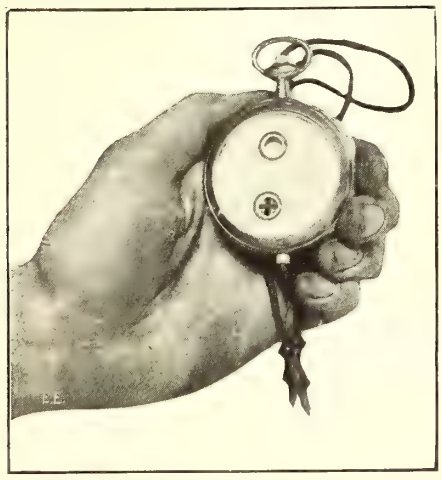
This display is worth anyone's time, and the cost is small.

Contributed by OTTO G. CLAWSON.

How to Make a Magnetic Polarity Indicator

By Samuel Cohen

It sometimes happens that the polarity of a current in a line is required and no available means is at hand. The writer



A Watch Style Polarity Indicator of the Magnetic Type Appeals to Every Electrical Man. Details for Making One Are Given Herein.

was in this predicament at one time and hurriedly constructed an instrument which served the purpose very well, and thought it worth while to show the readers of this journal how to make one of them.

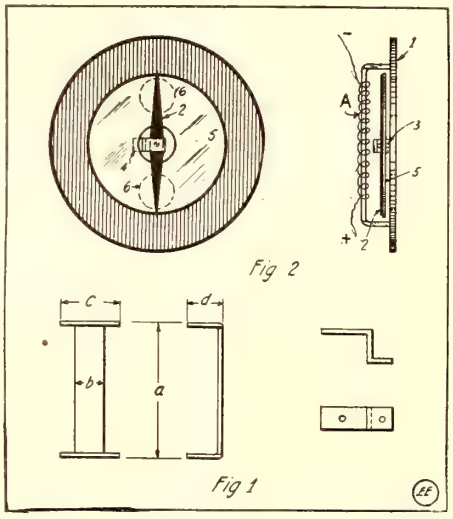
The accompanying photograph shows the instrument complete. Note the relative size of the same. The instrument consists of a watch case, in which a dial, supported on a pivoted permanent magnet, is enclosed. This magnet is acted upon by a magnetic field produced by a small electro-magnet coil.

The constructional details are given. It will be noted that actual sizes are not shown, as it depends mainly upon the size of the watch case. The field or exciting magnet consists of a core made as indicated in Fig. 1. The length A is equal to the inside diameter of the watch, while the width B should not exceed ⅜ of an inch. The width of the pole pieces C will depend upon the general features of the case. The height is determined by the depth of the case. It should be made as high as space permits, in order to enable one to close the back of the case with the cover. The winding of this field will depend on the character of work you desire to use the meter for. The following table has been made to facilitate matters. The resistance of the coil for the three voltages should be as follows: 110 volt circuit — 1100 ohms; 32 volts — 256 ohms; and 6 volts — 25 ohms. The number of turns and size of wire is greatly dependent on the size of the magnet and the figures can readily be obtained from any wire table.

The indicating face of the watch is removed and in its place another circular brass disc 1, Fig. 2 is placed. The magnetic vane 2 is made as shown, the length of which should be three-quarters the diameter of the disc 1 and the width 5/16 of an inch. It is made of the best tool steel, preferably spring steel, and should be magnetized in the usual manner by the application of a strong permanent or electro-magnet. A pivoted rod 3, is fastened to the center of the magnet as shown. This is used to support the magnet between the standard 4, which is a piece of stiff brass bent as indicated and soldered to the rear of the plate 1. A small hole is made on the interior face of this standard and exactly opposite this another hole is made on the plate 1, in order to hold horizontally the pivoted magnet shaft 3. A paper dial 5, is fastened to the ends of the magnet. Two dial holes 6,6 are drilled in the plate 1. These should so be situated that they cover the ends of the dial 5.

The field or exciting magnet A, is placed in a horizontal position while the magnet 2, is stationed in a vertical position. By the passage of a current of electricity thru the coil in one direction, the needle will be displaced in one direction, but it will change its direction if the terminals of the coil are reversed.

If a known polarity indicator is on hand so as to show the direction of current in the line, it is very easy then to calibrate the instrument or the following simple chemical polarity indicator can be used. Place the two current terminals in a sliced potato and the surface about the wire which bubbles indicates the negative terminal. Connecting the same two wires to the magnetizing coil and knowing their polarity, it is easy to mark either the lower or upper wire as the negative or positive. So if the lower wire is positive, then indicate by (+) on the lower part of the dial. When the current is flowing thru the coil and as soon as the current is released the indicating mark will disappear. The whole arrangement should be placed in the watch case and the coil terminals



Detail of Magnetized Needle and Electro-Magnet Used in Making Polarity Indicator.

should be led thru the bottom and top of the case by boring a hole in each end and properly insulated.

The time spent in building this instrument will never be regretted by the experimenter as it will amply repay him in future service.

NON-CORROSIVE COBALT ALLOYS.

A recent bulletin of the Canada Department of Mines gives an account of some tests by H. T. Kalmus and K. B. Blake on non-corrosive cobalt alloys. The addition of cobalt or nickel to iron proved beneficial as far as non-corrosive qualities are concerned. Cobalt is somewhat better than nickel in this respect. The extent of corrosion appears to be dependent on time of exposure, but is not a simple function of the cobalt content. A small addition of copper also seems to reduce the atmospheric corrosion of American spigot iron.

AN INDUCTIVE OCEAN CABLE SYSTEM.

I think I have an improvement over Mr. Schultz's invention as described in the April issue. Instead of using buoys I propose that a submarine cable be laid on the exact route of the ship. This would be a guide for the vessel as well as a means of communication with the shore by means of an *induction* system. Thus the ship will always be on the safe route by constantly communicating with the shore, especially in a heavy fog and gale. In war time a guiding scheme like this would save many a ship from being blown up by mines. A scheme like this would be invaluable on a route running among dangerous rocks and reefs. In time of danger, help can be summoned without delay. This idea, I think, is as good as wireless telegraphy, if not better, because wireless telegraphy will not guide a ship in dangerous waters or be so efficient. By means of my proposition the use of buoys in dangerous waters would be eliminated, and buoys can't always be depended upon.

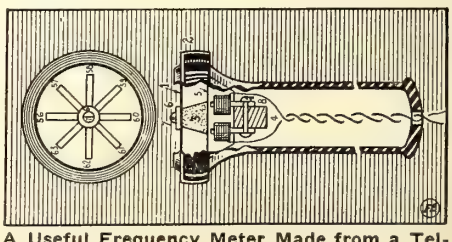
Contributed by HARRY E. FUCHS.

(*This scheme would be feasible if the cable was but a short distance underneath the ship. But to obtain an inductive effect over* 500 *to* 2,000 *feet of depth is not possible for the reason that, first, the iron clad cable absorbs most of the inductive currents and, second, because only a few volts and less than* 1/100 *of an ampere can be used for submarine telegraphy. When stronger currents are used, the cable—which is nothing but an immense condenser—breaks down, as happened to several of our first transatlantic cables.*—EDITOR.)

A HOME-MADE FREQUENCY INDICATOR.

In the absence of a more expensive instrument, a frequency indicator which gives good results has been constructed, as shown, says an *Electrical World* writer, from a telephone receiver as follows: Eight strips of 0.006 in. spring steel 5/64 in. wide by 2 in. long marked (1) in the side view of the receiver shown in the accompanying illustration were clamped radially between two burrs (6) on the cork (3) by means of a wood screw (7). The contacting metal surfaces were tinned and sweated together. The whole was then mounted on the diafram of a telephone receiver (5) by means of beeswax. The magnet had been previously removed from the receiver, and the brass screw (8) replaced by one of steel.

For use with 110 volts it was found necessary to use a 400-ohm resistance in series. In calibrating this device a motor-generator of adjustable frequency was used in connection with a standard instrument. After setting the machine at 56 cycles, one of the springs was carefully clipt off at the end, piece by piece, until it set up a strong vibration. The machine was then raised to 57, and the operation repeated with the



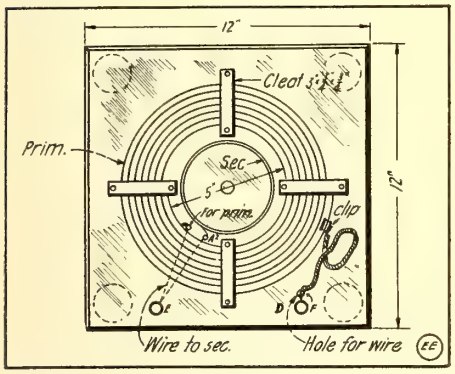
A Useful Frequency Meter Made from a Telephone Receiver and a Few Steel Reeds, Properly Calibrated.

next spring, and so on up to 63 cycles. Each spring thereafter vibrated only in response to the frequency to which it was adjusted.

CONSTRUCTING A ¼ K.W. HIGH FREQUENCY OUDIN COIL.

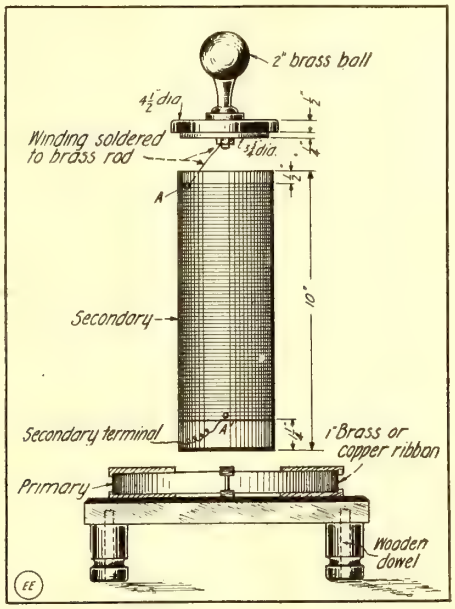
By George Sutton, Jr.

FIRST I procured a card-board tube in which a Pyrene fire extinguisher was packed, at a local auto supply store. The size of mine is 10 in. long and 4 in. in diameter. Next I painted the card-board cylinder with 3 coats of orange shellac to make it stiff. Then I constructed the wooden heads; they may be turned up on a lathe or with a compass saw if no lathe is available. One head measures 4½ in. in diameter and the other head 3¾ in. in diameter. The smaller head is eventually fastened to the base to hold the cylinder in place. I turned the top head, which is made all in one piece as shown, and put the heads on the cylinder and mounted it between the centers of my lathe. The cylinder was wound with one layer of No. 26 enameled magnet wire, between the turns of which I wound a layer of heavy linen thread to separate the turns. I started ½ in.



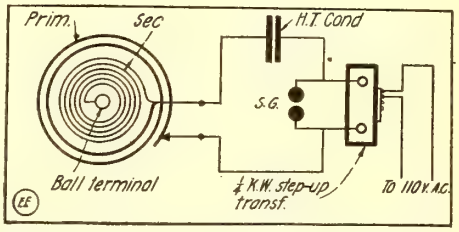
Plan View of Small High Frequency Coil of the Oudin Type.

from the top and finished 1¼ in. from bottom; this will take about eight hundred



Details of Small Oudin Coil Suitable for Use with ¼ K.W. Step-Up Radio Transformer or 6 to 8 Inch Spark Coil.

turns. Two holes are punched, one at A and one A^1. The top turn is run thru the hole A, and connected to the brass ball on top; the bottom turn is run thru hole A^1 and thru hole A^2 and connected to binding post E. After the cylinder is wound it is necessary to coat it thoroly with several coats of shellac, as this prevents the sparks from jumping between turns and also holds the wire in place. Now comes the base; I used a piece of yellow pine 12 in. square, ¾ in. thick, then gave it several coats of black asphaltum paint. The brass ball may be obtained from a bed-post or may be purchased from a local hardware dealer. The secondary cylinder was put in place, the bottom turn of secondary connected with binding post E, and the top turn connected with the brass ball. I then constructed the primary; first I took a ring of card-board 5 in. inside diameter and 1 in. wide and fastened one end of the brass tape by binding it with friction tape. The primary is made of 8 or 9 turns of 1 in. brass or copper ribbon separated by a layer of corrugated card-board. When the primary is completed it is bound by winding some friction tape around the outside; the inside turn of primary is also connected to binding post; this flexible wire has a clip attached to it and is connected to binding post D, and run thru hole F, so as not to interfere with making connections with as many turns of the primary as may be needed. Four standard porcelain insulators are used for feet. Sparks from 8 to 12 in. long can be drawn from this Oudin transformer when excited by ¼ K. W. wireless transformer.



Connections for Oudin Coil, Showing How the Secondary and Primary Windings Are Connected Together.

Trials of a Troubleshooter

By THOS. W. BENSON

HAVE you ever indulged in that great indoor sport of "trouble-shooting." Especially that brand of trouble that infests the network and web of a telephone system in a large town. NO?

Never stood by when a cable "blows up"; when pair after pair goes bad? Never held your breath as that infernal meter on the test table swings over and in its cold, impersonal way quietly shows "dead pairs," "shunts," "opens," "grounds," and what not, knowing meanwhile that you are going out to shoot the said trouble? Great life! Take it from your Uncle Dudley.

Paradise, according to the late Elbert Hubbard, is a town with only one telephone system. Perhaps so, but you can stake your last jitney against a cancelled postage stamp that the said system keeps the recording angel busy at times, even more so when old Jupe Pluvius lets drive with a rain storm.

But there are some troubles that seem to have no rhyme or reason. This is the case when transmission is poor. There are several million different things that can cause this and the majority are not in the text book. It is simply a case of pulling wires and tightening screws till the trouble goes off.

For instance, a certain 'phone goes bad and you jump over to see what the "bug" is. But, curses, the instruments test O.K. The cord seems to have a light shunt on it so you put in a new cord. But behold, next day the same 'phone is on your bogey with the same trouble. An examination shows that the cord is at fault again. And that was a perfectly good cord when put in a few hours before. Well, we will put another one in and see how that works. Test table reports clear and away you go.

But, the next day sees you back at the old stand. Now what in the name of a bald-headed South African flea is wrong? The cords look perfect, not wet or spotted. (It is practically impossible to pick up a single wet spot on a cord.) A new cord and the 'phone is reported clear. Yes, you are now shooting trouble with a great big "T."

Perhaps this will continue till you happen in on the 'phone and find that blamed pet poddle snapping at the cord. Yep, those toy hounds can wet that cord sufficiently by biting on it till the relay at central drops over and flashes up on the board.

Of course you can't warn the dog off, but you would be surprised at the number of times you have to warn off the "PEEPUL." They seem to think that a telephone cord makes a good washline to dry handkerchiefs, or support wet umbrellas, or use it for a pincushion. I suppose it does take all kind of people to make up our old planet. Sometimes they decide to shorten the cord and use a safety pin for the purpose. Of course that means a call from the 'phone Doctor who has to operate and remove the obstruction from the path of speech.

But, as in the previous case obstructions do not always stand up and holler at the "Doc." No indeed not; take the case of the "Mysterious Shunt."

Tests from the table showed that a perfect shunt existed on a certain 'phone. On arriving the troubleman took down the receiver and found everything O. K. No shunt or anything else seemed to be in that vicinity. The test table swore that was the 'phone reported in, but now it tested clear.

But it came to pass, as the stories go, that an equally good short made itself apparent the following day. Again there was no trouble when "Doc" arrived. "The man is crazy," was his diagnosis of the trouble. And still it came and went, on one day, clear for a while, then on again. Pairs were changed at the cable box. "Hah, faulty pair," was the troubleman's exultant exclamation, as the 'phone was clear for several days. But—that shunt still hung around and dropt on after a week.

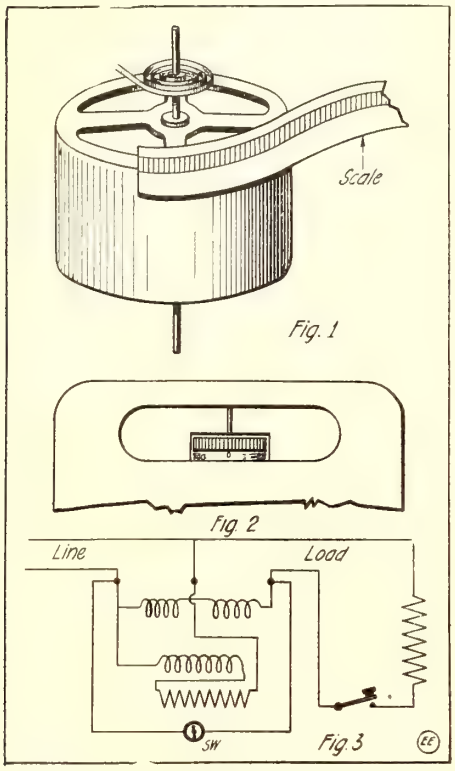
"Doc" made up his mind he would kill that trouble or stay there the rest of his days. He fust around, asked for a ring that meant something and finally noted that the shunt would go on as soon as the 'phone was called and drop off later. This looked like a case of renewing the fuses in the lightning arrester and he started up to see if they were faulty. Having looked at these previously they were alright, but on this day he noted the fact that a new curtain had been hung over the window above which the lightning arrester was located. And said curtain had a brass rod that just about touched the ends of the fuses. When a ring came it would jump thru the lacquer on the rod and short-circuit the line and mate; the least little vibration would then break the circuit and the line cleared up. Yes, you could almost count the number of rings

(*Continued on page 427*)

CONVERTING AN INTEGRATING WATT-METER INTO AN INDICATING TYPE.

By Geo. Sturley.

Have you an old integrating watt-meter among the things you do not use? If so, perhaps you can make good use of it by



Practically All Tests On Alternating Current Circuits Call for an Indicating Watt-Meter. Here is a Way to Make One from an Old Integrating Watt-Hour Meter.

trying the following. The idea is to rebuild an *integrating* meter into an *indicating* one. This is done by removing all the gear-trains and dials of the integrating system and attaching to the shaft of the rotor a hair-spring taken from an alarm clock. Then the twisting effort at the shaft will rotate the cylinder part way around against the tension of the spring. A paper scale (Fig. 1.) marked with drafting ink is glued on the cylinder and all desired calibrations marked on it.

The writer made such an instrument from a Fort Wayne Type K meter of 5 ampere rating and it reads up to 750 watts. And when the scale shows a reading of 100 watts or better, the meter is sensitive to 3 watts.

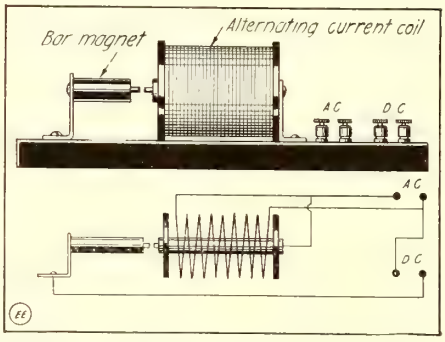
A paper scale was made from a strip of good ink paper three quarters inch wide, and long enough to reach around the cylinder. Lines about 1/8 inch apart were drawn for scale divisions. The magnets in the meter were left in place as they greatly improved the damping of the instrument. As this meter has a revolving scale, the pointer is arranged stationary, and is nothing more than a heavy cross-line drawn on a piece of card board which is fitted in the glass window where the dials used to be. Fig. 2. When the meter is not indicating, the zero on the scale is right in line with the pointer. The meter was calibrated by a lamp bank, using different numbers and sizes of lamps for the calibrations desired. With a 5 ampere meter it is inadvisable to calibrate higher than 750 watts. This Fort Wayne style of meter is the easiest form to remodel. In the case of changing a meter having a disc-rotor, you will have to turn it bottom-end up for a front, and a circular scale having radial markings will be required. Also a hole will have to be cut in the bottom to view the scale thru.

The meter can be used in connection with a wireless sending set to conveniently read at any time how much power is being used. When anyone asks, "How much power (in true watts) are you using?", you can tell the amount at once. Fig. 3 is a hook-up whereby the meter is permanently wired in with the primary of the "bug", and a snap switch when closed shunts the current coils in the meter out when no readings are desired. When a reading is desired, open the snap switch and hold down the key. Also the meter may prove useful in determining the power-factor in your transformer primary circuit, if you have a volt meter and ammeter. The power factor is determined by dividing the *actual watts* (watt-meter reading) by the *apparent watts* (volts x amps). If you aim to improve your set, this power factor if kept up to a high value will mean your transformer is actually handling more power.

USE OF PERMANENT MAGNET IN A.C. TO D.C. RECTIFIER.

In the May, 1916, issue, there was described a magnetic rectifier, and finding it rather troublesome to have to use batteries for the permanent field excitation, I found that if a steel bar-magnet was substituted instead of the electro-magnet, the device would work as well and save the trouble and cost of the batteries. [*Note: By referring to the May, 1916, issue, full description will be found.*]

Contributed by A. ALLIN.



Extremely Simple Form of Vibrating A.C. to D.C. Rectifier Made With a Permanent Magnet Armature.

ODDMENTS FROM THE HOUSEHOLD.

The experimenter whose purse is no deeper than the average will need to extemporize much of his apparatus, and if carefully made such appliances will be quite as serviceable as the shop-made article, tho probably lacking in finish. No opportunity should be lost to secure unclaimed oddments of household utensils. An excellent electroscope can be made from a lamp chimney, plugging the top with sulfur and embedding the wide end in paraffin wax contained in a flat tin; part of a broken window makes a good fulminating pane if the sharp edges are rubbed down with a file or emery cloth, and many other examples might be quoted.

Contributed by H. J. GRAY.

AN ELECTRICAL SHUTTER RELEASE FOR CAMERAS.

Following is a description of an electrical release for camera shutters, to be used in photographing wild animals and birds from a distance. It can also be used when the experimenter desires to take his own picture, etc.

In the accompanying drawing (Fig. 1), A is the main part of the frame, or base. It is made of ¼-in. square brass rod, about 6 in. long. It is bent at right angles about 4 in. from one end, and has a 1/16-inch slot cut in the end of the short leg.

B is the clamp to hold the release in place on the bed of the camera. It also is made of ¼-in. square brass rod, and is bent as shown. *These bends CANNOT be made* COLD.

C is the movable lever, of ¼-in x 1/16-in. brass strip, about 5 in. long. It is drilled at the places shown in drawing, and has a short slot cut where the rivet 7 passes thru. The part X of lever C, indicated by dotted lines, is turned up to a horizontal position. This forms a broad striking surface for the release, and is covered with leather.

D is a solenoid, size 1 in. x 1¼ in. It is formed of an old hard rubber fountain pen barrel or other tube having an inside diameter of ¼ in., fitted with two 1/16-in. fiber washers, of 1⅛-in. diameter, wound with No. 22 gage enameled magnet wire.

E is the core of the solenoid, of ¼-in. soft iron rod, 1¼-in. long. It has a 1/16-in. slot cut in its upper end and a hole drilled for rivet 7.

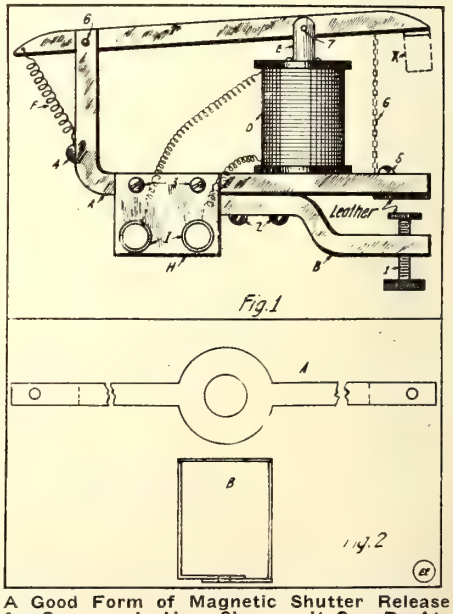
F is a spring to draw lever C upward, away from the solenoid. The upward movement of lever C is limited by G, which is a short section of cheap watch chain or other small chain, the upper end of which is fastened to a hole in C, and the lower end to screw 5.

H is a block of hard fiber, 1¼ in. x 1 in. x ⅛ in., on which are mounted binding posts I.

I is the clamping screw, made of an 8-32 battery binding post screw, with the head filed flat and the lower end fitted tightly in a fiber washer for a handle. 2, 3, 4 and 5 are 6-32 brass machine screws. 6 and 7 are small rivets.

A small dashpot added between the solenoid and the upright part of frame will make the action much smoother and soften the jar to the camera, but it is not absolutely necessary.

Fig. 2 is given merely as a suggestion for a method of mounting the solenoid. A piece of sheet brass is cut to the shape shown at A, and is bent on the dotted



A Good Form of Magnetic Shutter Release for Cameras Is Here Shown. It Can Be Attached and Detached in a Few Moments.

lines to the shape of B. It is then slipt over the solenoid and fastened to the frame by a screw dropt thru the solenoid into the small hole in clip and screwed into the frame. This will hold the solenoid firmly.

Contributed by J. E. HENDERSON, JR.

Chemical Action of Storage Batteries

By ALBERT W. WILSDON

MANY experimenters have frequently used storage batteries but have possibly never stopt to inquire as to the action which takes place in them. To obtain best results in any branch of endeavor, it is necessary to understand the fundamental principles which govern each individual case. This is also true as regards storage batteries. If improperly taken care of or handled, they will not give satisfactory results, the same as if a gas engine were to be permitted to be run without water, oil or cleaning.

The lead storage battery in the charged state consists of a positive plate of lead peroxide (PbO_2) and a negative plate of finely divided lead, both being introduced into sulfuric acid (H_2SO_4) of about 1.2 sp. gr. When discharged the surface of the plates has been changed to lead sulfate ($PbSO_4$). The plates may be brought back to their original condition by sending a current thru the battery in the *reverse* direction.

During the formation the plates are frequently permitted to stand in some corroding solution of acids that produce a thick layer of lead sulfate ($PbSO_4$), for a certain time. The lead sulfate may then be reduced electrolytically to lead, or oxidized to lead peroxid (PbO_2). When acids other than sulfuric are used, these must be thoroly washed out before the battery is ready for use. For instance, a mixture of nitric and sulfuric acids would have the effect of producing a layer of sulfate.

By another method the plate is electrolyzed as an anode, but lead peroxid (PbO_2), which would protect the plate from further action, is prevented from forming by adding some salt or acid to the solution, the union of which separates at a lower potential than the peroxid ion and causes the production of sulfate. Lead sulfate ($PbSO_4$), being a non-conductor, requires the lead below to be penetrated by the current, and as much sulfate may be produced in one step as is desired. Such additions are acetates, tartarates, chlorids, nitrats, chlorats, perchlorats, and the corresponding acids.

Peroxid is not always formed on a lead anode in sulfuric acid, even when no substance is added to the solution to prevent it, which is made apparent by the fact that the lead plate, which is the anode, on *discharging,* becomes covered with sulfate. If therefore, a lead plate is short-circuited in

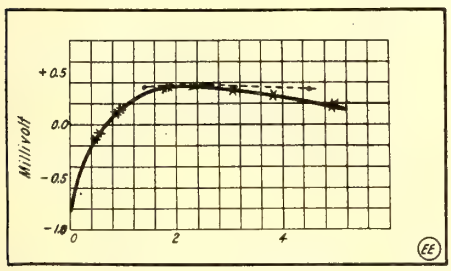


Fig. 2. Temperature Coefficient of Electromotive Force of Lead Storage Battery As Function of the Acid Concentration.

a solution of sulfuric acid with a peroxid plate, it will become covered with sulfate, proportional in amount to the current that flows thru the plate.

In the Faure type storage cell the plates consist of lead with about 5 per cent of antimony. The active material is made by making a paste of lead oxid (PbO) and sulfuric acid, and applying it to grooves cast in the supporting grid. The paste sets and becomes hard, after which it is changed to lead sponge and peroxid by electrolysis in a solution, which may, or may not be, sulfuric acid.

The theory of the lead storage battery which is generally accepted, is known as the "sulfate theory", and is due to Gladstone and Tribe. Sulfuric acid combines with the plates on *discharge,* and is set free on *charge,* according to this theory. On discharge hydrogen is deposited on the lead peroxid which reduces it to lead oxid (PbO), which is changed to lead sulfate ($PbSO_4$), as represented by the equation:

(1)
$$\underset{\text{Lead Peroxid}}{PbO_2} + \underset{\text{Hydrogen}}{H_2} + \underset{\text{Sulfuric Acid}}{H_2SO_4} = \underset{\text{Lead Sulfate}}{PbSO_4} + \underset{\text{Water}}{2H_2O}$$

At the same time the sulfate radical (SO_4) is deposited on the lead plate and changes to lead sulfate:—

(2)
$$\underset{\text{Lead}}{Pb} + \underset{\text{Sulfate Radical}}{SO_4} = \underset{\text{Lead Sulfate}}{PbSO_4}$$

The sum of these two equations is the total change in the storage battery on discharge:—

(3)
$$\underset{\text{Lead Peroxid}}{PbO_2} + \underset{\text{Lead}}{Pb} + \underset{\text{Sulfuric Acid}}{2H_2SO_4} = \underset{\text{Lead Sulfate}}{2PbSO_4} + \underset{\text{Water}}{2H_2O}$$

When in the discharged state both plates are covered with sulfate. Upon charging, the reaction on the positive plate is:—

(4)
$$\underset{\text{Lead Sulfate}}{PbSO_4} + \underset{\text{Sulfate Radical}}{SO_4} + \underset{\text{Water}}{2H_2O} = \underset{\text{Lead Peroxid}}{PbO_2} + \underset{\text{Sulfuric Acid}}{2H_2SO_4}$$

While in the negative plate:—

(5)
$$\underset{\text{Lead Sulfate}}{PbSO_4} + \underset{\text{Hydrogen}}{H_2} = \underset{\text{Lead}}{Pb} + \underset{\text{Sulfuric Acid}}{H_2SO_4}$$

The sum of the last two equations (4 and 5) represents what takes place in the whole battery on charging:—

(6)
$$\underset{\text{Lead Sulfate}}{2PbSO_4} + \underset{\text{Water}}{2H_2O} = \underset{\text{Lead Peroxid}}{PbO_2} + \underset{\text{Lead}}{Pb} + \underset{\text{Sulfuric Acid}}{2H_2SO_4}$$

This equation is just the *reverse of the sum* of the first two equations (No. 3), and the changes taking place both on *discharge* and *charge* may be represented by the following *reversible* equation:—

(7)
$$\underset{\text{Lead Peroxid}}{PbO_2} + \underset{\text{Lead}}{Pb} + \underset{\text{Sulfuric Acid}}{2H_2SO_4} \rightleftarrows \underset{\text{Lead Sulfate}}{2PbSO_4} + \underset{\text{Water}}{2H_2O}$$

From right to left this represents the *charge,* and from left to right the *discharge.*

By measuring the electromotive force (e.m.f.) of different oxids of lead and hydrats of lead on lead against a zinc electrode and comparing with a charged positive plate it was shown that the charged positive plate is the peroxid of lead and not some other oxid or hydrat.

The tabulated results being:

Pb/Pb_2O	—Zn 0.42 volt
Pb/PbO	—Zn 0.46 volt
Pb/Pb_3O_4	—Zn 0.75 volt
Pb/H_2PbO_3	—Zn 0.96 volt
Pb/PbO_2	—Zn 0.41 volt

A charged plate has a potential of 2.4 volts, showing that *lead peroxide* is the compound that exists on the *positive* plate.

Kohlrausch and Heim showed by measuring the specific gravity of the acid on charge and discharge that the production of sulfate on each plate was proportional to the quantity of electricity that had been past thru the cell; *the density changing exactly in proportion.* A calculation of the change in specific gravity by means of equation 7 agrees with that found. The calculation is as follows:— The uncharged battery contained 3350 cubic centimeters of acid of 1.115 sp. gr. corresponding to 16.32 per cent acid. The total solution therefore weighed 3735 grams, and contained 610 grams of acid, and 3125 grams of water. After charging with 50 ampere-hours, according to equation 7, the amount of water

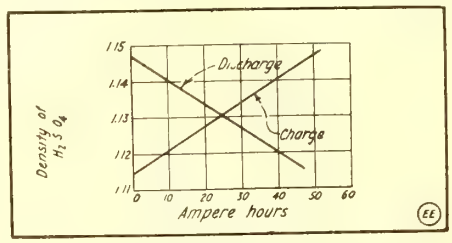


Fig. 1. Curve Showing Change in Density of Acid With Charge and Discharge.

that disappeared was 33.6 grams, and the amount of sulfuric acid formed was 183 grams. The solution therefore contained after charging, 3091 grams of water and 793 grams of sulfuric acid. The total weight was therefore 3884 grams, and the amount of sulfuric acid contained was 20.42 per cent., corresponding to a density of 1.146. The observed density being 1.147.

It is quite evident that since the acid becomes more dilute on discharging a lead battery, the electromotive force must decrease with decreasing concentration. The table given below, shows the relation between the concentration of the acid and the electromotive force, from direct measurements.

TABLE.

Density of H_2SO_4	Per Cent H_2SO_4	E.M.F. at 15 Deg. C.
1.050	7.31	1.906
1.150	20.91	2.010
1.200	27.32	2.051
1.300	39.19	2.104
1.400	50.11	2.330

It will be noticed that the electromotive-force of the lead storage battery, with the concentration of acid ordinarily used, has the unusually high value for a battery of over two volts. Sulfuric acid, if electrolyzed between platinum electrodes, gives a weak evolution of gas at 1.7 volts and at 1.9 a strong evolution. If lead sulfate were spread on platinum, it would therefore not be possible to reduce it to lead and oxidize it to peroxid, for the potential required could not be reached. On lead, however, the *over-voltage* is so great that the gas evolution does not take place below 2.3 volts, which is greater than the voltage needed to change the sulfate in lead on one electrode and peroxid on the other. If it were not for this high over-voltage on lead, the lead storage battery would be an impossibility.

The temperature coefficient of the lead storage battery for the concentration of acid used is *positive,* but on decreasing the concentration of acid the temperature coefficient falls to zero and then becomes *negative.* The curve (No. 2) represents the results of experiments in which the temperature coefficient was determined between 0 deg. and 24 deg. C. The temperature coefficient is constant in value between 10 and 71 deg. C. The heavy line in the plot gives the experimental results.

The mechanism of the reactions taking place in the lead storage battery has been

(*Continued on page* 422)

HOW TO MAKE IT

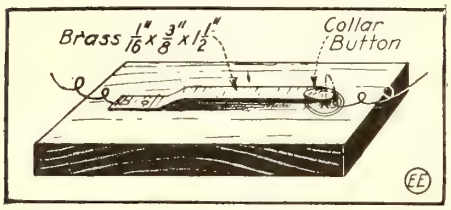


This department will award the following monthly prizes: **First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.**
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

AT LAST! THE "COLLAR-BUTTON" SWITCH.

I give herewith a description of a "collar-button" switch, which I am contributing to the "How-To-Make-It" Department.



Somebody's Been Reading Faithfully Page 330 of the September "E. E." Instead of an Electrical Stunt with Old Shoe Nails, However, We Are Presented with the "Collar-Button" Switch, for Which We Are All Duly Thankful.

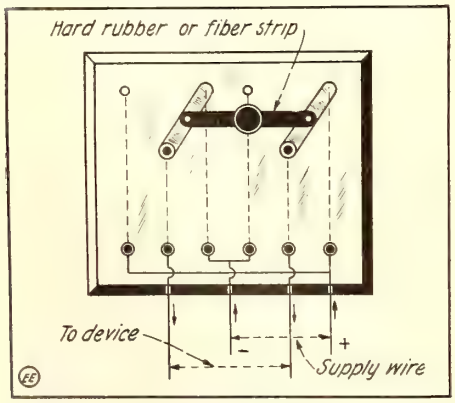
This switch can easily be made with a collar-button and a small strip of brass. By simply putting the head of the collar button down, the switch is "on." This small switch can be used where any battery switch is needed and can be quickly and easily made. (Bugdom extends its sincere thanks, Albert!—Editor.)

Contributed by
ALBERT CHOQUETTE.

A SIMPLE POLARITY REVERSER.

The device described and illustrated herewith is a convenient means of changing the polarity of a pair of wires, of reversing small motors, etc.

It consists of a wooden base upon which are mounted six binding-posts and a pair of two-point switches, so connected by a hard-rubber strip as to move both the switches at the same time. The manner of reversing the polarity at once becomes evident by referring to the diagram. Connections from the binding-posts are made in grooves on



A Handy Polarity Reverser Constructed from Two Switch Blades, Four Contact Points, Some Binding Posts and a Base.

the under side of the wooden base.

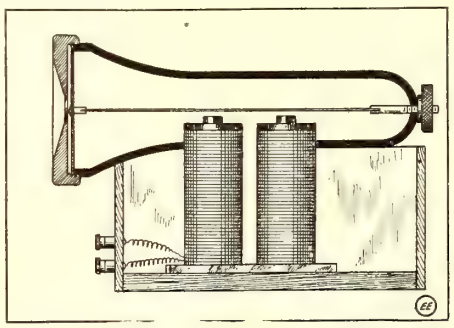
Contributed by
PETER J. M. CLUTE.

SECOND PRIZE, $2.00

ADJUSTABLE LOUD TALKING RECEIVER.

Manufacturers of high-resistance telephone receivers are well aware of the advantages to be gained by tuning the diafram of the receiver to the desired note. However, their's is a compromise. Nearly every radio station emits a tone distinctively its own and the manufacturer has to strike a mean. Receivers have been developed that were adjustable as to the tension on the diafram and worked with satisfaction when *both* diaframs were tuned alike. A receiver that can be adjusted instantly to any note within a wide range is shown in the attached illustration. It is designed particularly for use with some form of amplifier that allows of its use as a loud-talker, but by using high-resistance windings it will serve in place of the regular receivers for nearby or powerful stations.

To construct this receiver the shell of a long type telephone receiver is required. A hole is drilled in the center of the diafram and a short brass bolt inserted. The threaded end of the bolt is slotted to take



Here's What You've Been Looking For, "Bugs"; a Loud Talking Telephone Receiver and Amplifier Which May Be Adjusted for Different Currents and Circuits.

a strip of thin iron ½-inch wide and long enough to reach the length of the receiver. One end of the strip is soldered into the bolt on the diafram and the other end of the strip is soldered into the head of a brass bolt that passes thru the hole in the small end of the receiver shell. The latter bolt is fitted with washers and a nut to adjust the tension on metal strip.

A hole is cut in the side of the receiver shell large enough to pass the magnets as shown. If the device is to be used with an amplifier the magnets shown have a low resistance of about 20 ohms. When used in place of the regular receivers they may be taken from a thousand ohm telephone ringer. The magnets are supported in a box and wired to two binding-posts.

The pole pieces of the magnets should come within 1/64th of an inch of the iron strip. In use the apparatus is connected in the circuit in the usual manner. The thumb nut at the small end of the receiver is turned till the strip is just taut. When the signals come in it is only necessary to turn the nut and adjust the tension on the strip till it is in resonance with the note of the signals, which point will be indicated by the loudest tone.

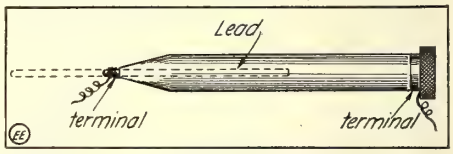
When high-resistance magnets are used and the instrument is connected direct to the circuit without an amplifier it will be found advisable to use a mica diafram and a steel piano wire instead of the metal diafram and the iron strip.

Contributed by THOS. W. BENSON.

THIRD PRIZE, $1.00

ANOTHER PENCIL RHEOSTAT.

The accompanying drawing shows a very simple pencil rheostat. It is simply a common "clutch" pencil as sold anywhere for ten cents, and no work is necessary to convert it into a rheostat—just the con-



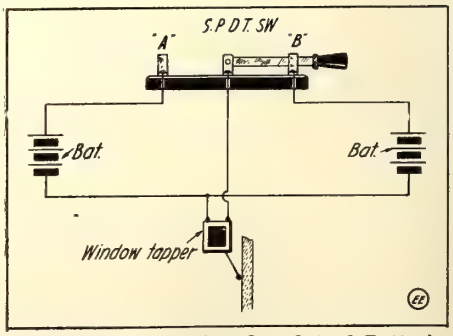
If You Carry a Metal Magazine Pencil You Are a Potential Electrician. Connect a Wire to the Case and Lead, and Presto! You Have An Adjustable Rheostat.

nection that is all. To vary the resistance it is only necessary to slide lead in or out of the pencil case.

Contributed by G. SCHOENDUVE.

AUXILIARY BATTERY POWER FOR WINDOW TAPPER.

When a window tapper is running for a long period, the dry batteries run down, causing the tapper to stop. In order that it may work again the batteries must be disconnected until they regain their full strength. Using the method shown here the tapper can be used continually without a stop.



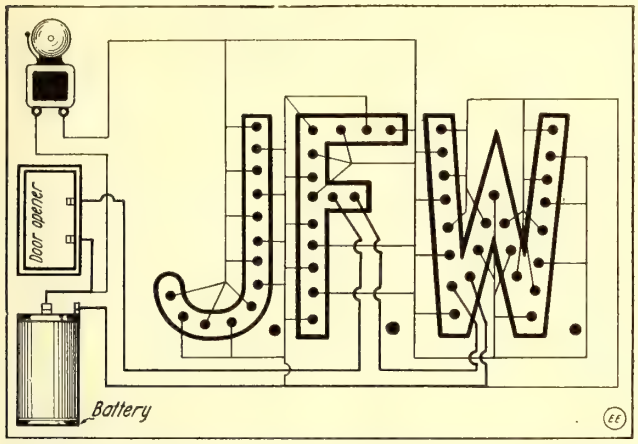
To Prevent Paralyzing One Set of Batteries When Operating a Window Tapper, Use Two Sets Alternately with This Circuit.

The S.P.D.T. switch blade is in contact at "B," making a circuit. When the power is exhausted, it is thrown to "A," putting a new set of batteries in the circuit; while the others at "B" will be recuperating.

Contributed by FRANK HARAZIM.

SECRET DOOR LOCK AND ALARM.

The illustration is of an electric door lock and bell alarm for the front door of a home, garage or shop, which is easily made and installed in a very short time.



The Electric Puzzle Lock Shown Acts As Its Own Thief Alarm. The Uninitiated Will Invariably Short-Circuit the "Alarm" Contact Points Instead of the "Lock" Circuit Contacts.

It consists of a half-inch quartered oak board large enough for the initials, which are made by driving brass upholsterer's tacks in the board. On the under side of board wires are connected to the tacks as per diagram and should be soldered to the points. An ordinary electric bell and a bell-ringing transformer or dry batteries are connected according to illustration and it is then ready for use. The heavy lines indicate the circuit which operates the lock. A finger ring or any small piece of metal placed in contact with the two tacks on F and W will operate the lock and open the door. Anyone tampering with or not knowing the secret of the lock will cause the bell to ring, as the diagram will show. A push button connected to the lock circuit and located at a convenient point inside will be found very handy. A low-voltage lamp can also be placed in the circuit and will serve to light up the entrance. This device has given excellent service for a long time and is still in fine condition.

Contributed by JOHN F. WALLACE.

KEEP YOUR BATTERIES WARM.

Both primary and secondary or storage batteries (accumulators) are affected by temperature. A battery that gives no trouble in an ordinarily warm room shows a falling off in the output of current if exposed to a very low temperature. This is due to the fact that the internal reristance decreases as the temperature rises, within certain limits. Storage batteries have been found to develop a maximum efficiency at temperatures approaching 50° C. If the temperature is much above or below this figure, the output of current falls off. Since the ordinary temperatures of a room at any time of the year is generally between 12° and 20° C. it will be seen that most storage batteries are not given an opportunity to deliver the maximum amount of energy of which they are capable.

Contributed by H. J. GRAY.

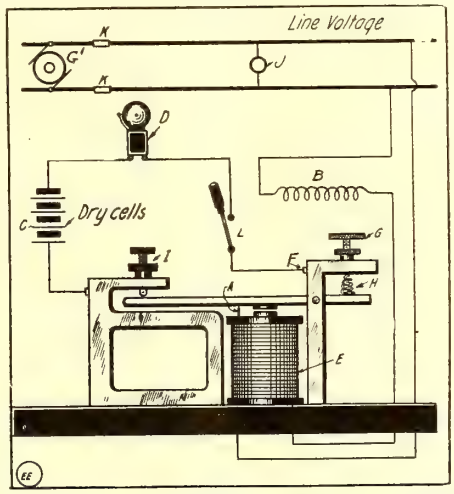
TELEGRAPH RELAY USED FOR VOLTAGE INDICATOR.

Where an operator can not watch his voltage continuously and where a constant voltage is required, the accompanying diagram shows how a telegraph instrument can be made into a voltage indicator in a few minutes' time.

If a motor (J) was operating a flood pump or any other apparatus automatically, it would be essential that the supply of current is always on the line. If one of the fuses (K) should blow out the line would be dead, and unless the operator was on the scene it might cause serious damage.

With this apparatus he can be in his office and will be notified by the bell that the line is dead. The explanation of this device is as follows:

The current passes in thru the resistance (B) which amount depends upon the voltage and the current in the line; this can be easily calculated by applying Ohm's law. The current continues to flow thru the magnet (E) back to the line; thus the current passing thru the coil will energize it, and will hold the armature down. In case the voltage goes off the line the coil (E) ceases to be magnetized, and the armature is pulled away from the coils, by spring (H)—(which has a tendency to pull the armature away from the coils) and a local circuit is made at contact (I), which in turn is in series with a battery and bell, as shown. A, is a rubber contact to prevent cross-connections.



When the Line Voltage Fails the Relay Closes an Alarm Bell Circuit, the Bell Being Placed At Any Point Desired.

Besides this use of the indicator it can be put to many other advantageous uses as the operator sees fit.

Contributed by H. E. BEANE.

CHEMICAL EXPERIMENTS.

Spontaneous Combustion: A mixture of potassium chlorat and flour at once takes fire on being touched with a drop of sulfuric acid.

The Spontaneous Combustion of Three Metals: In a perfectly dry ladle place a small piece of sodium with an equal quantity of potassium. If a little mercury be added, and the whole well shaken, it will take fire and burn vividly.

The White and Black Statue: Construct a small figure or statue of white paper or cardboard, and moisten it with a solution of lead acetat. Expose it to fumes of sulfuretted hydrogen, and it will turn black.

The Kettle that Boils on Ice: Set a small water kettle on a piece of ice, now put a small amount of liquid carbon dioxid into the kettle. The contents will boil violently.

The Blushing Picture: If any plain print or drawing be taken (preferably one of a young lady) and the face, hands and neck be painted with a solution of equal parts of water and methylated alcohol, to which a few grains of phenolphthalein have been added, on subjecting the picture to the influence of ammonia vapor it will "blush" most vividly. Contributed by ELLIOTT S. BUCHANAN.

UNIQUE GLYCERIN SWITCH MADE FROM SOUNDER.

It is often necessary to break a circuit at relay contact points, where the circuit to be broken carries current at 110 volts. The arcing is intense when the current is much above 1 ampere. A simple and very effective oil switch may be made from material which is almost always on hand.

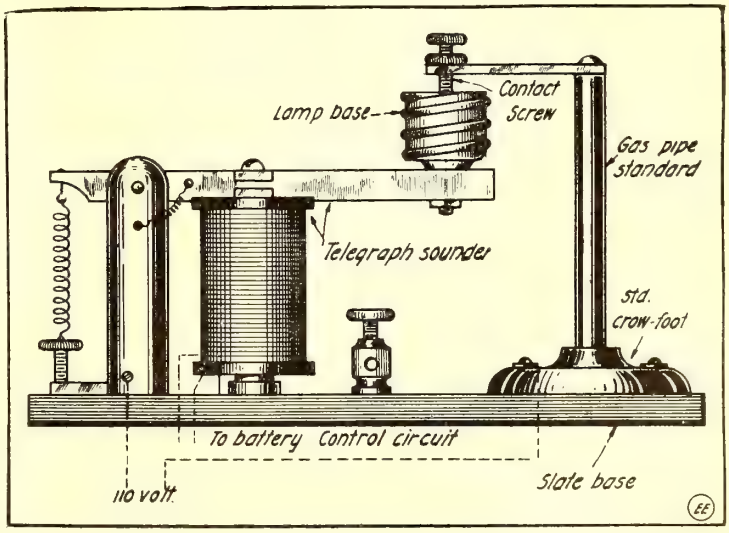
Secure a brass base from an Edison lamp (one may be removed from a lamp by heating the glass near the base in a Bunsen flame). Drill a hole in the bottom of it for a bolt to pass thru. Screw the socket onto the end of the armature of a telegraph sounder which will serve as the relay. Before putting the bolt thru the socket, slip a soft rubber or fiber washer on to prevent any leaking of oil thru the hole.

A standard which serves as the rear contact may be made from an ordinary fixture crow-foot, a piece of gas pipe and a piece of 3/32" brass or steel which is threaded to receive an adjusting screw. (See illustration.)

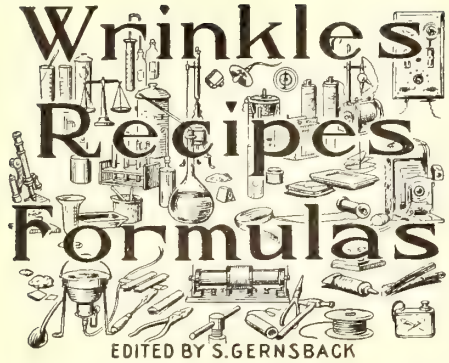
The writer had a great deal of difficulty in securing a suitable oil to kill the arc. After trying sweet oil, linseed oil and machine oil he tried—glycerin. And it does the work. Arcs from breaks carrying 10 amperes were successfully quenched by using glycerin in the cup.

It may be also of interest to note that castor oil is quite as satisfactory as glycerin, and a lot cheaper too. The cup may be partially filled with mercury with the oil over the top of it.

Contributed by ALBERT H. BEILER.



For Breaking Heavy Currents the Arc Is Best Broken in Glycerin. The Latter Is Held in a Cup, Operated by "Sounder" or Other Magnets in the Manner Indicated.



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

FOR CLEANING VARIOUS SUBSTANCES.

Alabaster.—Use strong soap and water.

Black Silk.—Brush and wipe it thoroly, lay on table with side intended to show, up; sponge with hot coffee strained thru muslin; when partly dry, iron.

To Remove Stains or Grease from Oil Paint.—Use bisulfid of carbon, spirits of turpentine, or if dry and old, use chloroform. These and tar spots can be softened with olive oil and lard.

Stains, Iron Rust, or Ink from Vellum or Parchment.—Moisten the spot with a solution of oxalic acid. Absorb same quickly by blotting paper or cloth.

Rust from Steel.—Take half ounce of emery powder with one ounce of soap and rub well.

Fruit Spots from Cotton.—Apply cold soap, then touch the spot with a hair pencil or feather dipped in chlorate of soda, then dip immediately in cold water.

Grease from Silks.—Take a lump of magnesia, rub it wet on the spot, let it dry, then brush the powder off.

Iron Rust may be removed from white goods by sour milk.

Scorch Stains from White Linen.—Lay in bright sun.

Mildew.—Moisten the spot with clean water; rub on it a thick coating of castile soap mixed with chalk scrapings; rub with end of finger, then wash off.

Oil Marks on Wall Paper.—Apply paste of cold water and pipe clay, leave it on all night, brush off in the morning.

Paint Spots from Clothing.—Saturate with equal parts turpentine and spirits of ammonia.

To Cleanse House Paper.—Rub with a flannel cloth dipt in oatmeal.

Black Cloth.—Mix one part of spirits of ammonia with three parts of warm water, rub with sponge or dark cloth, clean with water, rub with the nap.

Furniture, for Finger Marks.—Rub with a soft rag and sweet oil.

Chromos.—Go over lightly with a damp linen cloth.

Zinc.—Rub with a piece of cotton cloth dipt in kerosene, afterwards with a dry cloth.

Hands from Vegetable Stains.—Rub with a slice of raw potato.

Window Glass.—Paint can be removed by a strong solution of soda.

To Clean Tinware.—Common soda applied with a moistened newspaper and polished with a dry piece, will make it look like new.

DIRECTIONS FOR WHITE METAL PLATING.

By Aaron Van Citters.

A number of firms have advertised white metal plating outfits, for plating knives, forks, spoons, etc., for which they charge from ten to twenty dollars. By following the instructions given below, you can, with the assistance of a blacksmith in making the crucible and hood, set up this outfit complete for about two dollars and a half or less.

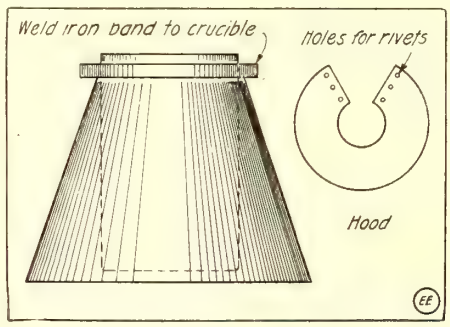
To make the crucible—Take a piece of gas-pipe 4x6 inches, weld a bottom in it, and a band around the top from which it hangs inside the hood.

To make the hood—Make a flaring cylinder of sheet iron, the small end the proper size to fit under the ring of crucible; the other end about one-fourth larger in diameter, and sufficiently long to hold crucible upright with bottom just clear of the stove or gas plate.

To make the White Metal—Pure tin, 10 lbs., lead 4 ozs., antimony 2 ozs. Melt and mix thoroly. A better grade is made by using 2 ozs. of pure silver in place of the antimony.

Jar No. 1 (Pickle Solution)—For iron or steel is composed of muriatic acid only.

Jar No. 2 (Dip Bath)—Dissolve 2 pounds refined zinc in 2 quarts fluid hydrochloric acid C. P. When dissolved and cold, add half a teacup of clear rain water or filtered water. (This is a dangerous solution to mix, as it is very violent when the zinc is being consumed, and great care should be taken.)



How Crucible Is Made for White Metal Plating.

Jar No. 3 (Chill Bath)—Dissolve 6 ozs. di-ammonia carbonate in 3 pints of filtered water. Use at a temperature of 120 degress F.

Jar No. 4 (Pickle Solution)—For Irish silver and brass, dissolve 12 ozs. granulated nitratum in 2 quarts of filtered water; then add *slowly* 2 quarts commercial sulfuric acid. (Note—Unless you are going to do a great deal of plating, Jar No. 4 is unnecessary, as Jar No. 1 answers as a pickle solution for all metals.

Stripping Solution—Is composed of 1 pound granulated kali; or potash and 2 scruples of French rouge; dissolved in 1 gallon commercial sulfuric acid.

(*The Flux*)—Mix thoroly 5 lbs. granulated white ammonia hydrochlorate with 4 drams French rouge. For convenience in using, put a portion in an ordinary tin pepper box.

Directions for Plating—Place the sheet iron hood on the stove or gas plate, the small end up, then set the iron crucible previously filled with the *white metal,* inside the hood, so edge will rest on top of same. But little heat is required to melt the metal, which forms a thin metallic solution. Care should be taken not to get it too hot. If after an article is plated it shows a yellowish color, it is because of too much heat, which should be partly turned off. Proceed to plate as follows:

First, put articles to be plated in Jar No. 1, allowing them to remain ten minutes to remove all rust, etc., then rinse in clear, cold water. Next take one piece at a time and rinse in Jar No. 2 for a few seconds; then immerse the article slowly in the crucible containing the melted metal; raise slowly up and down once or twice, sprinkle a little flux on the article, letting some of the flux fall on the melted metal. Then draw article from crucible and immerse slowly into Jar No. 3, which hardens the plate, after which rinse in clear water and it is finished.

Knives, forks and spoons should be plated, one-half at a time; then the operation reversed. About one minute is required to plate a single article. A little practise will make you perfectly familiar with plating in this manner, and you will be able to see at a glance when everything is perfect. When there is much old plate on an article, place stripping solution in a crock, heat it, and immerse article therein until the old plate is all removed; then rinse in clear water, dry with a chamois skin, and proceed to plate as above.

(Special Note)—When much old plate is removed by stripping, it pays to reclaim the silver, which may be done in the following manner: Add common salt to the stripping solution as long as it throws down a precipitate, then pour off the solution. Wash the precipitate with clear water, then add a few small pieces of sheet zinc to it and let stand until the preciptate turns to a black powder, which will take several hours. Then wash the powder several times in warm water, dry between sheets of blotting paper, and pick out the pieces of zinc. The powder will be pure silver which you can melt and run into bars.

VALUABLE HINTS FOR PHOTO WORKERS.

Bottles.—Better to send the unknown contents of a bottle down the sink than risk spoiling a formula with it. Do not wait for labels to drop off; give the lot an inspection every three or six months, and replace any which are becoming illegible, says the *Am. Photog's Weekly.* Don't wait till this has happened.

Labels on Bottles Containing Solution.—Place the label in such a position that you can indicate by an arrow point on the label just how far up in the bottle the stock solution comes when making up a fresh lot.

Waste Box.—Do not throw spent matches, plate-box wrappers, bits of string, or anything else (not even cigarette ends) on the floor, but in the waste box (a large-size biscuit tin is just the size and shape). Everything on the floor makes for dust.

Seconds Pendulum.—A little over a yard of fire string, the bob of an old clock, a long bit of brass chain. This clinks against the rim of a half-pound tobacco-box lid every second swing. The pendulum hangs from a nail in the wall. The pendulum is forty inches long.

Cotton-Batting Bottle.—This bottle contained caustic potash solution. The stopper being fixt resisted "firmly but gently" every persuasive invitation to move it. It was tapt off at the neck. The shoulder of the bottle was cut with a file scratch and hot wire. The sharp edge taken off with a hard pebble. It now stands on the sink shelf, and holds cotton batting with which to swab the surface of a negative or use as a quick filter.

Toothbrush Bone Handle.—Filed down to make a finger-nail shaped end, which acts admirably as a plate lifter.

Experimental Chemistry

By ALBERT W. WILSDON

Seventeenth Lesson

Ammonia (NH_3) and Ammonium Hydroxid (NH_4OH)

HISTORY:

THE aqueous solution of ammonia gas and some of its salts, as ammonium chlorid, or sal-ammoniac, were known to the early alchemists, and described by them as "Spirits of Hartshorn." Basil Valentine in the

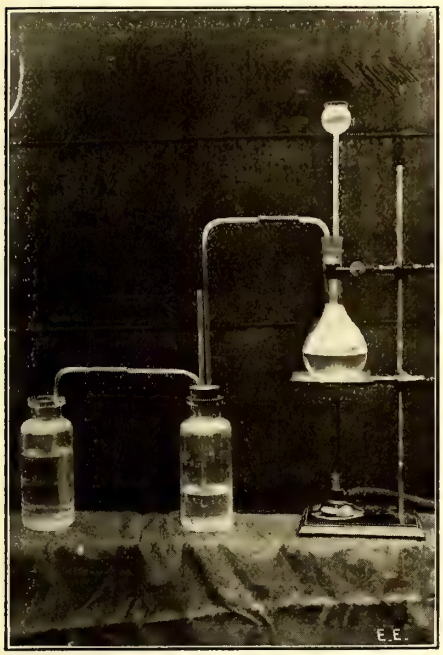


Fig. 84. Apparatus Set Up for the Preparation of Ammonium Hydroxid—NH_4OH.

fifteenth century showed that the gas could be made as we make it to-day; namely, from ammonium chlorid (NH_4Cl). Priestley in 1747 was the first to prepare gaseous ammonia, by heating together sal-ammoniac (Ammonium chlorid), and lime, and collecting the gas over mercury. He called it "Alkaline Air" which was later changed to "Volatile Alkali."

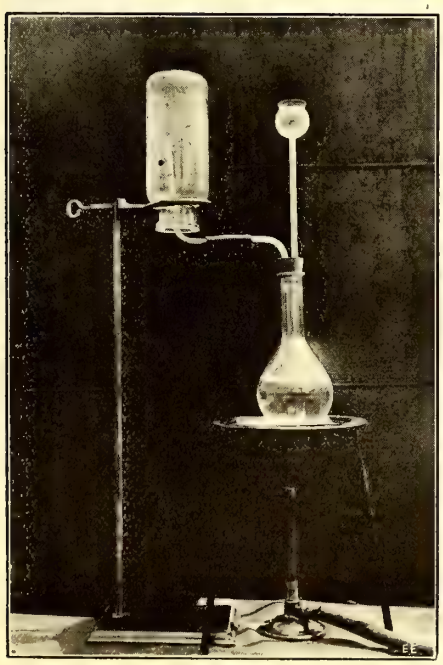


Fig. 85. Necessary Apparatus for the Collection of Ammonia—NH_3—by Upward Displacement.

Berthollet in 1785 showed that it is composed of Nitrogen (N) and Hydrogen (H), and Davy in 1800 made the volumetric determination necessary for the symbol.

OCCURRENCE AND FORMATION:

Ammonia is found free in small quantity only. A very minute quantity is formed in combination with carbonic, nitric and nitrous acids, during electrical discharges in the air, from the hydrogen of water, and nitrogen of the air. This often combines with an oxid of nitrogen (formed by the same process) to make ammonium nitrat (NH_4NO_3), and the product is finally washed by rain into the earth.

It is also found as sulfate and chlorid near active volcanoes, having been produced by the hot lava flowing over fertile soil containing nitrogen. Ammonia and its salts are formed in the distillation of many organic substances as bones, and other animal tissues and excretions, as well as the putrefaction of nitrogenous organic substances.

Formerly horns, hoofs, and other animal products were distilled, and ammonium carbonat thus produced neutralized with hydrochloric acid, the product after sublimation being known as sal-ammoniac (ammonium chlorid). At the present time coal is used and the supply obtained by a similar process.

PREPARATION:

1. Thru the union of its elements by means of the silent electric discharge.

2. Thru the reduction of the various compounds of nitrogen and oxygen or their acids.

$$\underset{\text{Nitrogen Dioxid}}{N_2O_2} + \underset{\text{Hydrogen}}{5\,H_2} = \underset{\text{Ammonia}}{2\,NH_3} + \underset{\text{Water}}{2\,H_2O}$$

3. Thru solution of many metals in Nitric acid.

$$HNO_3 + 4\,H_2 = 3\,H_2O + NH_3$$
$$(4\,Zn + 9\,HNO_3 = 4\,Zn(NO_3)_2 + NH_3 + 3\,H_2O)$$

4. By the reduction of nitrats or nitrits by nascent hydrogen in alkaline solution.

$$NaNO_2 + 3\,H_2 = NaOH + H_2O + NH_3$$
$$8\,Al + 5\,KOH + 3HNO_3 = 2\,H_2O + \underset{\text{Potassium Aluminat}}{8KAlO_2} + 3NH_3$$

5. Ammonia gas is prepared on a large scale by heating together calcium hydroxid and ammonium sulfate or chlorid.

$$(NH_4)_2SO_4 + Ca(OH)_2 = CaSO_4 + 2NH_3 + 2\,H_2O$$

6. For laboratory purposes it is preferable to heat the solutions of ammonia.

7. The hydroxid is prepared by the action of a strong base or one of its salts. The chief salts are ammonium chlorid (NH_4Cl); ammonium nitrat (NH_4NO_3); ammonium sulfate ($(NH_4)_2SO_4$) and ammonium carbonat ($(NH_4)_2CO_3$). By mixing any one of these with either calcium, potassium or sodium hydroxid, and applying gentle heat, there are formed ammonium hydroxid (NH_4OH) and ammonia (NH_3). These reactions come under *Barthollet's law of gases.* Sal-ammoniac (NH_4Cl) and slaked lime ($Ca(OH)_2$), because of their cheapness, are usually employed.

$$\underset{\text{Ammonium Chlorid}}{2NH_4Cl} + \underset{\substack{\text{Calcium Hydroxid} \\ \text{(Slaked lime)}}}{Ca(OH)_2} = \underset{\text{Calcium Chlorid}}{CaCl_2} + \underset{\text{Ammonium Hydroxid}}{2NH_4OH}$$

It should be remembered that the hydroxid is only the gas combined with water, and two substances, ammonium hydroxid (NH_4OH) and ammonia (NH_3) are both called "ammonia", but not accurately so. Whenever one of them is found the other usually exists, *as Ammonium hydroxid gives off the gas and ammonia takes up water.*

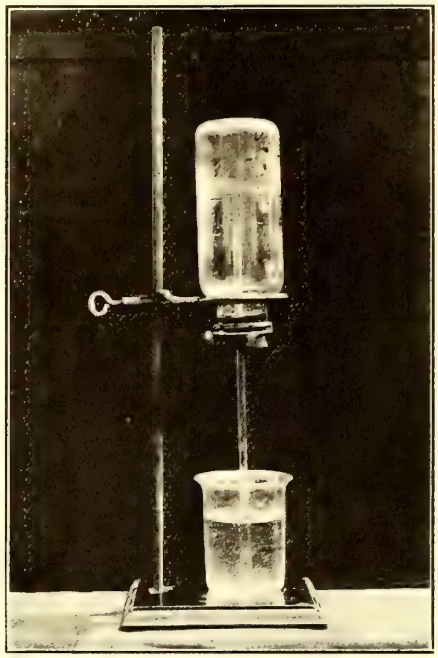


Fig. 86. Simple Apparatus Required in Performing the "Ammonia Fountain" Experiment. It Is Shown Here in Acual Operation.

When required *pure,* the gas must be past over calcium oxid (quicklime) to remove the moisture, and then collected over mercury.

(*Continued on page* 427)



Fig. 87. Apparatus for Illustrating Diffusion and Absorption of NH_3. Left Hand Flask Contains NH_4OH; Right Hand Flask—Water.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

At Last an "Electrical Laboratory" Photo!!!

Well, "Radio-bugs," you have got to take off your hat to Mark Slabodnik, of Ely, Minnesota, winner of this month's prize, and mark you, the ONLY prize awarded this month in "With the Amateurs' Department." Now, why is it that we can't receive more photos from "ELECTRICAL LABORATORY" owners, when there are about a million of you scattered thruout the United States at this very moment! As you will remember we made all of you a special offer in the September number, *viz.*, we offered to give not only the $3.00 monthly prize for the best "Electrical Lab." photo, but 5 (five!!!) additional prizes of one year's subscription to this journal, and a copy of the "EXPERIMENTAL ELECTRICITY COURSE" for the best five photos submitted, after awarding the first prize. But nary a peep from a blessed mother's son of you. Now it is up to you to get busy at once, and photograph that "Electrical Lab." We mean every word of it, "Bugs"! For if you do not, this department is simply going to slide into oblivion. As we have just said, it is strictly up to you whether you wish to take a chance on winning the $3.00 cash prize, and also if you wish to throw away the chance of receiving "The ELECTRICAL EXPERIMENTER" magazine for one year **free of all cost**, besides the copy of the *Experimental Electricity Course*, which is worth $1.00 alone to any electrical student. Address the Editor "With The Amateur's Prize Contest."



A GROUP OF REPRESENTATIVE AMERICAN AMATEUR RADIO STATIONS.

Electrical Laboratory of, 1—Mark Slabodnik, Ely, Minn. (Prize Winner); Radio Stations of, 2—G. Eddie Johnson, Toledo, O.; 3—Nicholas L. Googin, Jr., Cazenovia, N. Y.; 4—Armin Vogt, Jansen, Nebr.; 5—Steddom Bros., Oklahoma City, Okla.; 6—Warren Benson, Brooklyn, N. Y.

That "Perpetual Motion"

WE HAVE never publisht a prize contest that came within miles of being such a hilarious success as our "Scenic Railroad" hoax. When we publisht it, we did it more in order to show how young boys are often misled, due to incomplete knowledge, rather than our exploiting a scientific impossibility. In other words, the whole thing simply was a joke.

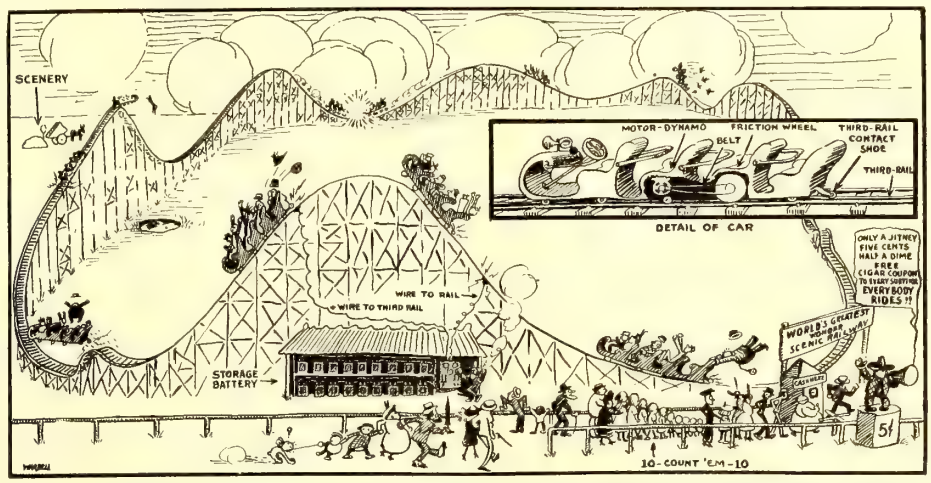
Imagine then our genuine surprise when immediately after publication, hundreds upon hundreds, nay thousands of letters poured in upon us, telling us why the scheme would not or really *would* work! Up to this time of writing 2,109 letters were received! Imagine such a thing—and they still come and come, and we have as yet to hear from foreign countries!!

The amount of good people who took the thing really serious is little short of astounding. And hundreds really imagined it worked! Even the gentle sex wrote four letters!

Hundreds of letters were alike, most of their writers considering "friction" only. But the greatest bone of contention was the dynamo-motor point. Almost a thousand correspondents contended that when feeding the storage battery current back into the dynamo, the latter would reverse thus making the car go backward! These good people evidently never heard of an automatic reversing switch, nor did they stop to think that the great Chicago, Milwaukee and St. Paul Railroad actually works on this principle, where the coasting trains pump energy back into the line. Of course, this is not perpetual motion, nor anything near it, it is simply efficiency.

Only one letter, Mr. L. J. Bair's, mentioned this fact, hence the award of the "first prize" to him. Several other good letters are also publisht and prizes were awarded to the writers.

Scores of correspondents turned unconscious humorists, and we are printing a few choice samples selected at random. We are genuinely sorry that we have not the space to publish several hundred more of them!



In Our "August" Number We Publisht This "Perpetual Motion" Scenic Railway Problem. The Large Storage Battery Was Supposed to Supply Current to the Ascending Cars; the Descending Cars Pumped "Juice" Back Into the Battery, etc., ad infinitum. Here Are Some of the Answers We Received. The Editor's Chair Is Still Oscillating From the Shock.

First Prize and Subscription to "E E"

As an answer to your Perpetual Motion Scenic Railway Puzzle, I wish to offer the following for your consideration:

The facts resolve down to the following conditions: We have a weight mounted at a height, and in falling or rolling from this height, it attains a certain amount of kinetic energy in foot pounds. It requires exactly the same amount of energy in foot pounds to elevate this weight to the same height as is generated by falling.

From these facts, it is self-evident that were all apparatus and processes of this transfer of energy one hundred percent efficient, the system described would be O. K., but it is also evident that, due to wind friction and bearing friction on the cars, and copper, iron, windage bearing and brush losses, of the generating apparatus and motor equipment, it will be only about 60 per cent efficient at its best. *This efficiency is attained by the regenerative apparatus used on the Chicago, Milwaukee and St. Paul R. R. on a three phase electric system over the Rocky Mountains.*

The misleading feature of this perpetual motion scheme is that, due to the momentum of the car on the downward slide, it would reach to a high point on the upward grade and requires only a little effort to carry it over the top peak, but when using the regenerative apparatus, no such momentum will be attained as the speed of the car will be reduced in direct proportion to the amount of current generated.

LEIGH J. BAIR,
111 West 111th Street,
New York City.

Honorable Mention and Subscription to "E E" 100 Words—Count 'Em

The air resistance, friction of bearings, brush on third rail and magnetic drag on armature reduce speed in descending hill so that the momentum of car will not ascend a hill equal in height to its starting point, consequently in order to have the car travel nearly around the ring, each succeeding hill must be less in height. Therefore car will stop some distance below its starting point.

Assuming efficiency of dynamo, storage battery and motor 80 per cent each, then about 51 per cent of energy lost is returned to it as motive power. Therefore, would come nearer performing feat without dynamo attached.

C. F. RUDOLPH.

Honorable Mention and Subscription to "E E"

The fallacy of the idea may be shown in the clearest way by a simple mathematical process. In this solution the loss of energy thru friction, dynamo inefficiency and electrical resistance is disregarded, altho, of course, this would be great enough to make the idea impractical.

It may be asssumed that the energy required to drive the car from the point B to C would be equal to the energy obtained from the car traveling from A to B. Let these amounts equal x and x^1.

Then

$$x = x^1$$

Also let the kinetic energy $= K$ and the electrical energy $= E$.

Now in traveling from A to B, kinetic energy K will be obtained minus the electrical energy used to charge the storage batteries, or

$$K - E = x.$$

Now from B to C, the energy required will be the kinetic K, which will carry the car to some point C^1, *plus* the electrical, from C^1 to C, or

$$K + E = x^1$$

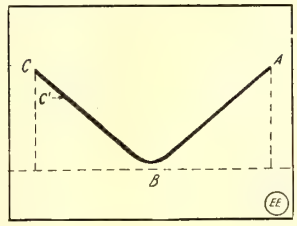
and since

$$x = x^1$$
$$K - E = x$$
$$K + E = x^1$$

then

$$K - E = K + E$$

which, of course, is impossible.



JOHN R. MARTIN,
333 E. Morton Ave.,
Jacksonville, Ill.

Honorable Mention and Subscription to "E E"

In explanation of the inoperativeness of the Perpetual Motion Scenic Railway, described on page 249 of the August number of your magazine, I would state the following: It is well known that a dynamo consumes mechanical energy in proportion as it produces electrical energy. Therefore, the power required to drive the dynamo would so retard the descent of the car on the down-grades that, having less momentum, additional power would be required to lift it on the up-grades. This would be drawn from the storage battery and, owing to the losses in the machinery, more power would be consumed than was generated.

WILLIAM C. BELLER,
51 East 123d St.,
New York City.

Is He Joshing Us?

The Scenic Railway idea would be fine but for a few obstructions.

The energy loss due to the friction between the flange of the wheels and the rails is hardly worth mentioning. The voltage drop in the iron rails is small. Some energy is also lost in overcoming the air pressure on the front of the car.

Much energy is wasted in starting and stopping. This could be prevented, however, if the passengers *would jump on and off while the car is in motion.*

Not counting these few hindrances the idea is fine and it ought to be patented.

C. M. HOLLENBACH,
Saegersville, Pa.

Collisions and Wrecks! Wow, What a Headache!!!

The "Perpetual Motion Device" won't work because when the dynamo operates as a motor it will run the car backwards, which would collide with the other cars. Also while ascending cars are using current, the descending cars are sending current in the *opposite direction* to charge batteries. Thus there would be two electrical currents tending to go in opposite directions in the same conductor, and that is impossible, as each would tend to stop the other.

H. KERSTETTER,
633 Carlton Street,
Toledo, Ohio.

"Closed Circuit"—Bless Its Heart!!

The Scenic Railway cannot operate perpetually, because the dynamo-motor is connected to a closed circuit. To operate a circuit of this kind a dynamo must have sufficient power applied to it. Thus, when descending a hill, the energy required by the dynamo checks the speed of the car so that after a few descents the car must stop altogether.

PAUL R. GROVE,
714 Moore Street,
Huntington, Pa.

Eureka! It Works! Oil!! (Castor Oil?)

The reason why this device will not work is this: Tho the energy generated by the descending car would be sufficient to carry up a similar hill a similar car some of the energy is wasted in heat by friction. Altho by oiling this could be reduced, it could not be eliminated. Then some current would be wasted in heating the wires. If there were fewer cars or fewer people on the next trip it might work. But it would die down in a short time unless power were supplied from an outside source.

JOHN A. McGUIRE,
39 Hope Street,
Ridgewood, N. J.

Quick—Call an Ambulance!!

The car in going down-hill would generate a current that would, at the bottom of the incline, tend to drive the car *back up again,* and it would back it up a little way, the car only to come to rest at last at the bottom.

LESTER WOLF,
920 S. 11th Street,
South Bend, Ind.

Everett Has the Right Dope!

A car would climb just as far up the last peak without the addition of a generator and storage battery plant as with it, since its momentum would be impeded by the running of the generator, as by the well-known law: The current generated in a conductor by its motion in a magnetic field flows in such a direction that its magnetic field tends to prevent the motion. In other words, the amount of energy used up by the running of the generator is greater than that gained by the motor, the loss being due to resistance, friction in the generator and motor, etc.

EVERETT L. SWEET,
145 Congress Ave.,
Providence, R. I.

This Bird Claims It Will Run 40 Seconds!!

It is impossible for your "Perpetual Motion Scenic Railway" to work for several reasons:

Regardless of what height the grades are upon which the cars descend, the dynamo-motor *would*

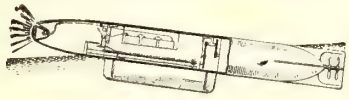
(*Continued on page* 430)

LATEST PATENTS

Illuminated Torpedo

(No. 1,232,671; issued to Alphonse Ferandez.)

This electrically illuminated torpedo is intended for use by mariners, as an aid in discovering the presence of enemy craft at night. The torpedo may contain explosives if desired. To prevent disclosing the location of the ship dispatching the torpedo, a special electric time switch is provided, which does not close

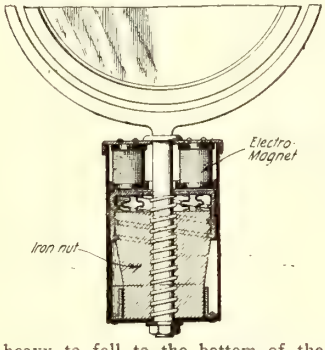


the searchlight battery circuit until the torpedo has reached a predetermined distance away from the ship. Also the inventor provides a centerboard or keel which is automatically released after the torpedo has reached the end of its range, and which device helps to keep the torpedo in a given course; the inventor thus not relying on the ordinary rudder or plane steering mechanism. It is possible to retrieve torpedoes of this type after they have performed their service.

Magnetic Shift for Head-Lights

(No. 1,233,341; issued to Henry S. Gove.)

Electro-magnetic shifting device for rotating head-lights of an auto or other vehicle which involves the use of an extremely simple motor, the head-light being mounted rigidly on a central threaded stem, which engages a relatively heavy iron nut. Normally this nut is sufficiently

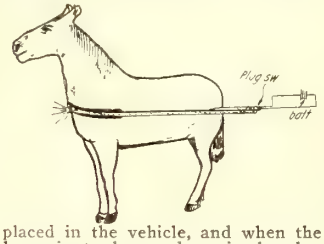


heavy to fall to the bottom of the casing, and maintain the head-light in a straight ahead position. If battery current is past thru the electro-magnets at the top of the casing, the iron nut is drawn upward and in so doing, it causes the threaded cap just under the magnets to rotate, thus, turning the central stem on which the head-light is mounted.

Portable Lamp for Harness

(No. 1,232,201; issued to Carl F. Brown.)

A novel use for a battery lamp designed so as to be quickly attached to or detached from an ordinary harness, the wires carrying the current to the lamp being concealed within the traces. Battery may be

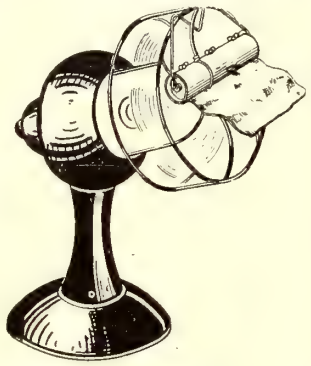


placed in the vehicle, and when the lamp is to be used a simple plug connector or switch can be attached to the trace closing the lamp circuit. An auxiliary switch mounted on the vehicle seat, may be used if desired. The inventor claims by this arrangement to be able to illuminate the road ahead of the horse, and thereby prevent shadows being caused by the animal from the usual lights on the vehicle. When not in use the lamp attachment can be removed in part, and the remainder of the lamp provides a neat ornament upon the breast collar.

Fan Deodorizer

(No. 1,233,039; issued to Bert W. Flanders.)

This invention provides a simple deodorizing attachment which may be readily attached to the wire cage found on all eletcric fans. The patent relates to refrigeration, and

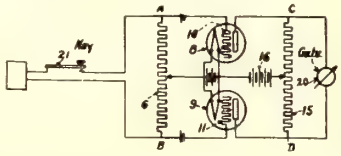


more especially to air coolers and deodorizers which include a fan or other means for pumping air into contact with water or other liquid before it is delivered to the point of use. This attachment includes a reservoir for water or deodorizing liquid, also a moistening surface with a fabric sheet hanging in front of the fan, and means for delivering the liquid as rapidly as may be desired to this surface, so that the air from the fan is blown against the moistened fabric and cooled or dried by the deodorizer before it reaches the point of application.

Thermionic Amplifying Circuit

(No. 1,232,879; issued to Peter I. Wold.)

This invention relates to the amplification of small continuous voltages or currents, and its purpose is to make it possible to detect or measure such voltages or currents, which might not otherwise be detected. Audion type vacuum amplifiers are utilized which are connected in a

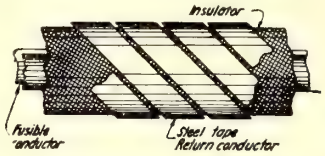


special circuit as shown. It will be observed that current from the battery 16 divides at the middle point of the resistance 15, and flows thru the two output circuits. It is also apparent that the two halves of resistance 15 will be equal and opposite, and points C and D will normally be at the same potential, and no current flows thru the galvanometer 20. When key 21 is closed, however, the current will flow thru the resistance 6, and if the direction is such as to bring the terminal A to a higher potential than the terminal B, the grid 10 will have a higher potential than grid 11. This results in the current flowing thru output circuit to amplifier 8, being greater than that of amplifier 9. Thus point C will be at a lower potential than point D, and current will flow thru the galvanometer 20.

Fire-Detecting Wire

(No. 1,235,028; issued to Charles A. Harsch.)

This invention involves the use of a fusible conductor inclosed within the walls of a cell or tube in the wall of which there is provided an

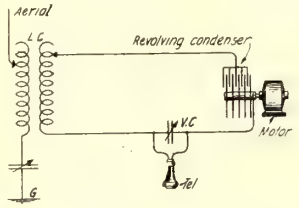


outlet, so that when the metal becomes plastic, it may be forced outward thru this perforation in the wall of this cell, and penetrate thru the fibrous insulating material surrounding it, and establish the desired electrical connection between the inner and outer conductors. The fire-detecting wire as devised by this inventor comprises an inner core of easily fusible metal, a galvanized steel tape of suitable breadth to nearly envelop a soft metal core, leaving a longitudinal slot, a braided insulated wrapping and an exterior conductor, formed preferably of a galvanized steel tape, helically disposed on the exterior.

Radio Receiving Circuit

(No. 1,233,841; issued to Elmer E. Butcher.)

Radio-telephonic or telegraphic signals of any characteristic, and particularly undamped wave signals are received and made audible by the simple arrangement here shown. The patent covers the use of a per-

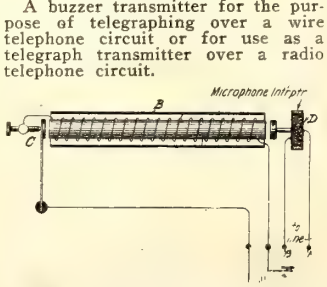


iodically changing capacity constant in the receiving circuit. A constantly changing condenser driven by a motor is shown in the present diagram. It is thus apparent that as the revolving condenser plates rotate, the capacity of the condenser increases to a maximum, and decreases to a minimum periodically; thus throwing the secondary circuit into and out of resonance with the aerial circuit, and an audible signal of a frequency proportional to the speed of rotation of the condenser is produced. No exact tuning is necessary with this circuit, as the revolving condenser, within limits, finds the exact point of resonance automatically.

Microphonic Buzzer Transmitter

(No. 1,234,650; issued to John Patrick Ferriter.)

A buzzer transmitter for the purpose of telegraphing over a wire telephone circuit or for use as a telegraph transmitter over a radio telephone circuit.

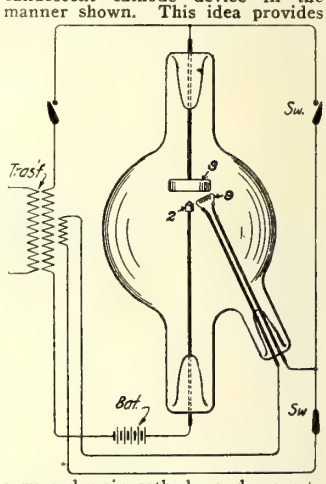


The apparatus comprises an actuating coil as shown, which is inclosed in an open-ended metal tube (B) of brass or copper. At one end of the coil is a spring interrupter (C), and at the opposite end a microphonic transmitter (D). The coil may be 6 inches long with an iron wire core ½ inch in diameter, wound with five layers of No. 23 B. & S. magnet wire. The metal tube (B) absorbs the brush discharges. The microphonic interrupter (D) acts in unison with the spring interrupter (C), but is not electrically connected with it. Terminals (13 and 14) go to the line.

Vacuum Bulb Rectifier

(No. 1,230,004; issued to George S. Meikle.)

An improvement in vacuum tube rectifiers involving the use of an incandescent cathode device in the manner shown. This idea provides

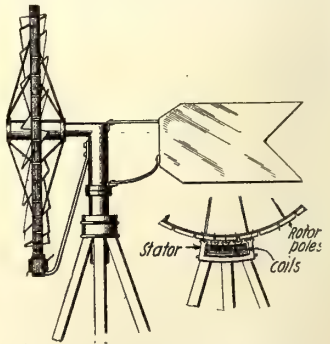


a rugged main cathode, and separate or auxiliary electrode which operates in conjunction with such cathode to spring a starting arc which heats the cathode to incandescence, preliminary to starting the main arc. The cathode tip perferably consists of tungsten; the space within the bulb should be carefully evacuated of all gases and vapors, and the envelop is then filled with an inert gas, such as hydrogen, argon, etc. When the tube is to be started, a suitable heating current is conveyed to the starting electrode 9, from a special winding on the transformer as shown.

Wind-Wheel Electric Generator

(No. 1,233,232; issued to Albert H. Heyroth.)

A very clever form of wind-wheel electric generator in which the



wind-wheel itself acts as the rotor of an alternating current dynamo. The rotating element simply carries inductor plates, which are caused to move by a series of stator poles, which poles carry a series of electro-magnetic windings. The device acts in the same way as an alternating current generator, and also serves as its own exciter. The terminals of the stator windings may be connected with a rectifier to change the alternating current into a continuous one when so desired.

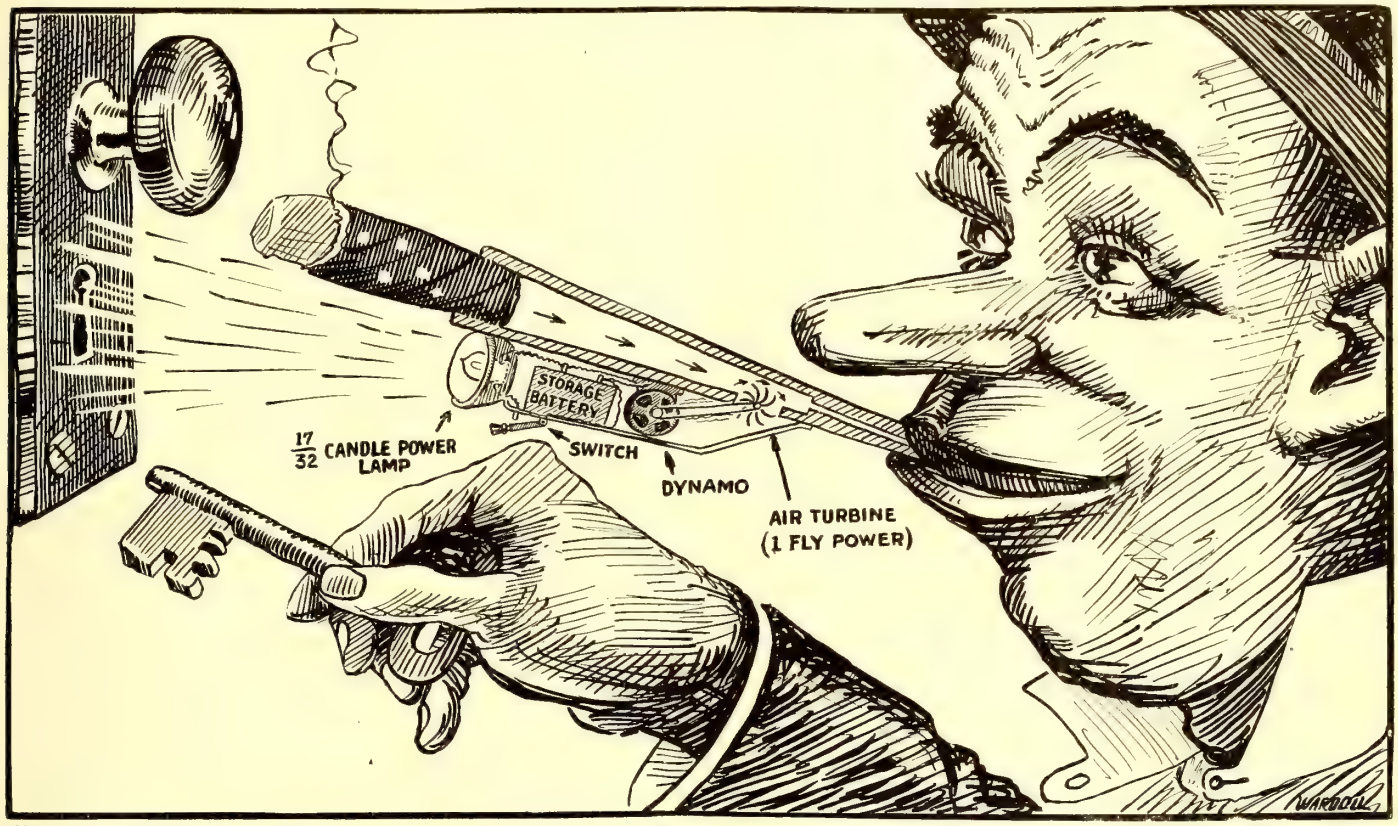
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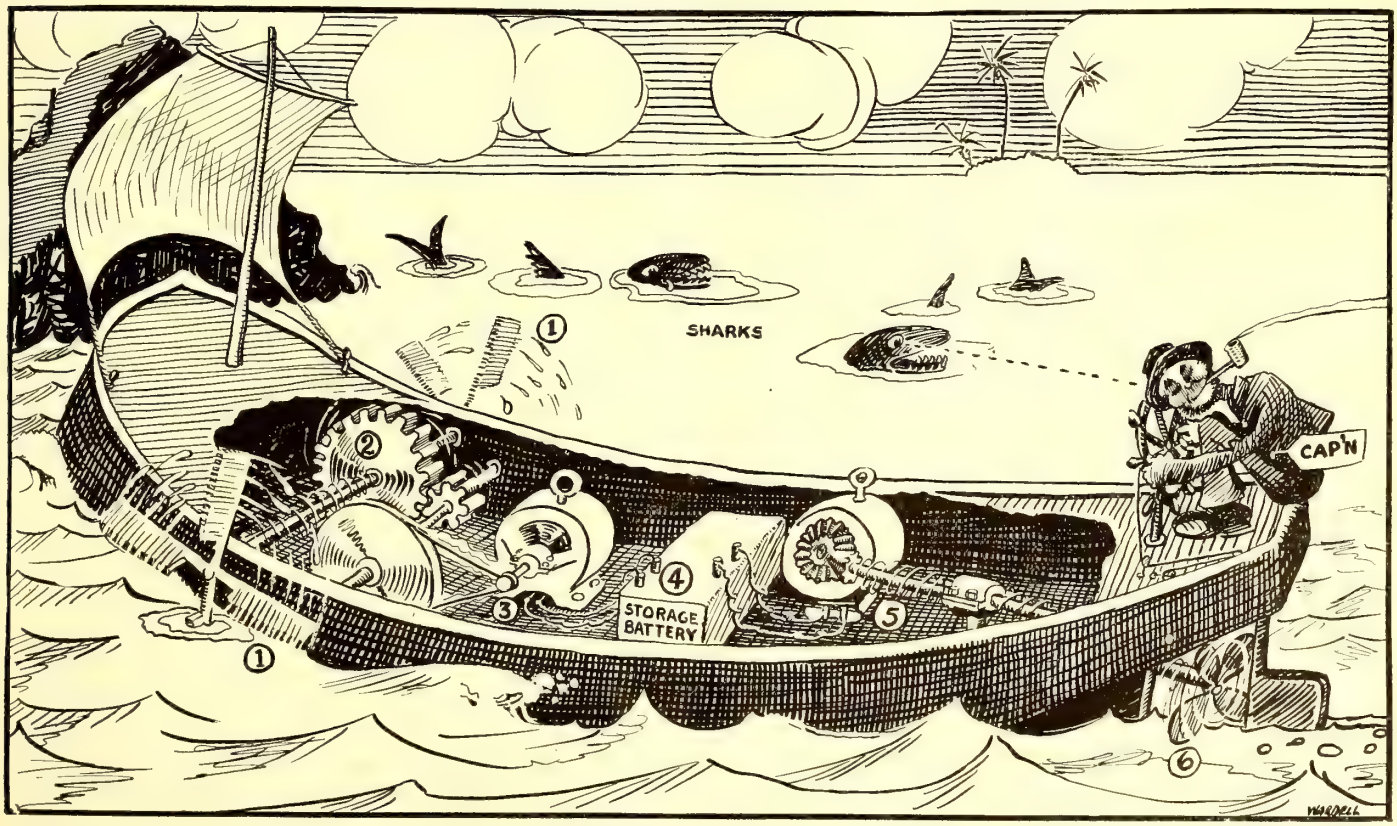
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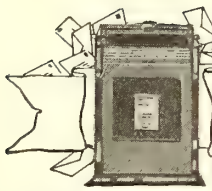
PHONEY PATENT OFFIZZ



FIRST PRIZE, $3.00: Smokelight. Works on Vacuum Cleaner Principle. Suction Created by Smoking, Operates Air Turbine, Which in Turn Energizes Dynamo. The Latter Charges Storage Battery Which Feeds the Current to Electric Lamp. Thus Collisions in Dark Are Avoided and Keyholes Are Found Easily. Inventor: F. R. Prey, Somerville, Mass.



ELECTRIC SAILOMOBOAT: Wind Fills Sails Which Slowly Move Ship. Water Turns Paddles 1, Which Thru Gear 2 Work Dynamo 3, the Latter Charging Storage Battery 4. This in Turn Drives High-Speed Motor 5, Which Turns Propeller 6 at 3898 R.P.M. Thus Ship Is Driven Forward at 49¼ Nots an Hour. Inventor: Albert Branson, Logan, Pa.



QUESTION BOX

This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

RESISTANCE OF SEA-WATER.

(842-A.) O. Saterdale, E. Boston, Mass., inquires:

Q. 1. What is the resistance of sea-water and what current could be transmitted thru 1,000 feet of it?

A. 1. The resistance of sea water varies somewhat of course, but it has an approximate resistance of 5 ohms per cubic centimeter.

Your question is very indefinite, as it makes all the difference in the world whether you wish to compute the amount of current which could be transmitted thru one thousand feet of sea water in a pipe; which would of course be a comparatively easy computation; or whether you wish to make such a calculation for an open body of sea water, such as in a harbor or inlet. In this case, the matter would become very involved indeed, and a number of soundings and breadth measurements of the body of water would have to be taken, and a mean of these values selected, so as to obtain the average cross-sectional area of the water. The resistance of a cross-section of sea water 10 centimeters square would only be 1/100 of the resistance of a cubic centimeter, etc. The current in amperes which could be transmitted thru a certain resistance of sea water would be given by Ohm's law or

$$C = \frac{E}{R}.$$

CONDENSER FOR REDUCING SPARKING.

(842.) Charles Honeywell, Gloversville, N. Y., asks:

Q. 1. Can you suggest proper size of condenser to eliminate sparking at bell circuit contact shown in diagram?

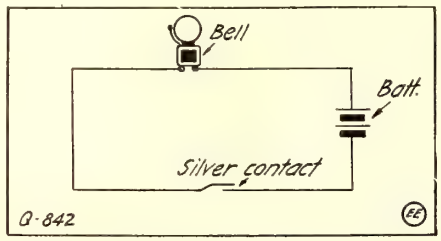
A. 1. Concerning the special electrical contact which you are experimenting with, would advise that without more exact details as to how you have the special contact arranged, we cannot very well advise you as to how to overcome the trouble.

We should think that it would be possible to make the spring tension acting on your contact sufficiently strong so that the contact will not be jarred shut by a slight mechanical disturbance.

A condenser will only help you indirectly in solving this problem, if you have the contact member arranged so delicately that the slightest jar will cause it to close. We would like to advise you further, but feel that it would only be a waste of time to discuss matters which we do not quite understand for the reasons above stated. Your trouble apparently seems to lie in the manner of arrangement of the contact. Besides the condenser the principle of the magnetic blow-out could be applied to overcome the arcing at your contact, but even the latter would seem to hardly be of any distinct benefit to you, if the design of the contact is not properly carried out.

The principle of the magnetic blast as applied to radio keys and other switches carrying heavy currents and liable therefore to severe arcing, lies in the fact that a strong electro-magnet is connected in series with the circuit, in most cases. This magnet for small circuit breakers, may be of about the same size as a telegraph sounder electro-magnet, and in any case, this series blow-out magnet should be wound with wire of the same size as that used on the primary of the transformer, spark coil or other apparatus which the key controls.

It is usual to allow from 800 to 1,000 circular mils per ampere, in designing such blow-out coils, and the electro-magnet should be provided with suitable tapered pole-pieces with a small air gap between them, and so arranged that the break between the platinum or other contacts of the circuit-breaker takes place between the magnet pole-pieces. In this way the arc will be blown out by the magnetic field.



A Simple Yet Difficult Problem. It Is Required to Break This Circuit With a Minimum of Sparking and the Interrupter Is a Delicately Mounted One, Easily Vibrating With a Slight Jar.

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As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 *to* 150 *words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.*

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, *233 Fulton Street, New York City.*

ELECTROLYTIC PRODUCTION OF HYDROGEN.

(844.) A. Luchs, Jr., Ridgeway, Pa., asks a number of questions regarding the electrolytic production of hydrogen.

A. 1. With respect to the explosive quality of hydrogen gas, would say that this is an explosive only when mixed with oxygen or with air, which is the same thing.

The most efficient way, and the one now used commercially in the largest oxygen-hydrogen producing plants in the country, is that producing hydrogen or oxygen gas by the electrolysis of water, which is accomplisht by passing a strong electric current thru it.

The following data is given by one of the leading manufacturers of oxygen and hydrogen gas. A current of 2 volts and 600 amperes is used per cell and 4.8 cubic feet of oxygen and 9.6 cubic feet of hydrogen per hour are produced with this current of 1,200 watts. The U. S. Army balloon electrolizers use 1,000 watt hours to produce 7½ cubic feet hydrogen and 5.76 gallons of water per 1,000 cubic feet of hydrogen are required. The electrolytic apparatus used for producing these two important commercial gases is usually designed so that the two gases are collected separately and independently; the hydrogen gas being evolved at the negative electrode and the oxygen gas at the positive electrode. You will do very well to obtain a copy of U. S. Patent No. 1,219,966 describing an improved form of electrolytic gas generator as used for the commercial production of these products, and which we can supply at 10 cents.

With reference to the proper ratio of hydrogen gas and air, to make the most explosive mixture, we would suggest that you try this out by experiment, as it would depend to some extent on the quality of the air; *i.e.*, it would vary for different levels, and an adjustable mixer valve should be used in any such work as this, similar to the carburetor employed universally on all gasoline automobiles.

LARGE AND SMALL WIRE IN SAME CIRCUIT.

(845) E. E. C——, Ohio, asks whether several sizes of wire can be used in the same circuit in a satisfactory manner.

A. 1. With regard to running a 3-phase 7200-volt line one-half mile, to deliver current to a bank of 3-25 K.V.A. 25-cycle, 6600-volt to 440-volt transformers for power load would advise as follows:

We have not made any calculations on this problem, but assume that you are taking care of these calculations yourself. However, regarding the use of various sizes of wire in the transmission line, would advise that so long as the smallest size of conductor used is not below the minimum allowable cross sectional area, in circular mils, as computed by the usual A.C. formula for such circuits, then it will not matter in the least for all practical purposes, whether you use several different sizes of wire in the circuit or not.

That is if, say, No. 6 B & S conductor was given by the usual voltage-drop formula, then so long as any of the pieces of wire to be used are not smaller than No. 6 gage, the circuit will operate satisfactorily. Of course it is the usual case that no one would want to use sections of conductor larger in size than that absolutely required by the conditions surrounding the problem, but of course in your case, there is an exception as you state, owing to the fact that you have a quantity of various sized conductors on hand for the installation in question.

REPELLING TORPEDOES WITH A. C. ELECTRO-MAGNETS.

(846.) John Davidson, Ohio, asks several questions regarding A. C. magnets to be used for repelling torpedoes.

A. 1. We have considered such an electrical device as you describe, and which is supposed to repel metallic bodies such as those made of steel or iron.

Considered from a fundamental electrical viewpoint, an ordinary magnet excited by a direct current will not exert any repelling effect on an iron or other body. It is possible to create a magnetic repulsion effect if powerful alternating current electro-magnets are used, but this effect exists only over a distance of a few inches at the most, and several inventors have recently proposed that it would be a good idea to put a belt of these powerful A.C. electro-magnets around the waterline of a steamship so as to repel torpedoes and the like.

While we are on the subject, it is well to point out that if this arrangement was carried out that firstly, the cost would be practically prohibitive, and secondly there would be no repulsion effect exerted on the torpedo, which is made of steel, for the reason that it would not be of the proper shape. To produce a repulsion effect between an iron core within an a.c. magnet coil and a copper or aluminum inductor, the latter must be made in a ring form either square or round, so that induced currents are set up in this ring which will produce within the ring an opposing magnetic field, which reacts with the inducing a.c. field of the electro-magnet just mentioned.

COMPUTING SIZE OF ELECTRIC LIGHT WIRING.

(847.) Roy N. Meier, Wayne, Nebr., wishes to know how the size of wire for lighting circuits is computed.

A. 1. One of the simplest and most reliable rules for computing the proper size of a conductor to be used for wiring a house for lights, etc., is the modification of Ohm's law which states that the resistance of the wire in the circuit (both legs) in ohms should equal the volts drop in the circuit, divided by the current in amperes in the circuit.



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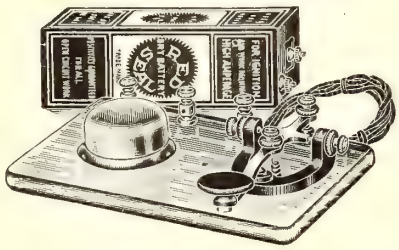
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For Learning Telegraph Codes



The Practice Set comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

The key and buzzer are mounted on a highly finished wood base, and three nickel plated binding posts are so connected that the set may be used for five different purposes.

For the beginner, the set is of exceptional value, for it may be used for individual code practice or for operation of a two party line, which is an excellent method of quickly learning the code. After the beginner has mastered the code, the set may be used in his wireless outfit for setting the detector in adjustment, and also the key may be used to control the spark coil.

Recommended for schools, as it gives excellent service for class instruction in code work. Full directions with each set.

The main object of the set is to enable the beginner to master the telegraph codes. The buzzer emits a sound similar in pitch and tone to that heard in wireless receivers.

Every beginner needs one of these sets, and as it is the equivalent of five different sets, the price is very low.

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JEWEL ELECTRIC COMPANY, 112 N. Fifth Av., CHICAGO

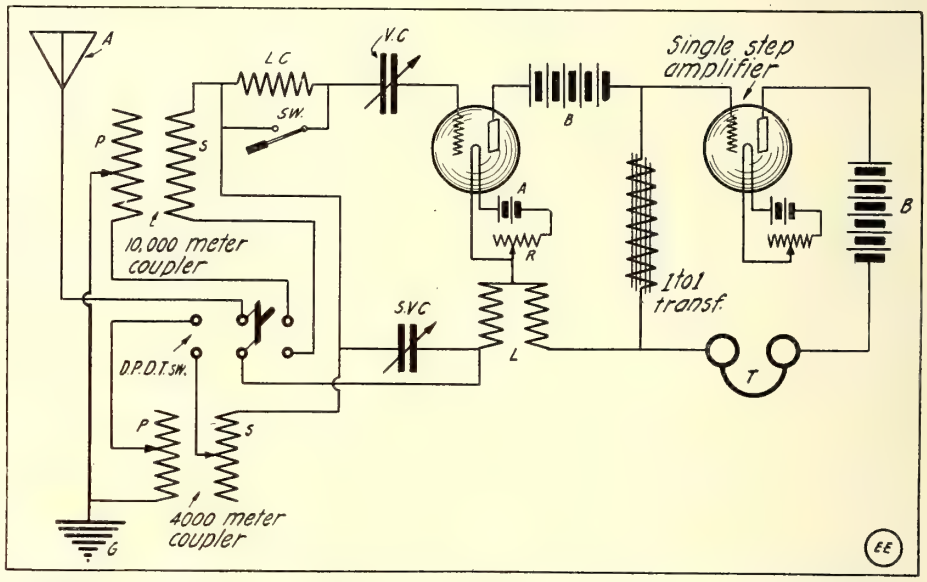
STROMBERG-CARLSON RADIO HEAD SET $8.25

Stromberg-Carlson Telephone Mfg. Co. Rochester, N. Y.

It is usual to allow about 3 volts drop from the main panel board to the lamps.

In making the final selection of the proper size of wire to be used for light and power circuits reference should be made to the Fire Underwriters' rules and tables, and if they specify a slightly larger conductor than the one given by the above formula, then that is the one that should be used of course.

With reference to the size of fuses to be used on the main panel board, these should be a multiple of the fuses in the branch circuits. For example if a panel board supplies four branch blocks, each fused at 5 amperes, then the panel board should be fused at 4 times 5, or 20 amperes, etc.



Connections of a One-Step Amplifier and Audion Detector Arranged to be Quickly Switched In For Undamped Waves Up to 10,000 Meters or Damped (Spark) Signals Under 4,000 Meters Wave Length.

WIRING DIAGRAM.

(848.) Leroy F. Bremmer, Fort Dodge, Iowa, wants to know:

Q. 1. What is the wave length of an aerial 80 feet long, 4 wires, 55 and 38 feet high, with lead-in 100 feet long.

A. 1. The wave length of your antenna is 350 meters.

Q. 2. Please show diagram of connections of a one-step amplifier which can be changed from a 10,000 meter undamped wave set to a 4,000 meter spark set by switches. Please show all necessary instruments in hookup.

A. 2. Diagram herewith shows connections of the necessary instruments. The double-throw, double-pole switch is employed for changing from the 10,000 meter coupler to the 4,000 meter coupler. In receiving spark stations it is essential that the *grid* loading coil is short-circuited by means of the switch as shown. To receive spark station the D. P. D. T. switch is thrown to the left and for undamped wave it is placed to the right.

IS HYDROGEN SULFID IN WATER A PHYSICAL OR A CHEMICAL SOLUTION?

(849.) S. Lenkin, Washington, D. C., wants to know if hydrogen sulfid (H_2S) in water is a physical or a chemical solution, and why.

A. 1. Hydrogen sulfid in water is a physical solution. When the gas is past into the water there is no evidence of any effervescence or of any precipitat forming (unless lead is present in the water which will cause the H_2S to precipitat the lead as an insoluble sulfid). This operation is sometimes called a *simple solution,* the original substance (H_2S) is present in the liquid, and can be obtained by evaporation. (This is not, however, the case with HCl.) The solution of the gas will, however, give certain chemical reactions, as, turning litmus, and when deposited on a silver coin, will produce a black stain of silver sulfid.

OSCILLATING A. C. MOTOR.

(850.) E. W. Cleave, Oakland, Calif., wants to know if an A.C. motor can be built in which the rotor will oscillate back and forth instead of rotating.

A. 1. Concerning oscillating squirrel-cage A.C. motor, we must say to the best of our knowledge, there is no method of winding such a motor so as to cause the rotor to oscillate back and forth thru say, 1/8th of a revolution as you suggest.

We would suggest that you take up this matter with the Engineering Department of the General Electric Co., Schenectady, N. Y., as we have an idea, if we recollect correctly, that that concern have a special alternating current apparatus, which operates on a principle somewhat like the one you outline.

LARGE SPARK COIL DESIGN.

(851.) B. P. B., Chicago, Ill., asks about constructing a large spark coil.

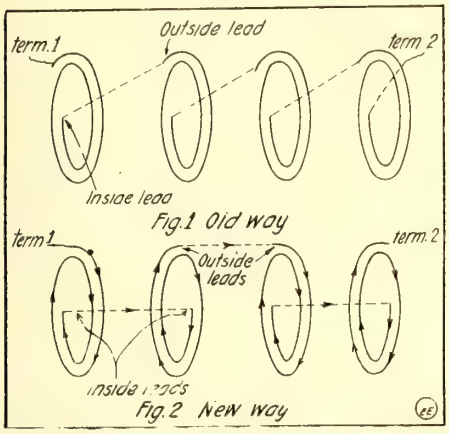
A. 1. It is often the case, as you suggest that the efficiency, and therefore the length, of spark produced by a given induction coil will be intensified by substituting a vulcanized fiber, or a hard rubber tube for a pasteboard one, if that is the kind of tube now separating the primary and secondary coils in your apparatus.

Some makers have used to very good advantage a glass tube, the point at issue being to have the very best insulation possible between the primary and secondary, owing to the very high voltages induced in the secondary winding, which will of course always attempt to jump the shortest possible path or gap, such as around the ends of the primary insulating tube into the iron core.

For this reason in designing large induction coils, above the 2-inch spark size, it is invariably the practise to so proportion the secondary winding that it shall not come all the way to the end of the primary insulating tube, but a considerable distance from it.

You are correct in your statement accompanied by diagram (Fig. 1) relative to the connection between various secondary sections, but this is the older and practically

obsolete manner of making these connections, and most always leads to dissatisfaction at an early date, for the reason that there is a very high potential always existing between the top of one section or "pie," and the down-coming lead wire from the adjacent "pie." It is the best and modern practise to connect first two inside leads together and then two outside leads, etc., etc., *reversing* every other "pie" of course as it is placed in position over the primary insulating tube. The Editor has generally found it most convenient and practical to secure the primary element with its insulating tube in place in a vertical position by means of wooden blocks, etc. This could easily be arranged, and a few blocks may be used if necessary to form a sufficiently high base at the point where the first "pie" will come. All leads should be soldered, using a non-corrosive flux. You will find a number of excellent books on this subject illustrated in our "Book Catalog."



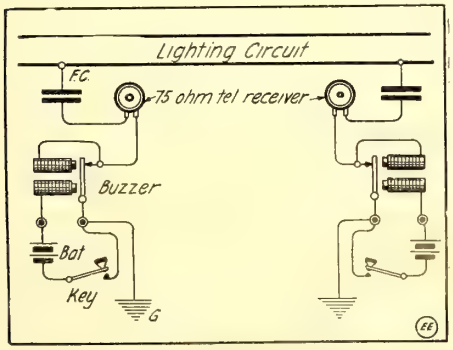
Old and New Method of Arranging Spark Coil Secondary Sections. In Method of Fig. 1, the Full Potential of Each "Pie" Tends to Jump Between the Lead and the Winding.

BUZZER TRANSMITTER FOR LIGHTING CIRCUITS.

(852.) Cecil Mathers, Miami, Fla., desires a hook-up for a buzzer system to work on lighting circuits.

A. 1. We give you herewith diagram of connections for two buzzers, batteries and keys to be used with ground return and electric light or other circuit, for the purpose of transmitting telegraphic signals over a one mile range.

Both telephone receivers (of the usual 75-ohm type) should be connected to the same line wire; i.e., both of them should be connected to either the positive or the negative line wire. If you experience any trouble due to a grounded system, a small fixt condenser should be connected in series with the telephone receiver at each station.



Simple Buzzer Telegraph for Use on Lighting or Power Circuits.

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The use of electricity for lighting is rapidly increasing in Japan, even in the homes of the poorest classes in the cities.

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The Government and Merchant Marine need thousands of TRAINED operators now, the demand far exceeding the supply. Men are needed urgently for the Naval Reserve, Naval Militia, and Signal Corps, etc., etc.

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Send stamp for catalog giving facts. Resident classes open Oct. 2nd.

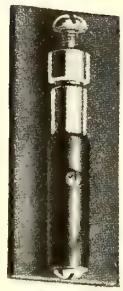
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Annunciation of falling temperatures and automatic lighting of heaters in citrus groves.
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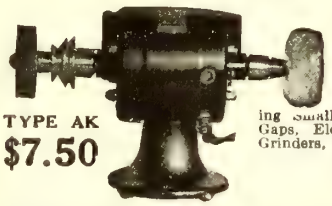
Pat. Feby. 23, '09 other patents pending

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1/20 H. P. 6000 R. P. M.

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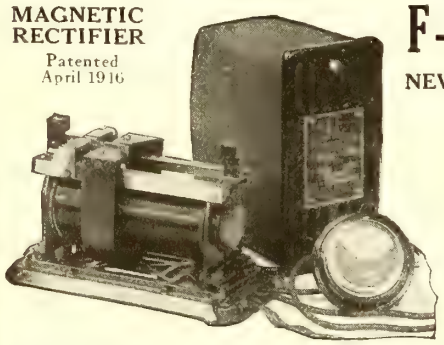
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Patented April 1916



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For Public or Private Use

You yourself can KEEP YOUR BATTERY FULLY CHARGED and give it a REFORMING CHARGE when necessary right in the car. You save a big charging bill and expensive rental battery. No delay, bother or nuisance whatever. Big profit in taking batteries in to recharge.

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ELECTRIC "ZIG-ZAGGER" AIDS SHIPS TO FOIL U-BOATS.

(*Continued from page* 367)

the first officer of one of the large British merchant ships has invented a simple and very effective "zig-zag control board," which is herewith illustrated. It consists of a board about two or three feet square, carrying in its center a clock, and on each side of the clock a series of alternate green and red cards and glow lamps, each card and lamp corresponding to the starboard and port courses on which the ship is being navigated at any given time. Above the clock, extending across the head of the board, is plotted a zig-zag course which it will take the ship one hour to cover.

In the accompanying chart (top) the straight line represents the true course which, in this case, is, let us say, due north. The ship commences her zig-zag course at, say, 2 o'clock, at which hour the helm is thrown over and the ship's course is altered 30 degrees to port of the true course. [*The original conception of this "zig-zag" control board was limited to automatically warning the helmsman every time the rudder was to be thrown over. The helmsman then set the electrical clock contact to ring after the next leg of the course had been completed, thus introducing manual control, which may or may not be a desirable feature. The editors have given this device considerable thought and suggest a full automatic electrical control of the rudder during such "zig-zag" runs, leaving of course the manual control always operative in the event that the course might have to be suddenly changed or when the automatic control might fail.*] She continues on this course until seven and one-half minutes past 2 o'clock, when the minute-hand of the clock makes electrical contact with a bell which rings loudly, announcing that the time has come to change course again. (In the original scheme; in the revised plan shown in the diagram herewith the contact closed by the clock hand causes the proper relay to function, running the "port" or "starboard" rudder motor for a predetermined time, sufficient to pull the rudder over sufficiently to start the new course.) The helm is now thrown over, and the ship is put on a course 45 degrees to starboard of the true course. This course is maintained for ten minutes, when another electrical contact is made, the bell rings, and the ship is turned the necessary number of degrees to port until she is on a northern course, parallel with her true course.

There are seven changes of course during the hour, at the end of which, the ship is back again on her true course. In this particular zig-zag a 12-knot ship loses two knots of distance in one hour, which represents a loss of about fifty miles in the twenty-four hours; but it is better, surely, to lose fifty miles of distance than to lose the ship.

The course herewith shown is a purely suppositious one. The navigator can plot any course he may desire in a few minutes' time, and having done that, he has merely to shift the electrical contacts from hole to hole around the periphery of the clock, in accordance with the zig-zag as plotted.

The explanation given so far will undoubtedy make clear the action of the "electrical zig-zag" course apparatus. Let us now consider one change of the course right straight thru to see just what happens.

Suppose the "zig-zag" course is suddenly decided upon. The navigating officer throws in the proper switches to permit the automatic helmsman to take control of the ship's rudder. The clock may be turned

so that the hour hand with its attached contact is just on the hour. The first stationary contact is thus livened up, causing the rudder motor to function, and the ship to take its first lap on the "zig-zag" course or 30° to port. In order that the helm motor shall run just long enough to throw the rudder to the proper course angle, the stationary clock contact could be made a certain length or else a dash-pot time switch can be used in the circuit to cut off the motor after the proper time has elapsed.

But this is not all of the problem by any means. We can't leave the helm thrown over, say 30° to port, indefinitely, or the vessel would turn a complete circle. We will have to use either an automatic time relay to close the opposite motor circuit and rectify the rudder to a position parallel with the ship's keel, or better yet, rig up a special gyroscopic compass so that when the ship has turned and lined up on its new course, the compass will actuate a relay controlling the opposite helm motor and pull the rudder to its central position. The gyroscopic compass is rugged enough to stand this work, but it would not be necessary to fit any rubbing contacts to it. A Tesla relay would do the work, the relay current passing thru a spark, or the proper contacts could be closed by an inductio mechanism. The plans here shown include tell-tale lamp signals, which indicate the course the ship is changing to, and also two distinct "zig-zag" course charts, each good for one hour's sailing. One course is the exact converse of the other, *i. e.,* the first lap of 7½ minutes on the left-hand chart is run at 30° port; the corresponding lap on the right-hand chart is run at 30° starboard.

THE AMATEUR'S OPPORTUNITY.

(*Continued from page* 389)

with the November issue we are going to print a monthly list of names of those young men who think sufficiently of their services to Uncle Sam as radio operators.

This list will be termed:

RADIO ROLL OF HONOR.

At the end of this article you will find a blank to be signed by you. Fill it out at once and mail it today. *There are no charges, no expenses.*

Sign the blank, showing that you are a good citizen and that you are prepared to do your "bit" for your country. We pledge ourselves to publish *every* name sent in to us—even tho we have to run ten solid pages of names a month.

You may never be called for service, but in the years to come you will look with satisfaction and pride upon the *"Radio Roll of Honor"* containing your name, in mute testimony of your genuine patriotism.

Now amateurs, all together: LONG LIVE AMERICA! LONG LIVE WIRELESS!

RADIO ROLL OF HONOR

Application for Membership in the Radio League of America

I, THE UNDERSIGNED, a Radio Amateur, am the owner of a Wireless Station described in full in this application. My station has been in use since....., and I herewith desire to apply for membership in the RADIO LEAGUE OF AMERICA. I will abide by all the rules of the LEAGUE, and I particularly pledge my services as a Radio operator, or for Signal Corps duty to the United States Government when called upon.

I understand that this blank with my signature will be sent to the United States Government officials at Washington, who will make a record of my name.

Witnesses to signature:

.....

.....

Name.....

City.....

State.....

Date.....191

Description of My Station and Apparatus

Sending .....

.....

Receiving .....

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.....

.....

I can send approximately.....words per minute.

I can receive approximately.....words per minute.

My age is.....years.

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(10-17)

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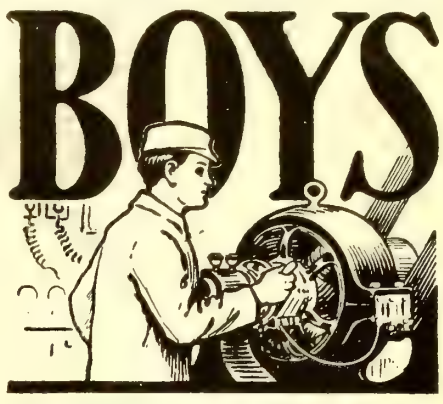


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Explain, without obligating me, how I can qualify for the position, or in the subject, before which I mark X.

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☐ Heavy Electric Traction	☐ Outdoor Sign Painter
☐ Electrical Draftsman	☐ RAILROADER
☐ Electric Machine Designer	☐ ILLUSTRATOR
☐ Telegraph Expert	☐ DESIGNER
☐ Practical Telephony	☐ BOOKKEEPER
☐ MECHANICAL ENGINEER	☐ Stenographer and Typist
☐ Mechanical Draftsman	☐ Cert. Pub. Accountant
☐ Machine Shop Practice	☐ Railway Accountant
☐ Gas Engineer	☐ Commercial Law
☐ CIVIL ENGINEER	☐ GOOD ENGLISH
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☐ Metallurgist or Prospector	☐ Railway Mail Clerk
☐ STATIONARY ENGINEER	☐ Textile Overseer or Supt.
☐ ARCHITECT	☐ AGRICULTURE ☐ Spanish
☐ Architectural Draftsman	☐ Navigator ☐ German
☐ PLUMBING AND HEATING	☐ Poultry Raising ☐ French
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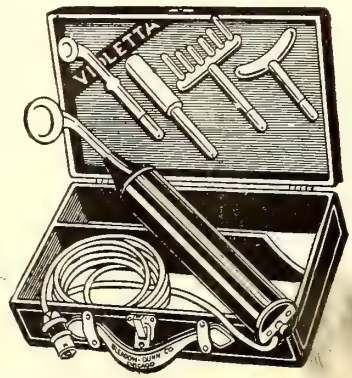
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FIRING BOMBS BY ELECTRICITY.

(*Continued from page 370*)

of the cable, and this of course is but a few ounces. Even the sudden jerk after releasing the bomb is not imparted to the wire—the reel takes it nearly all.

Now, the observer thru his trench periscope watches the flight of the bomb. His one hand rests on the switch which is connected to a thirty- or forty-volt storage battery, while the bomb-cable connects with the switch and the battery also. By merely throwing the switch, the man at the periscope can set off the distant bomb at the proper moment. What this proper moment is depends of course upon circumstances as well as the will of the operator.

And now we come to the point showing where this device is superior to the present bomb. Suppose during a dark night we throw several hundred of these bombs in "no man's land" (the strip of land between our own and the enemy's trench). They may rest peacefully here for days or months well hidden by plants or dirt. The fine cables running toward our own trench can hardly be seen. The enemy therefore is unaware of the hidden bombs. It goes without saying that all the cables are connected to one central point under supervision of one or more operators. If now the enemy wishes to raid our trench we can set off the entire string of bombs right under his feet, as he advances toward us. Such tactics are sure to demoralize the bravest troops, and the second advancing column will hesitate, not knowing if there is not another set of bombs, which may go off at any second.

Of course, the electrically fired bomb would probably be used mostly to "bomb" the enemy's trenches, exploding it after its descent into the trench. And after the enemy becomes acquainted with this devilish device, no one will be fool enough to pick up such a bomb with an idea to hurl it back at the sender. For the sender, thru his periscope, would see it before it was two feet above the enemy's trench, when he would explode it of course, thereby almost certainly killing the man who attempted to throw it back.

Also, suppose that due to faulty throwing the bomb does not reach the enemy trench. Is the bomb thereby lost as is the case with its present brethren? Indeed not! For we can pull it back by means of the cable, and throw it once more!

Now let us turn from the murderous to the more humane. Instead of filling our bomb with a high explosive, let us fill it with chloroform. Our Fig. 2 illustrates such a bomb. It is composed of two hemispheres separated by a soft gasket. After partly filling the bomb with chloroform, the remaining air is pumped out, thus leaving a vacuum. This will cause the hemispheres (working on the famous "Magdeburg Hemispheres" principle) to hold together as if riveted. The two ends of the electric cable go to a fusible plug in the wall of the bomb which when melted by a heated platinum wire allows either air or chloroform to leave the bomb. Or otherwise a minute electrically fired charge of explosive will separate the two hemispheres, spraying the trench with chloroform. If a sufficient number of such bombs are thrown into a trench, the occupants will promptly fall to sleep for some time to come. No, this idea is not half so ridiculous as it seems, and we may see it tried yet.

If the "powers that be" do not approve of the chloroform bombs, they may replace the narcotic with oil. In this way the entire trench of the enemy can be set on fire when setting off the bombs.

Probably quite a few more ideas will suggest themselves when the electrically fired bomb is tried out in actual warfare.

MR. AMATEUR, "I WANT YOU!" SAYS UNCLE SAM.

(*Continued from page* 387)

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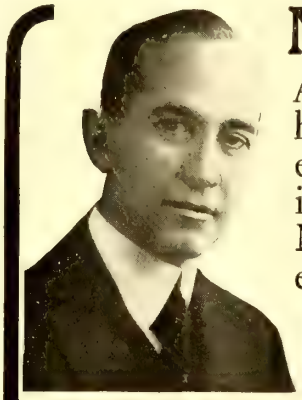
So its up to you, Radio Amateurs, and those desiring further information should present themselves to, or communicate with the Enrolling Officer, Building No. 13, Navy Yard, Brooklyn, New York.

ARE THERE CURRENTS ABOUT A MAGNET?

(*Continued from page* 381)

noid, "F". At "G", at the upper end of the wooden lever "B", is attached a cord which is led across and over the pulley "I" to the scale pan and weight "K". With "A" just at the level of the pole and inside the solenoid, this solenoid, with the battery which I used, will draw 15.8 grams two centimeters out of perpendicular. Inside, four centimeters from the pole, it will draw 25.8 grams—the additional weight being placed at "K"—the same distance; an increase of power of *sixty-three percent.* At seven centimeters within the solenoid it will draw 22.5 grams; an increase from the poles of *forty-four percent.* At the center of the solenoid the power varies but little from that at the poles. (This will be explained later.) If it were possible to investigate the interior field after the insertion of an iron core, it would probably be found that the point of greatest lateral (outward) attraction is near the center of the magnet.

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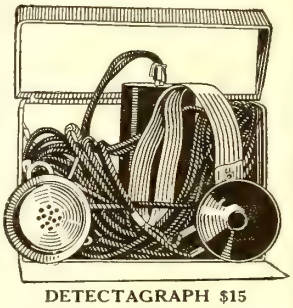
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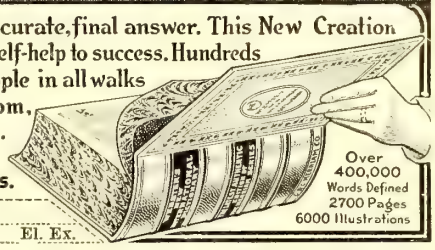
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It is now possible to map completely the exterior and interior "lines" or currents of a magnetic field; a thing never heretofore truthfully done. Those produced heretofore have been merely guesswork. Fig. 6 shows such a mapt field. A,A, is the point of greatest compression. This point would also be the point of the greatest interior lateral attraction if it were not for the fact of the conflicting currents from the poles meeting at this point. B,B, on both sides of the magnet is the *neutral* line, or line of repulsion, the point of the *outward flowing currents,* corresponding to the greatest internal pressure. E,E, are the points of greatest relative lateral attraction on the interior of the solenoid. The several lines C,C, are the reverse curve lines on the side of the magnet and the lines D,D, are the *slightly curved* or *straight lines* entering the magnet near the poles. In all of these the arrows indicate the direction in which the iron tends to move and consequently the direction of the force or current. It must be borne in mind that all of these lines have another motion, that is—*a spiral motion,* as has been shown, and that while the spiral lines or currents meet in the center of the magnet, the rotation of the spiral is continuously in the same direction thruout the length of the magnetic field.

These experiments, including the production of *Magneto-graphs* by means of a magnet, prove unquestionably the following negative facts:

The "lines of force" in a magnetic field are not "lines of tension," "mere lines of direction," or "imaginary lines of direction like the lines of latitude and longitude on the earth." It will be noted that these expressions are quoted from high and accepted authority.

That the lines of force in a magnetic field are not continuous from the *North* to the *South* pole, that they do not "exist" from the *North* pole to the *South* pole, and that they do not "emerge" from the *North* pole, or that so far as the lines about the *North* pole are concerned they do not "pass to" or "enter" the *South* pole.

The same experiments seem to prove beyond controversy the following positive facts:

Currents surround and enter magnets and solenoids and make up the field of force surrounding them, and their effects are due to these currents. The word "currents" is here used and will be continued to be used for the present without reference to the matter which composes them; for, of course, currents must be composed of matter. This is done advisedly, and in due time the nature of the matter will be conclusively proven. There can be no question but that these are currents. A child seeing straws moving about will at once tell you that there is wind—currents—and indicate its direction. This is in conformity with every known fact of physics as shown in liquids and gases. The fact is doubly confirmed by the *Magneto-graphs.* No one except a person seeking some mystic or mysterious cause instead of the plain and simple laws of nature, would question this or assert otherwise. Especially is this true when, as here, the motions are so many and so various, so complicated. No "line of force", "line of direction", "tension", or other mythical cause can account for the results shown in these experiments and especially for the production of *Magneto-graphs.*

The action of the electro-magnet, the permanent magnet, and the solenoid are exactly the same, their effects are the same, and are produced in the same manner, and they are governed by the same laws.

These currents do not *emerge* from either pole of the magnet. They enter at the poles and at the sides of the magnet. They emerge from the center of the magnet, to some extent at least, and if they do not cause a point of actual repulsion, they form a line of neutrality in the center of the magnetic field and from this neutral zone, as well as from other surrounding points, they move toward the sides and poles of the magnet. Beginning at this neutral zone they move in opposite directions.

Currents entering the poles of the magnet meet at the center, or near the center.

Currents, both *inside* and *outside* the magnet, while they move toward the center, are *spiral* and the *motion is continuous,* in the same direction, thruout the magnetic field. The motion of these spiral currents is such that, viewed from above, the rotation is counter-clockwise over the *North* pole and clock-wise over the *South* pole.

The action of the magnet is not due to *molecular arrangement.* Molecular arrangement could in no wise produce the spiral motion nor affect a photographic plate. If the action of the magnet were due to *molecular arrangement,* there would be no attraction at the sides of the magnet near the poles for the reason that, theoretically, the molecules in the body of the magnet neutralize each other and there would be no attraction. Moreover, when the iron core is removed the action continues, being only less in degree, due to the magnetic conductivity of the iron, and there are no molecules to arrange.

Next will be taken up the *nature* and *cause* of these currents, the "field of force" or the magnetic field about a *charged wire,* and the logical accounting for the formation of a magnet and the logical explanation of the several phenomena of magnetism. This will include *Magneto-graphs* produced by a *charged wire.*



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Edited by H. GERNSBACK

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Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

RADIOMETERS.

(172.) Harry Abrams of New York, N. Y., thinks he has a new means of producing electricity by means of ordinary sunlight. The idea is to use apparatus similar to the Crookes radiometer. By placing these Crookes devices in a certain electrical field, he has observed that electrical current can be generated. He wants to know if this idea is practical and also patentable.

A. We have strong doubts as to the practicability of an idea of this kind. It seems that the power that can be obtained from each one of these radiometers would be so infinitesimally small, that it really could not be termed *power;* but at best would only be faint impulses. We doubt if the idea has any commercial possibilities.

GYROSCOPIC AUTOMOBILE.

(173.) Frank C. Stanton of San Francisco, Cal., has submitted to us an elaborate illustration of a gyroscopic motor car, showing an automobile designed to run on two wheels, one behind the other. He wishes to know if he can obtain a patent on this device without litigation.

A. Brennan of England has experimented with a car of this kind, having it run over a small, thin cable. We doubt if you can obtain a patent that would be of any value to you, in view of the fact that not alone Brennan, but also other workers as well have worked along these same lines for quite some time past. Our correspondent also submits illustration for a field wireless set which can be carried complete by one man, and he wishes to know if the idea is feasible and practical.

Nothing new is shown in the illustration or description, and while the disposition does show several novel points, we doubt very much if the novelty is sufficient to warrant a patent.

Our correspondent wants to know if one has to be a subscriber to THE ELECTRICAL EXPERIMENTER in order to contribute to any of the various departments.

Anyone can contribute to any of the departments of THE ELECTRICAL EXPERIMENTER, and one need not be a subscriber in order to send any contributions or participate in any of the prize contests which we conduct from time to time.

AUTOMATIC STEP-LADDER.

(174.) Paul William Dorst of New Albany, Ind., submits to us an automatic step to be attached to hollow steel flag-poles, the idea being that the steps are folded back ordinarily, so that when climbing the pole one step after the other is released automatically as soon as one of the steps is deprest.

A. This is a capital idea, and we have not seen anything quite like it, and are certain that it can be patented. We also think that there should be a good field for a device of this kind, particularly for steel flag-poles on tall buildings.

CONDENSER.

(175.) H. S. Moody of Edmonton, Alta., has an idea to make a small condenser in a certain manner by using certain dry mounting tissues, etc. Several other means are shown to hold metal foils which are secured by melting the tissue. He wishes to know if an idea of this kind is patentable.

A. Without making a thoro search in the patent office, we are unable to tell whether this idea is of sufficient originality to warrant patenting. We would advise to have a patent attorney make search with a view to ascertaining what has been done in the same field before. The idea seems quite clever.



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I have given your "RADIOTONE" Buzzer a thoro test and find it to give VERY GOOD SATISFACTION. Also that I am very much pleased with it and that it comes up to my expectations. I would recommend it to all learners as a very good Buzzer. In case I have any more orders I will extend them to you.
W. H. CRUDGINGTON,
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I received my "RADIOTONE" Buzzer a few days ago, and have tried it out in a number of ways. It is exactly like you describe it, and one of the biggest advantages of it is that the sound is always EXACTLY WHERE YOU WANT IT, right in the receivers. It is by far the best buzzer I have seen on the market. It has also a very beautiful appearance, and has one of the CLEAREST AND HIGHEST PITCHED TONES any buzzer that I have yet come across. Thanking you again for your wonderful buzzer, I am,
Yours very truly,
HOWARD A. PAGE,
900 Harrison St., Lynchburg, Va.

Your "RADIOTONE" Buzzer certainly came up to all my expectations. Its tone is exactly like that heard in a regular wireless phone. It is not affected by high altitude nor damp weather. It is as beautiful an instrument as one could wish to see. IT IS SILENT. That is the most important of all in the work for which I use it. It produces a clearer and higher-pitched tone on less current than a buzzer of any other make that I have tried. IT HAS NEVER STUCK nor FAILED TO RESPOND instantly to the application of current since I have had it. I wish you and the E. I. Co. every success and I will do everything in my power to help you as you are a PROMPT AND SQUARE DEALING COMPANY.
C. M. McBURNEY,
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I wish to say that your "RADIOTONE" Buzzer is the only test buzzer that I have seen in which I can find NO fault whatever. I received it in good condition and it is that way now, THOUGH I ACCIDENTALLY DROPPED IT SEVERAL FEET. I am using it on a code practicing set. It has the best tone of any buzzer that I have seen.
LESTER SHIPLEY,
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I have given the "RADIOTONE" Buzzer which I have received from the E. I. Co. a thoro test and find it satisfactory in all respects. I also used other buzzers, but the "RADIOTONE" IS THE BEST THAT I HAVE EVER USED and BEYOND MY EXPECTATIONS. The other goods that I received are also satisfactory.
A. WITMER,
Muir, Pa.

I am very pleased to say that I am satisfied with the results obtained from the "RADIOTONE" Buzzer. It gives a really WONDERFUL IMITATION OF A WIRELESS MESSAGE.
GEORGE DIMON,
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FROM A RADIO EXPERT

The "RADIOTONE" Buzzer which the E. I. Co. sent me some time ago has been thoroly tested out in my Laboratory, and I am very pleased to give you my opinion concerning its performance.

The tone and frequency of the instrument is TRULY A MOST WONDERFUL and perfect reproduction of a MUSICAL WIRELESS NOTE and when used in connection with a wireless receiver it would be most difficult to distinguish its rich tone from that of a real wireless station with FIVE HUNDRED CYCLES in the primary circuit. One of the most commendable features that the buzzer possesses is that of being capable of standing up under continuous service WITHOUT THE ANNOYING "STICKING" effect that has been so characteristic of other buzzers that I have had occasion to test. In conclusion I can say that both in performance and appearance the "RADIOTONE" is truly a WONDERFUL LITTLE INSTRUMENT. RAYMOND FRANCIS YATES, 815 Niagara Ave., Niagara Falls, N. Y.



No. HK 1800

The "Electro" Radiotone

HIGH FREQUENCY SILENT TEST BUZZER

The RADIOTONE is NOT a mere test buzzer, it is infinitely more. Mr. H. Gernsback who designed this instrument labored incessantly to produce an instrument which would imitate the sound of a high power Wireless station as heard in a set of phones. This actually has been achieved in the RADIOTONE. This instrument gives a wonderful high pitched MUSICAL NOTE in the receivers, impossible to obtain with the ordinary test buzzer. The RADIOTONE is built along entirely new lines; it is NOT an ordinary buzzer, reconstructed in some manner. The RADIOTONE has a single fine steel reed vibrating at a remarkably high speed, adjusted to its most efficient frequency at the factory. Hard silver contacts are used to make the instrument last practically forever.

Yes, the RADIOTONE is **SILENT.** In fact, it is so silent that you must place your ear on top of it to hear its beautiful musical note.

You will be astounded at the wonderfully clear, 500 cycle note, sounding sharply in your receivers, when operated on one dry cell. **To learn the codes, there is absolutely nothing like it.** With the radiotone, a key and one dry cell and ANY telephone, a fine learner's set is had. Two or more such sets in series will afford no end of pleasure for intercommunication work. Particularly now that we cannot use our Wireless sets, the **Radiotone** is already in wonderful demand. All the interesting things as described with our **CODOPHONE** (see our big ad on page 353, this issue), can be performed with the **Radiotone**, a key, a dry cell and a phone.

Radiotone as described.....each **$.90**

Shipping Weight 1 lb. Don't forget postage.
IMMEDIATE SHIPMENTS

ELECTRO IMPORTING CO.
231 Fulton Street New York City

I have thoroly tested your "RADIOTONE" Buzzer, which I received a few days ago, and find that it is very efficient in all respects. It is all that you claim it to be. The tone is so soft that it cannot be heard unless the ear is placed a few inches from the instrument. This makes it very desirable for testing detectors. I THINK THAT THERE IS NOTHING BETTER FOR LEARNING THE CODE, since the signals sound just like a high power wireless station. Everyone who has a wireless station or who wishes to learn the code should have a "RADIOTONE." BENNIE GREENSTEIN,
827-11th Ave., N., Minneapolis, Minn.

I received your "RADIOTONE" on June 20th, and tested it thoroly, and found it has the BEST IMITATION OF WIRELESS SIGNALS. All Amateurs should purchase one of these "RADIOTONES" if possible, and do self-practise during the war. I hope all Amateurs, who purchase one of these "RADIOTONES" will find it as great a help to them as I have.
Yours truly,
GEO. TANAKA,
AMATEUR 6 ATQ, San Francisco, Cal.

After testing the "RADIOTONE" I am pleased to say that it is the best toned buzzer on the market. The main thing is that IT DOES NOT STICK as so many others do, even among the high priced buzzers, when practising. I am using it with Omnigraph transmitter, 2 M.F. Condenser, 75 Ohm phone and small resistance shunt across phone. With the aid of battery rheostat and shunt resistance, I CAN OBTAIN EXACTLY SAME PITCH AS N.A.A.
FRANK WARMINSKI,
806 S. Milton Ave., Baltimore, Md.

I am entirely satisfied with the "RADIOTONE" Buzzer which I bought from you. It works fine, being BETTER THAN I EXPECTED IT WOULD BE AT THE PRICE. At first I didn't think that it would be very good at the low price, but it is all right. It appeals to me mostly because of ITS QUICK RESPONSE to the opening and closing of the key.
JOHN B. MOORE,
Delaware Co., Downsville.

I am pleased to say that after testing it out in a student's buzzer set, it comes up to my best expectations.
H. D. STRAUGHN,
Ripley, Okla.

Am in possession of one of your "RADIOTONE" test buzzers and wish to say that I could not have expected a more silent instrument, as well as the EXACT TONE OF A HIGH POWERED WIRELESS STATION.
S. W. DEARING,
R.2, Covington, Tenn.

It gives me great pleasure to recommend your "RADIOTONE" test buzzer. I find it very sensitive and responsive, ALWAYS EMITTING THE SAME HIGH PITCHED NOTE. But the best feature of all is ITS SOUND-PROOF CASE.
C. A. W. McMURTRY,
94 Gladstone Ave., St. Thomas, Ont.

I wish to say that I have given your "RADIOTONE" Buzzer a thorough testing and find it stands up beautifully under the conditions. Connected to a 75 ohm phone and a No. 10010 Junior Fixed Condenser per diagram in your catalogue, it makes an ideal practise set, the note of which can HARDLY BE DISTINGUISHED FROM "ARLINGTON." The "RADIOTONE" has EXCEEDED MY EXPECTATIONS by far.
E. A. ARMSTRONG,
R. R. No. 1, Indian River, Ontario, Can.

I have used your "RADIOTONE" Buzzer, and find it THE BEST EVER USED. I find it very useful for a layman to learn the code quickly. I would recommend it to any one interested in wireless.
ANDREW SCHRINER,
1722 Putnam Ave., Brooklyn, N. Y.

I have had the opportunity of making practical tests with one of your "RADIOTONE" BUZZERS, and I feel justified in making the following statements concerning it:
1. It is handsome in appearance.
2. It is practically noiseless in operation.
3. It gives a clear note of CONSTANT FREQUENCY.
4. It is equal in performance to other buzzers selling AT SEVERAL TIMES ITS COST.

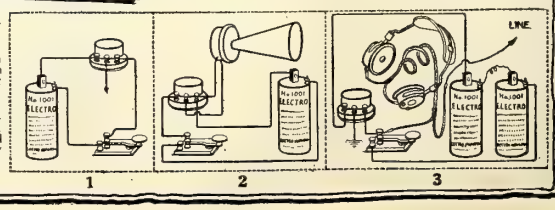
I have been perfectly satisfied with the "RADIOTONE" and I will be glad to recommend it to anyone.
E. K. SNYDER,
717 Lake Boulevard, St. Joseph, Mich.

E. I. Co., 231 Fulton St., New York City, N. Y.

On your absolute guarantee that your "RADIOTONE" works exactly as described by you, I enclose herewith 90 cents plus ..... cents for postage for one instrument. You guarantee to refund this amount to me if I am not entirely pleased, providing I return the "RADIOTONE" within 3 days after its receipt. YES
I also enclose NO 6 cents postage for your 200-page Electrical Cyclopedia, with 600 illustrations, and 500 instruments, etc.

Name .....
Address .....
10-17 City .....

Fig. 1. As a radio mineral tester.
Fig. 2. With 75 ohm 'phone and horn for practicing code.
Fig. 3. For intercommunication. Works several miles on 2 dry cells.



NEW ELECTRO-THERAPEUTIC APPARATUS.

(*Continued from page* 373)

Sinusoidal Machines

One of the most radical new developments in electrical therapeutics was shown in the form of a Morse Sinusoidal Wave Generator. The machine delivers a current of 21,000 alternations or 42,000 impulses per minute and is designed on what is known as the Kennelly design, the principle being a circular layer of spools composed of two separate coils, an inner one with eight layers of fine wire, and an outer one of two layers of coarse wire, the inner coil being connected in a series and constituting a *secondary* coil, while the outer coil, also connected in a series, forms the *primary* coil of the apparatus. A direct current is supplied to the primary coil and to the armature, which is composed of laminated iron. When the armature is made to revolve the primary coils, having a current circulating thru them, magnetizes the field magnets. The magnetic lines of force thus produced remain stationary in the field as long as the armature is stationary, but as soon as the armature rotates the lines of force shift from one side of the magnetic field to the other and cut the current in the wires of the secondary coil, first one side and then the other, which produces a Sinusoidal current in the secondary coil.

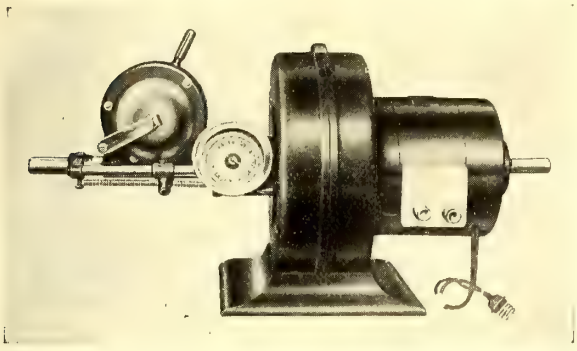
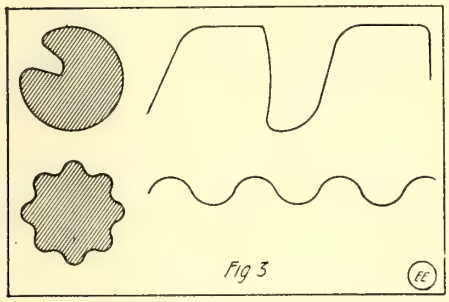
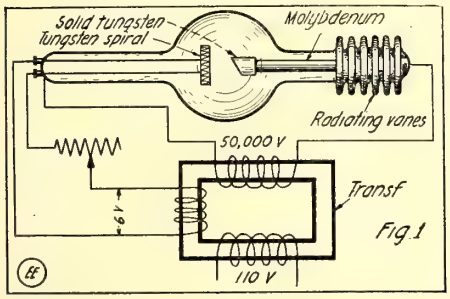


Fig. 3. The Latest Pattern Sinusoidal Generator Which Yields Currents of Any Desired Wave Form. Special Cams as Shown Below, Control This Factor and Can be Interchanged Instantly.





New Form of X-Ray Tube Which Rectifies Its Own Current, on the Principle of the Hot Cathode. Air Cooling Vanes Are Placed on the Anode.

In the apparatus shown, Fig. 3, the primary coil and secondary coil are conical in shape, one moving within the other, this being done by a set of cams, the shape of the cam regulating the type of wave which will be sent into the patient's circuit, and a separate rheostat controls the strength of this current.

Light Therapy

For the treatment of skin diseases a quartz mercury arc lamp was shown which gave off very powerful radiations, the radiations being so intense that the darkest kind of tinted glasses were loaned to the observer before he was allowed to look at the light. From a lamp of this kind a typical case of *sunburn* could be produced in a few minutes time. (See Fig. 4.)

Miscellaneous

A valuable Anesthetizing Outfit was shown (see Fig. 5), operated by a small electric motor of special design for use in operations of the month and head.

An interesting Recording Instrument was shown for obtaining the temperature within the stomach known as *introgastric temperature,* valuable in checking up the gastric response to stimulus, showing the action of different foods, both hot and cold, practically in degrees upon the scale of the instrument.

For the man with a microscope there were several new devices, such as a special light for illuminating the stage of a microscope, and one exhibit showed an electrically heated warm stage for the microscope for use in examining different bacteria and micro-organisms which only remain alive in warm temperatures (blood heat).

An Electric Incubator for use in connection with a microscope was exhibited, which can also be used in connection with the development of special animal organisms and bacteria so that they can be cultivated directly under the microscope.

THE EFFECT OF ULTRA-VIOLET RAYS ON MILK AND OTHER ASPECTS.

(*Continued from page* 383)

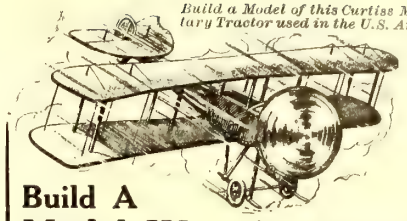
it for the protection of their soldiers and horses campaigning at this time in the colonies of Toncken, Asia, and as it had protected the head against the violent action of the ultra violet rays it was quite successful.

At this time England also tried this protection against the ultra violet rays and as an experiment, an under officer of the English army was completely clothed in garments which had been previously treated to withstand the ultra violet rays. It was found that he was able to stay in the sun of midsummer for hours, without feeling any disturbance or inconvenience in any way. Upon this and other experiments the English Government adopted this method for the protection of their Indian troops against the ravages of tropical sunlight.

INCREASE WIRELESS GUARD AT SAYVILLE.

Fifteen United States Marines have been added to the detail which has been guarding the wireless station at Sayville. There are now sixty-five men from the Marine Corps at the station and it is said that about twenty-five more will arrive shortly to augment the force. Ensign W. R. Smith, U. S. N. R., is in command.

The entire acreage belonging to the Atlantic Communication Company, which is in charge of the plant, is being cleaned up. Much of its area was wooded and afforded cover.



Build a Model of this Curtiss Military Tractor used in the U.S. Army

Build A Model War Aeroplane!

It's easy! With "IDEAL" Accurate Scale Drawings and Instructions you can build a 3-foot Model Aeroplane that looks like a real one and that will rise from the ground by its own power and fly 50 to 100 feet. It's a great summer sport, and you can learn a lot about Aeroplanes and how they fly. Send for the Drawings and Instructions for the one you want to build.

Curtiss Military Tractor
Bleriot Monoplane
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Wright Biplane
Curtiss Hydroplane
Curtiss Flying Boat
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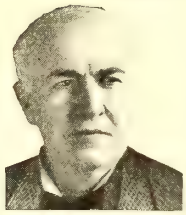
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"I have watched the progress of the International Correspondence Schools almost from the beginning. To me their rapid growth is easily understood because I realize the practical value that is back of it and know something, too, of the success attained by many ambitious men who have taken I. C. S. courses."

Edison knows what stuff men are made of who use their spare hours to train themselves for the bigger jobs ahead. And he knows what the International Correspondence Schools will do for the man with the grit to say, "I will."

All men who have made their mark in the world improved their spare time. Didn't Edison himself stay up half the night to read every get-at-able book on electricity? You, too, can possess power, money and happiness if you'll only make the start. With I. C. S. help the way is easy.

Put it up to us, without paying or promising—just mark and mail the coupon and find out.

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☐ Stationary Engineering	☐ Stenography	☐ French
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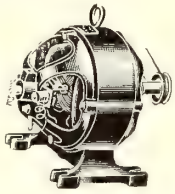
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Dynamo Motor

For Boys

$6.25

For producing current for inductance coils, re-charging storage batteries, electroplating and hundreds of other uses. Well constructed throughout, exceptionally smooth running and highly efficient. A good, strong, durable dynamo.



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KNAPP ELECTRIC & NOVELTY CO.
523 West 51st Street, N. Y. City

WOULD THE LAW LET YOU MARRY?

Some States have been wise enough to insist upon a medical examination of the two contracting parties to a marriage before a license is issued. Through the adoption of a law whereby the physically unfit were barred from marriage in every State in the Union, there would indeed be a relatively small percentage of the population that would measure up to the standard.

WOULD YOU BE ONE OF THOSE

doomed to go through life alone, without the joys that go hand in hand with a loving wife and healthy children? Our first duty is to posterity. We are not put here by an all-wise Providence merely to live out our lives, and then go out like a snuffed candle. We are entrusted with the sacred duty of perpetuating the race.



LIKE BEGETS LIKE: A man who is torn and racked by physical ailments and excesses of all kinds will some day see these traits in his children. On the other hand the strong, virile man, who jealously safeguards his body and his health, will some day revel in the sight of offspring that are a picture of joyous, bubbling health.

YOU OWE IT MOST TO THAT GIRL

The sweetest, purest, dearest girl in the whole world whom you would call wife. Is your body clean? Do you realize the terrible consequences of the follies that are wrecking your body? Remember then that STRONGFORTISM will restore to you the vitality of MANHOOD.

I have prepared a little book, "Intelligence in Physical and Health Culture," which should be read by everyone sufficiently interested in themselves to wish for the best in life. It points the way to better health, a cleaner, happier life, and a splendid physique. Three 2-cent stamps will pay for mailing the book. Send for it NOW.

LIONEL STRONGFORT, Master of Physical Culture
276 Park Building Newark, N. J.



$2.50 a Month

The masterpiece of watch manufacture—adjusted to the second, positions, temperature and isochronism. Encased at factory into your choice of the expuisite new watch cases.

21 Jewel Burlington

All sizes for both men and women

The great Burlington Watch sent on simple request. Pay at rate of $2.50 a month. You get the watch at the same price even the wholesale jeweler must pay.

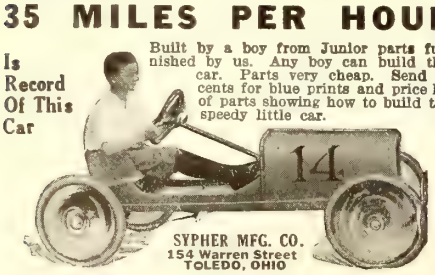
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See handsome color illustrations of all the newest designs in watches that you have to choose from. Your name and address on a postcard is enough. Get this offer while it lasts. Write today.

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Is Record Of This Car



Built by a boy from Junior parts furnished by us. Any boy can build this car. Parts very cheap. Send 26 cents for blue prints and price list of parts showing how to build this speedy little car.

SYPHER MFG. CO.
154 Warren Street
TOLEDO, OHIO

RADIO TO HURL MINES AT U-BOATS.

After working for many months to perfect a new type of mine, electrically controlled by means of a powerful wireless apparatus located at a distance from the mine itself, a device which would enable one submarine to destroy another, it was learned recently that Dr. J. B. Whitehead, of the Johns Hopkins University, had brought his labors to a successful termination.

While Doctor Whitehead refuses to comment on this new invention, it is learned that by means of a powerful electric battery the new style of mine can be directed upon whatever course its operator may desire and can be exploded by simply pressing a button, the wireless waves being employed both in directing it and in its explosion.

The advantage that such a mine will have over the ordinary torpedo used by the submarine is the impossibility of failure to either miss the target or its non-explosion after the target is struck. By this method Doctor Whitehead has solved the problem of destroying submarines by submarines. In connection with this is a report that an instrument has been perfected to locate positions and distances of the submarine to be attacked.

FREE ELECTRICITY FROM THE WIND.

(*Continued from page* 372)

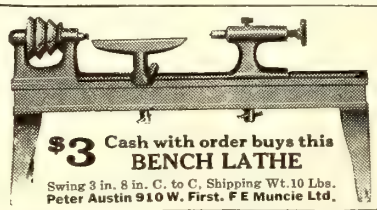
The invention of this new slow speed design at once eliminates the gear troubles which all others who have attempted to utilize wind-power to drive dynamos have had to employ. It also makes it possible to effect, by magnetic leakage in the machine itself, its own regulation, and eliminating the use of auxiliary apparatus.

A boy sixteen years old can turn a crank fitted on to the wind-motor axle, when the machine is on the ground, and generate sufficient current to magnetize the dynamo fields and to light to full brilliancy three 16-candle-power lights for a period of twenty minutes at a time.

The axles, differential gearing and bearings are contained in a hollow steel housing, the same as a motor car rear axle, and this housing is pumped full of gear grease. Several machines are on record that have not been re-greased for two years at a time.

The drawing shows that the automatic cut-out and cut-in for the battery is a mechanical ball governor, but this cut-out has been substituted by an electro-magnetic cut-out and cut-in. The electro-magnetic cut-out simplified the plant and is located on the switch-board. With an average wind pressure of ten miles per hour for ten hours per day the larger plant has in practise charged a 25 volt battery with 90 A.H. per days, and has maintained a daily discharge for 8 months of 75 A.H. per day.

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Mailed upon receipt of 8c in stamps or coin which may be deducted on first dollar purchase. Catalog contains 160 pages of wireless instruments and 140 pages of electrical supplies. No bigger or better values are obtainable elsewhere. We have a complete stock of everything listed in this catalog. Wireless orders promptly filled.

THE WILLIAM B. DUCK CO.
230-232 Superior St. Toledo, Ohio

NEW DISTANCES IN RADIO TELEGRAPHY.

The Marconi station at Bandoeng, East Indies, has succeeded in establishing communication with America, Madrid and Berlin, according to *The Batavia Nieuwsblad.* Presumably this refers only to the reception of messages sent out from those parts of the world. Experiments are being made at Bandoeng with a view to the ultimate establishment of regular wireless communication with the mother country, Holland, and a 300 horsepower motor has enabled the operators to secure the promising result recorded.

"BURNELL R. FORD—SCIENTIST—ELECTRICAL WIZARD."

(*Continued from page* 371)

ing trick of the electrical conjurer known as "The Human Dynamo." The lecturer's assistant *lights a candle from a stream of water.* The experiment is easily performed by taking the high-frequency current up thru the legs. A piece of wire here and there often helps out the lecturer and prevents him from getting unpleasant shocks. If the current is of sufficiently high frequency no trouble will be experienced in passing it right thru the body. But—don't try letting the current jump to or from the skin or you will rapidly lose your *sang froid.* Arrange matters so that the current jumps to or from a piece of metal in some way. And your conscience need not trouble you, either, for the audience is not being humbugged. The current actually does pass *thru your body,* just the same. It's simply a case of knowing how to handle the current.

The three lower illustrations are of Mr. Ford in a few more of his electrical rôles. At the left he lights fire balls by high-frequency current past thru his body. (The lecturer stands on a metal plate covered with a rug, the plate being connected to a high-frequency coil. A metal insole should be worn, making contact with a spiked nail in the heel of the shoe, which thus ensures a good *large area* contact between the charged plate and the lecturer's body.) The center photo shows the lecturer actually lighting up a bank of lamps thru his body. This experiment always attract undivided attention from any audience, large or small. It really is a remarkable demonstration, involving in many cases the transmission of possibly 500,000 volts and several amperes of current thru the body; and 1/10 of an ampere of low-frequency alternating current past thru the heart is said to invariably prove fatal. In the final photo at the right we see Mr. Ford bidding us good-night, and like all good souls, he lights his candle and prepares to retire. But he lights the candle by a spark shooting forth from his tongue. And just to make it interesting we are going to let our electrically inclined reader find out for himself how this trick is done.

CHEMICAL ACTION OF STORAGE BATTERIES.

(*Continued from page* 401)

explained with the help of the osmotic theory by Le Blanc. The difficulty in applying this theory to the lead storage battery is to know what are the ions in the case of the lead peroxid plate. According to Le Blanc's theory, the lead peroxid, having a definite, tho slight solubility, dissolves in the dilute sulfuric acid and then reacts with water according to the following equation:—

$$(8)\quad \underset{\text{Lead Peroxid}}{PbO_2} + \underset{\text{Water}}{2H_2O} = \overset{++}{\underset{++}{Pb}} + \underset{\text{Hydroxyl Radical}}{4OH^-}$$

During the discharge the tetravalent lead ions give up two charges of electricity and combine with the SO_4 ions to form lead sulfate. The tetravalent lead ions are replaced, as they are used up, by the solution of more lead peroxid. There is no loss in free energy in this solution and reactions with water, for both of these reactions take place at equilibrium concentrations. The spongy lead electrode is similar to the zinc in a *Daniell's* cell. It goes in solution as a lead ion, but is precipitated on the lead plate because of the low solubility of lead sulfate. The hydrogen ions of the sulfaturic acid combine with the hydroxyl ions of the equation last given, to form water. The equation representing the reactions that take place subsequent to the reaction of the last equation given, for the entire battery are accordingly:—

$$(9)\quad \underset{\text{Lead}}{Pb^{++}} + \underset{\text{Lead}}{Pb^{++}} + \underset{\substack{\text{Sulfate}\\\text{Radical}}}{SO_4^{=}} = \underset{\text{Lead Sulfate}}{2PbSO_4}$$

$$(10)\quad \underset{\substack{\text{Hydroxyl}\\\text{Radical}}}{4\,OH^{-}} + \underset{\text{Hydrogen}}{4\,H^{+}} = \underset{\text{Water}}{4H_2O}$$

On the *charge* the *reverse* of the above reactions take place. Both the positive and negative plates are covered with lead sulfate, and the sulfuric acid surrounding the plates must also be saturated with lead sulfate. On the *negative* plate the lead ions are deposited as spongy lead, and on the *positive* plate the bivalent lead ions are oxidized to tetravalent lead. The solution and electrolysis are represented by the equations:—

$$(11)\quad \underset{\text{Lead Sulfate}}{2PbSO_4\ \text{solid}} = \underset{\text{Lead}}{Pb^{++}} + \underset{\substack{\text{Sulfate}\\\text{Radical}}}{2SO_4^{=}}$$

$$(12)\quad Pb^{++} = Pb^{++} + Pb$$

The tetravalent ions then react with the hydroxyl ions according to the following equation:—

$$(13)\quad PbOa + 2H_2O = Pb^{++} + 4\,OH^{-}$$

taken in the reverse direction:—

$$(14)\quad 2H_2O = 4\,OH^{-} + 4\,H^{+}$$

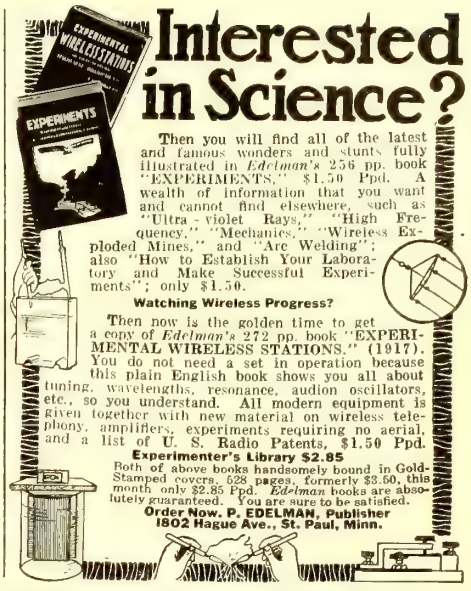
$$(15)\quad Pb^{++} + 4\,OH^{-} = PbO_2 + 2H_2O$$

The hydrogen ions corresponding to the hydroxyl ions and the sulfate ions from equation 11, unite to form sulfuric acid:—

$$(16)\quad \underset{\text{Hydrogen}}{4H^{+}} + \underset{\substack{\text{Sulfate}\\\text{Radical}}}{2SO_4^{=}} = \underset{\substack{\text{Sulfuric}\\\text{Acid}}}{2H_2SO_4}$$

The sum of equations 8, 9 and 10, and of the equations 11, to 16 will be found to result in equation 7. In support of Le Blanc's theory it may be stated that tetravalent lead ions *do exist*, and they are therefore probably capable of forming by the electrolysis of lead sulfate solutions.

Liebenow's theory differs from Le Blanc's



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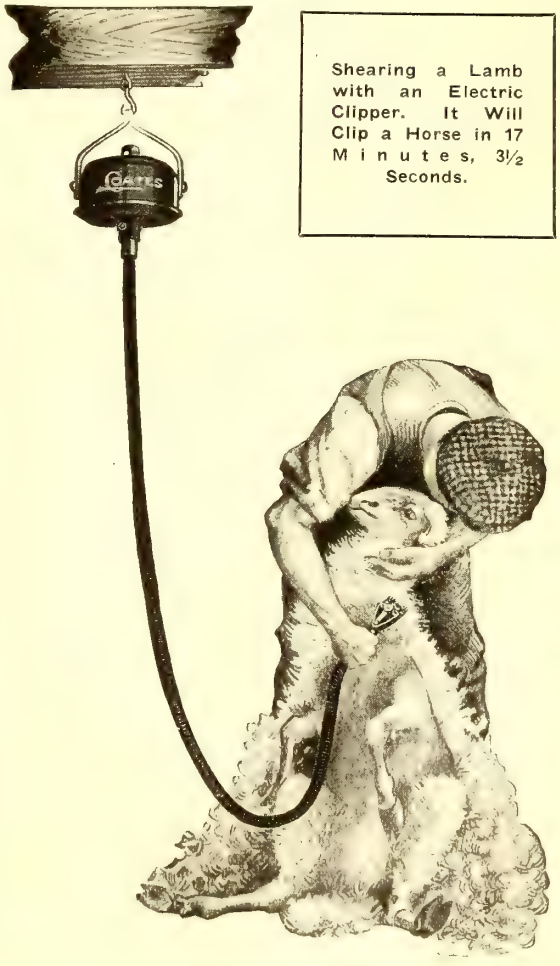
While the government will not permit the use of wireless telegraph and telephone equipment at present except under its supervision, the Public Service Company of Northern Illinois is investigating the practicability of using radio-telephones for load dispatching so that some development can be made along this line when conditions will permit. Two radio-telephone sets suitable for communication between sections 150 miles apart have been purchased and are being tested with the co-operation of the United States Navy Department. If the units prove satisfactory on test, and the indications are that they will, one unit will probably be installed in the system operator's office, which is in the new Joliet (Ill.) generating station, and the other will be placed in the company's generating station at Blue Island, Ill. It will be possible to use the instruments in these locations to facilitate load dispatching in emergencies that may be occasioned by failure of the company's private metallic-circuit line. If the units prove practicable in these locations, their use will probably be extended to other important switching centers. The use of the radio-telephone rather than the wireless telegraph was favored by the engineering department of the Public Service Company of Northern Illinois because the instrument can be used without a knowledge of the Continental Morse code and because it is possible to transmit messages with greater speed by telephone than by telegraph.

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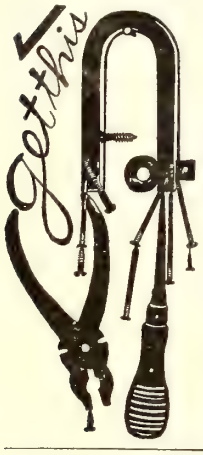


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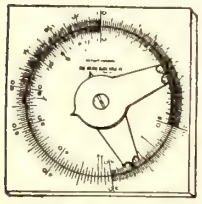
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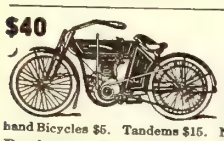
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only as to the action of the peroxid electrode. According to this theory the lead peroxid goes into solution as doubly charged lead peroxid ions, so that the peroxid plate is to be considered a *reversible electrode* with respect to the peroxid ions. On *discharge,* the peroxid passes into the solution surrounding the peroxid plate, which is already saturated with respect to these ions. They then react with the hydrogen ions of the acid as follows:

$$(17) \quad PbO_2 + 4\overset{+}{H} = \overset{++}{Pb} + 2H_2O$$

The lead ions then combine with the sulfate ions to form solid lead sulfate:—

$$(18) \quad \overset{++}{Pb} + \overset{=}{SO_4} = PbSO_4 \text{ solid}$$

During charge, just the reverse reactions take place. The lead peroxide ions are deposited on the *positive* plate, and are replaced as they are used up by the solution of the sulfate from the electrode and its hydrolysis:

$$(19) \quad \overset{++}{Pb} + 2H_2O = PbO_2 + 4\overset{+}{H}$$

The work obtainable from a storage battery depends on its capacity and the electromotive-force measured at its poles while the current is flowing. If V is the voltage on charging, E is the open circuit electromotive force, I is the charging current, and R is the resistance of the battery, then

(20) $V = E + IR$ and on discharge,
(21) $V^1 = E + IR$

(To be concluded)

EXPERIMENTAL PHYSICS.

(Continued from page 386)

perpendicular to the mirror and E_3C prolonged; the image of B will be found on the straight line E_2B, prolonged perpendicular to the mirror and along the line E_3D. These lines may be marked on the paper after sighting along a ruler or other straight-edge. If now these lines are prolonged after removing the mirror, the intersection of AF and E_3C will be the point A^1 the image of A, and the intersection of BC and E_3D the point B^1 the image of B. Light from A going along the direction AF is reflected back and appears to come from A^1. Light from A going in the direction AC is reflected along CE_3 making the angle of incidence equal to the angle of reflection.

In a similar manner light from B appears to come from B^1 and light from each of the points in between A and B appears to come from definite points in between A^1 and B^1 thus forming the complete image of AB. If the distances AF and A^1F are measured, they will be found equal. The same holds true for BC and B^1C and for any other set of corresponding points. In short, we have learned that EACH POINT OF AN IMAGE IN A PLANE MIRROR IS AS FAR BEHIND THE MIRROR AS THE CORRESPONDING POINT OF THE OBJECT IS IN FRONT OF THE MIRROR.

The question is often asked, "If a person runs toward a mirror, how fast does he approach his image?" The answer of course is, *he approaches twice as fast as he is running.* The image is just as far behind as the person is in front and hence if the person approaches a certain distance, the image approaches an equal distance, or the image and person are nearer by twice the distance that the person approached. It can be shown that a mirror must be at least half as tall as a person in order that the person may see his whole image. This is left as an exercise to the reader to try, and the author will gladly look over any solutions that may be sent to him.

EXPERIMENT 48. A very simple experiment can be performed which will illustrate the manner in which many of the magician's tricks are performed. Let M represent an ordinary milk bottle filled with water, GG a piece of smooth polished glass (the window after the pane has been well cleaned will do), C is a candle, and AB a board or other opaque object to screen the lighted candle. When the eye is at E, the observer cannot see the candle C, because it is screened by AB. Light from the candle however on striking the points P to Q is reflected according to our previously discust law, and appears to come from inside the bottle. Hence we see the image of the candle in the bottle, and not seeing the candle itself we are mystified to find that *a candle may burn in water.* Obviously, with large pieces of plate glass and by use of trap doors and strong light a person *under the stage may be made to appear on the stage.* When the magician shoots his gun at the image or ghost it disappears (lights were turned off underneath the stage). Also men may walk thru other men, men and women may change places in cages, heads without the rest of the human body may be made to appear, etc., etc.

EXPERIMENT 49. A piece of apparatus can be easily made as in Fig. 39-A, the working of which depends solely on the law of reflection, but which seems complicated to the person ignorant of Physics. M and M^1 are small mirrors or pieces of mirror placed at angles of 45 degrees in their respective corners. Mirrors M^1 should each have a hole bored thru them or else be cut and have openings near their centers. If now an object is placed at B and the hand or a brick or other screen at A, the object will be seen by the eye at E, since light from the object B is reflected by mirror M^1 to M_1 and from M_1 to M_2 and thence from M_2 to M^1 and from M^1 to the eye. If now the screen be removed from A and an opaque object placed in the tube at S, the light from B will pass thru the holes in the M^1 mirrors and to the eye at E so that the object will be seen in either case. Care must be taken not to have screens in place at A and S at the same time for then there is no path thru which the light may pass from B to E.

This same principle of reflection is made use of in the modern submarine boat. A long tube AB (see Fig. 39-B) with joints CA and BD extending in opposite directions. Small mirrors are placed at A and B, making angles of 45 degrees. Light from a distant ship is reflected by mirror A to mirror B and the image is seen.

EXPERIMENT 50. When light passes from air to water or some other liquid it is bent. This phenomenon is called *refraction.* This refraction can be shown to be due to the retarding of the speed of light when passing thru a medium more dense than air. If a spoon or a pencil is placed in a tumbler partly filled with water (see Fig. 40-A), it will appear bent. Place a coin in a bowl and step back from it until you *just miss* seeing the coin. If water is poured into the bowl carefully by someone without disturbing the coin and you stay in your original position you will find that you suddenly see the coin. The explanation is *refraction.* While the coin is at A before the water is in the bowl, the observer will see it if his eye is along the line ABD and hence if the eye is at E the coin will not be seen. However when water is poured into the bowl, light from A is bent along the broken line ABE and the coin is seen and appears to be at C, since the eye is accustomed to consider light to reach it thru a straight line path.

At this point it may be well to consider briefly what the present theory of light is, or rather to give the reader a start so that he may later read up intelligently on the subject. Like sound, light is considered to be a wave motion. The theory was first formulated by Huygens, the great Dutch

Physicist, in 1629-1695. The theory met with opposition on two grounds and even the great Newton died without accepting the theory which is universally accepted today. First, light travels thru vacua, and the better the vacuum the greater the speed, whereas sound does not travel thru vacua at all. Hence, if light is really a wave motion it is thought to be a motion of some medium which fills all space, but does not retard the motion of the stars and planets. [Good serials stop at tense moments like this, so we will stop here and say "continued in our next issue."]

MAKING AN ELECTRIC CLOCK.

(*Continued from page* 396)

When you have your arbors all done and wheels mounted, the hardest job is locating the bearing-holes in your plates, so that your gears will run neither too tight nor too loose. I made an adjustable frame (Fig. 9), in which the wheels could be set; and when they were running just right, I scratched the distance on the plates with the sharpened ends of the arbors. Screw the two plates flat together, and drill them both at the same time. These holes have to be center-punched and drilled with all the care you've got in your system, as a wonderfully small error will make your gears work as hard as getting Johnny home at supper-time.

That's all. Look like a good deal of work? Well, perhaps it is. It's a great pity you can't buy these wheel-works ready made. A movement like Fig. 6 (just the plates and wheels, I mean, without the escapement) would be very simple and cheap for a clock-manufacturer to produce. Maybe, if there was enough call for 'em, the supply houses advertising in the "E. E." would have some made up. Why don't you send the "Ed." a postal saying you are interested? and if enough postals came in, perhaps the Co.'s will get excited and think they see some business. The wheel-work is mainly a nuisance; and with that off his mind, a long-suffering "Bug" would be free to put his main effort into the pendulum and other mechanisms. There are several principles, such as torsion and scale-spring oscillation, working more or less in time-keeping intervals, that you want to try, but you don't feel like going to the trouble of making up wheel-work for each one.

I want to say right here, that in this clock game it's "no fairs" designing a mechanism to run on an electric-light current. The first rule is, it must run on one dry-cell, and the end to aim at is having the cell dry up on you before the clock takes all its electrical output. You'll find that's hitching your wagon to a star-wheel.

Oh, just to round out the article—as to clock hands—you can make them, of course, but they're very cheap and it doesn't pay to try. The dial you can make all right. Make it of zinc—wood is too apt to warp and stop your hands. Wrinkle: Put a coat of shellac on your zinc before you paint it, otherwise your paint will peel off when very dry. Lay out your figures and circles on paper first, and transfer them to the painted surface with carbon paper. If, like me, you haven't an artistic hand, you can put in the figures with India ink and a ruling pen. You can buy excellent engraved paper dials up to 11 inches diameter, but unfortunately that isn't quite big enough for a really *swell looking* tall clock.

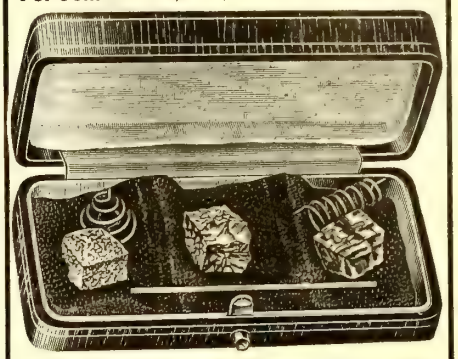
Fig. 10 is a detail sketch of a tall clock case. The design is copied from a very old clock, and is simple and pleasing and easy to make. Use ¾" stock. For the arch over the dial, select a nice colored picture and stick it on with shellac.

Final wrinkle: Harden up your heart like—like agate against all married sisters, aunts, friends of the family, and such like fry, for if you begin producing clocks, they'll beg 'em from you faster than you can make 'em. You don't have any difficulty in extorting admiration as in the case of your more mysterious rinktums; they go into fits over 'em, and contemplate larceny on you.

(*Continued on page* 427)

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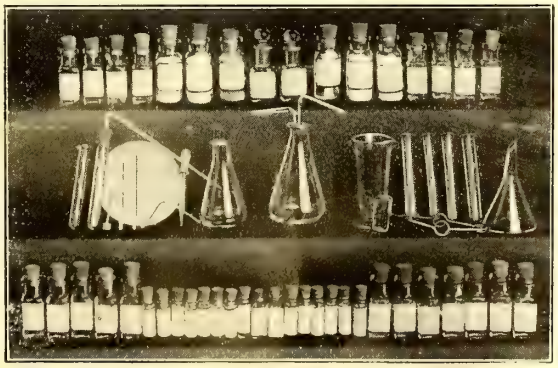
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What this remarkable instrument is and does.

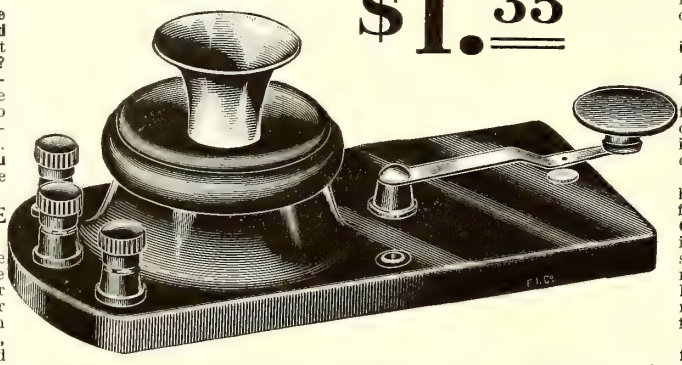
The "Electro" **Codophone** is positively the only instrument made that will imitate a 500 cycle note exactly as heard in a Wireless receiver, so closely and so wonderfully clear, that Radio operators gasp in astonishment when they first hear it. And you need no receivers over the ears to hear the imitation singing spark, which sounds for all the world like a high-pitched distant powerful Radio Station. No, the loud-talking receiver equipped with a horn, talks so loud that **you can hear the sound all over the room,** even if there is a lot of other noise.

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FURTHERMORE, this jack-of-all-trades marvel, can be changed instantly into our famous silent Radiotone test buzzer, simply by replacing the metal diaphragm with a felt disc, **which we furnish with every instrument.**

FOR INTERCOMMUNICATION. Using two dry cells for each instrument, two **Codophones** when connected with one wire and return ground, can be used for intercommunication between two houses one-half mile apart. Any one station can call the other, no switches, no other appliances required. No call bell either, the loud-talking phone takes care of this.

AS AN ARMY TYPE BUZZER. Last, but not least, **two Codophones** with two 75 ohm receivers can be used to converse **over miles** of fine (No. 36 B & S Wire), so fine that no one can see the wire. Or you can use a long metallic fence and the ground, or you can communicate **over your 110 volt line up to several miles, using no wires, only the ground.**



$1.35

Full directions how to do all this furnished with each instrument.

One outfit alone replaces the old-fashioned learner's telegraph set, consisting of key and sounder, which is all right to learn the telegraph code but not the wireless codes.

The "Electro" **Codophone** is a handsome, well made instrument, fool proof, and built for hard work. Contacts are of hard silver ⅛ inch in diameter, that will outlast the instrument. Base and housing is of metal throughout, horn and key lever nickel plated and buffed. Three new style metal binding posts are furnished.

There is also a neat code chart and full directions **enabling any intelligent young man or girl to learn the codes within 30 days,** practising one-half hour a day.

Sizes: 6¾ x 3 x 2⅝". Shipping weight, 4 lbs. **$1.35**
The "Electro" Codophone as described, complete

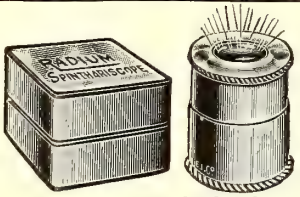
Money refunded if instrument is not as represented or does not come up fully to expectation.

Ready for delivery Aug. 25th. There will be an enormous demand for this new marvel—place your order now. All orders filled in rotation. Better order two instruments today.

THE "ELECTRO" SPINTHARISCOPE

As usual we lead—others follow. Now the **Spinthariscope,** first to be introduced to the American public by us. The **Spinthariscope** was originated by the famous English Radium expert, Sir William Crookes. Everyone knows that Radium gives off a tremendous amount of energy which goes on for several thousand years, with undiminished force.

MAKING RADIUM VISIBLE



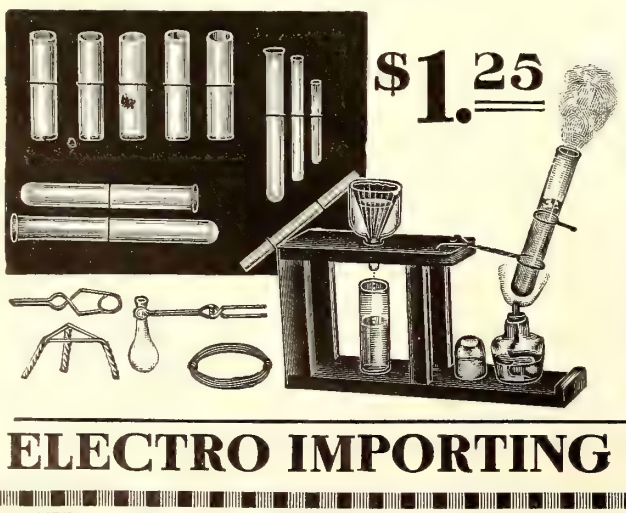
Radium gives off a number of rays of which the **Alpha rays are known chiefly for their great power.** These electric rays are invisible to the naked eye, the same as are X-rays. But if we take a small amount of Radium and place it in front of a zinc-sulfide screen, the latter lights up. If the radium speck is arranged suitably the Alpha rays will bombard the zinc sulfide with a veritable hail of electrons and the screen begins to scintillate like Fourth of July fireworks.

This is the principle of the **Spinthariscope,** which we present herewith. It is a little instrument made of two neatly nickeled metal tubes, one telescoping into the other. The top tube has a powerful lens. The bottom contains the zinc-sulfide screen and a minute quantity of REAL RADIUM, **too small to do any harm.** The instrument can only be used in the dark. After the top tube with the lens has been adjusted to the right focus, we observe a vividly illuminated green background, glowing in a soft light. As the eye becomes accustomed to it, we begin to see the **ELECTRONIC BOMBARDMENT** of the Alpha rays from the Radium. It looks exactly like tiny fireflies flashing off and on in the dark night. The more we look the better we see the miniature fireworks. We are now in the presence of the most marvelous substance man ever knew, **RADIUM** and its uncanny forces—Radium, which some day will turn the world upside down.

The **Spinthariscope** up to now sold from $10.00 upwards, but by greatly simplifying it the cost has been brought down by us to such a nominal figure, that no one can afford to be without this most important and marvelous instrument.

You owe it to yourself to own one. It is small enough to be put into your vest-pocket, and interesting enough to show it to all of your friends. **It will continue to operate after you are dead 2500 years!** We guarantee the instrument to be genuine and to contain a minute quantity of **real Radium salts.** "Electro" Spinthariscope, in neat box and directions for use, as described..... **$1.00**
Sent Prepaid. **IMMEDIATE SHIPMENTS.**

LABORATORY OUTFIT!



$1.25

We have spent considerable time to combine just such a practical outfit and present it herewith to our friends.

The outfit is complete as per illustration and consists of:

1 **Stand,** made of well quartered oak, varnished three times, so as to be acid proof and grooved on top and bottom, so that it will not warp in getting wet. Size 5¾ inches high by 11½ inches long.

1 **Glass Spirit Lamp.** Size 3½ inches by 2 inches. Uses wood alcohol and is invaluable to the experimenter. Besides being used to heat test-tubes contents as per illustration, it can be used to bend glass rods and tubings, to solder wire, etc.

1 **Glass Filter Funnel.** This funnel is made of heavy glass that will not break easily. It fits accurately in the hole on top of the Filter stand and is provided with a thick rim on the outlet, so that a rubber hose can be attached to it, without slipping off.

1 **Glass Rod,** to be used in stirring and mixing.

10 **Test Tubes,** made from the best imported glass. A new feature of some of the test tubes is that they have a flat bottom and therefore can be placed on any table if desired, needing no special stand.

1 **Roll of Copper Clad Steel Wire.** This wire is to be used to make a number of useful articles as shown in the illustration, such as test-tube holders, tripods to support retorts, etc. We furnish a blue print with the outfit, showing how to make all these wire articles.

Now this whole outfit as described costs you only **$1.25**

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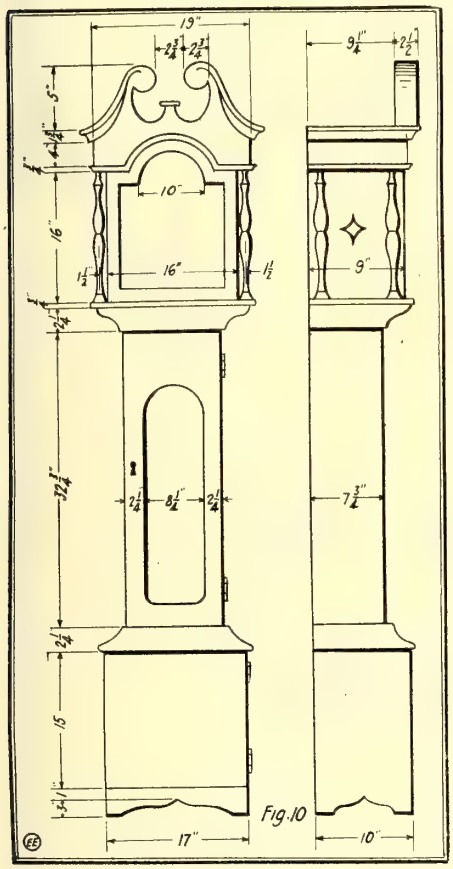
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MAKING AN ELECTRIC CLOCK.

(*Continued from page* 425)

By this time, you're either got the craze, or are deathly sick of clocks.. If the former, I could give you a little spiel on unusual forms of movement, striking-mechanisms, and other daffy dope, but I got to be coaxed—that is, you mail the Editor a nut or something to show you're crazy and not bored, because I don't want him to load up his Mag, with the kind of stuff that you skip when you come to it. I'm a modest and retiring guy—what's that?—Yes I am, too, and I can prove it in court if I have to. Now, is everybody happy?



Dimensions of Cabinet for Home-Made Electric Clock As Here Described. A Graceful, Yet Simple Design.

TRIALS OF A TROUBLE-SHOOTER.

(*Continued from page* 399)

by the tiny black spots on the rod where the lacquer had been burnt.

Yes indeed, trouble shooting is "Sport," sometimes.

There are possibly more chances for ridiculous situations and strange mistakes in the installing end of the game. Trouble is oftimes encountered in properly grounding the 'phone. One subscriber has to water his ground rod every day or so to keep the 'phone working properly. Reminds me of the chap that wanted to ground on a coal bucket. He even offered to allow enough slack so the lady of the house could bring coal out of the cellar.

And streaks of luck, let me tell you about a certain incident that caps them all. On a certain job it was necessary to drill a hole thru the floor to pass a pair of wires. Going down the cellar he started to drill up. After sinking the drill some six inches he began to wonder how thick the blamed floor was. He went upstairs and lookt for the hole but none was in evidence.

He then returned to the brace and sunk it another three inches before he decided to check up his measurements. After a little trouble he located the place where the hole was coming thru. Where, you ask?

Up a Piano Leg!

And plumb in the center. A quarter inch either way would have broken thru the veneer.

EXPERIMENTAL CHEMISTRY.

(*Continued from page* 405)

MANUFACTURE:

On a large scale it is made mostly from the ammoniacal liquor of the hydraulic main of gas houses, which results from the destructive distillation of soft coal. This liquor contains dissolved $(NH_4)_2S$; $(NH_4)_2CO_3$; etc., and when treated with hydrochloric acid, nitric acid or sulfuric acid, it gives the salts NH_4Cl, etc., and from these salts "liquor ammonia" is obtained. Great quantities of the gas are formed in the preparation of coke in the iron regions.

PROPERTIES:

Physical: 1. Ammonia (NH_3) is a colorless gas, possessing a pungent and characterisitc odor and acrid taste.

2. It is very easily soluble in water, with which it combines to form the hydroxid, which in turn gives off the gas at all temperatures.

3. Ammonia can be liquefied and when in that state it is colorless. The liquid boils at -40 deg.

4. It solidifies at about -80 deg.

5. Its own evaporation may produce cold enough to freeze water, hence the making of artificial ice.

6. Charcoal rapidly absorbes ammonia which may be shown by introducing a piece of charcoal into a tube of the gas over mercury.

CHEMICAL:

1. It is not ordinarily a combustible gas or supporter, but if mixed with a small quantity of oxygen combustion readily takes place on the application of a flame, with the formation of water, nitrogen, and nitric acid.

2. Like other bases, it combines with acids forming salts.

3. It gives a strong alkaline reaction.

4. NH_3 partially dissociates into its elements at 500 deg., as may be shown by passing it thru a red-hot tube.

5. The two elements do not combine under ordinary conditions.

6. It is decomposed at red heat or by the electric spark into nitrogen and hydrogen; when past over heated sodium, potassium, or magnesium, the nitrogen combines with the metal, forming a nitrid, and hydrogen escapes:

$$3\,Mg + 2\,NH_3 = Mg_3N_2 + 3\,H_2$$

When treated with an excess of chlorin or iodin, a salt of ammonia results, which in turn is decomposed by the halogen, yielding very explosive compounds, as nitrogen chlorid (NCl_3) or nitrogen iodid (NHI_2 or NI_3).

DETECTION:

(1) Ammonia and its solution (the hydroxid) are very easily detected by the characteristic odor. (2) In smaller quantities by bringing over the suspected solution a piece of moistened red litmus paper, which it turns blue. (3) A still more delicate test is the reaction with fumes of hydrochloric acid. A rod or piece of paper moistened with the diluted acid is brought

(*Continued on page* 429)

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When the typewriter arrives deposit with the express agent $8.80 and take the machine for five days' trial. If you are convinced that it is the best typewriter you ever saw, keep it and send me $2.50 a month until our bargain price of $48.80 is paid. If you don't want it, return it to the express agent, receive your $8.80 and return the machine to me. I will pay the return express charges. This machine is guaranteed just as if you paid $100.00 for it. It is standard. Over one hundred thousand people own and use these typewriters and think them the best ever manufactured. **The supply at this price is very limited, the price will probably be raised when my next advertisement appears, so don't delay. Fill in the coupon today—mail to me—the typewriter will be shipped promptly.** There is no red tape. I employ no solicitors—no collectors—no chattel mortgage. It is simply understood that I retain title to the machine until the full $48.80 is paid. You cannot lose. It is the greatest typewriter opportunity you will ever have. **Do not send me one cent. Get the coupon in the mails today—sure.**

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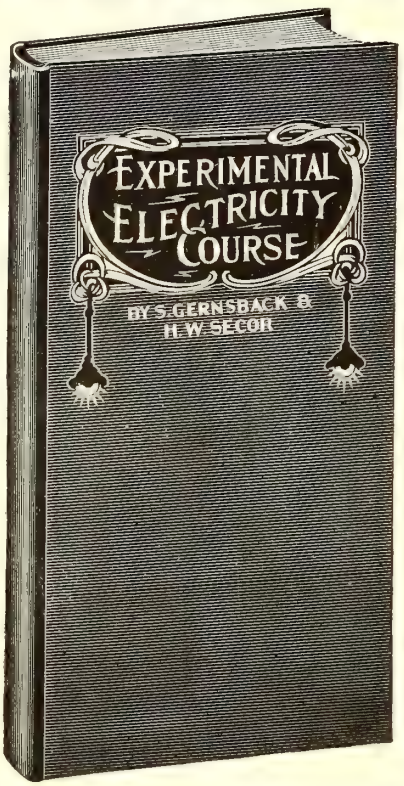
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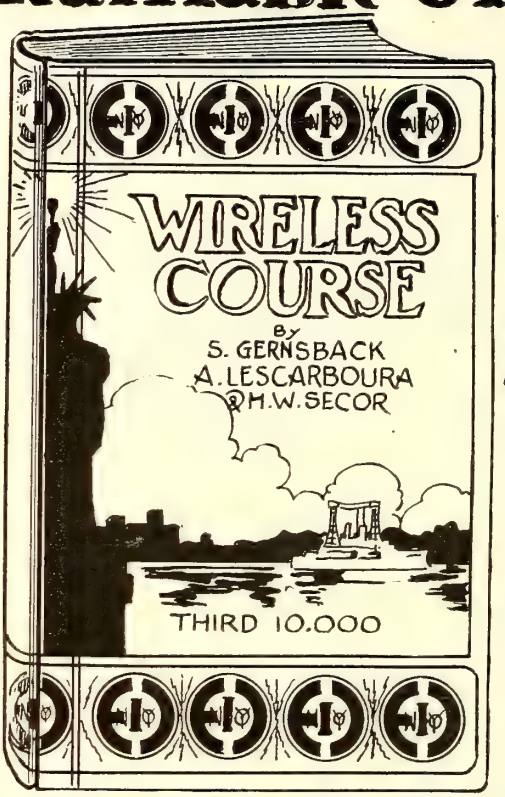
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EXPERIMENTAL CHEMISTRY.

(*Continued from page* 427)

into contact with some of the gas, or over some of the warm solution, when immediately dense bluish-white fumes of ammonium chlorid are formed. (4) When combined with acids, ammonia is detected by first liberating it from its combination with an alkali like potassium or sodium hydroxid, and then applying one of the above tests for the gas; or the solution may be acidified with hydrochloric acid and solution of platinic acid added, when a yellow precipitat of ammonio-platinic chlorid, will slowly separate in minute crystals. (5) *Nessler's Reagent* produces a *brown precipitate* with ammonium compounds, or if in very dilute solution a *brown or yellow color.* Nessler's reagent is made by adding to a solution of mercuric chlorid (corrosive sublimate) a solution of potassium iodid until the precipitate at first formed is nearly all redissolved. Solution of potassium hydroxid is then added to strongly alkaline reaction and the liquid allowed to settle until it becomes clear, when it is decanted from any sediment.

USES:

Ammonia is widely used in medicine and pharmacy, in making dyestuffs, in calico printing, and in refrigerating operations. Its compounds serve to furnish nitrogen, which is essential to the growth of both vegetable and animal life; hence the use of ammonia in fertilizers for the soil. The three elements necessary to be restored to the soil for the raising of crops are *nitrogen, phosphorous,* and *potassium.* Compounds of these three elements with others are made into fertilizers by manufacturers. Ammonium compounds, with some nitrats, furnish the nitrogen on which all higher animals depend for the nitrogenous material foods.

The value of ammonia water as a cleansing agent is due to its ability to dissolve grease. Its basic properties also give it a use in the laboratory, whenever a volatile alkali is desirable. Large quantities of ammonia are used in the manufacture of *sodium carbonat* by the *Solvay* process.

Ammonia is very extensively used for making artificial ice and for large refrigerating and cold storage plants. When a gas is liquefied, heat is liberated, and when the liquid returns to the gaseous state, heat is absorbed. The process consists of alternately liquefying ammonia and then vaporizing it. The ammonia gas is first obtained from very strong ammonium hydroxid, and by a compressor pump, and is forced as a gas into pipes, called condensers, upon which cold water is permitted to pass, which together with the compression, makes liquid ammonia, which then passes thru a valve, called the *expansion valve,* into a series of pipes.

These pipes are immersed in a strong brine of Calcium chlorid solution (Sodium chlorid not being so good). As the liquid ammonia goes thru the expansion valve and into the tubes it again vaporizes, and in the process withdraws heat from the brine, cooling it to -20 degs. or over, thus making a freezing mixture of the brine, in which tubes of pure water are immersed and the water frozen. The gas NH_3 then passes back to the pump, where it is used again, the process being continuous.

EXPERIMENT No. 93:

Made from Ammonium Chlorid and Calcium Hydroxid.

Connect a plain Florence flask (125 or 250 cc.) having a two-hole stopper with a thistle and delivery tube (the delivery tube in the Florence flask should just pass thru the stopper, (but the thistle tube should be immersed beneath the solution), to an 8-ounce bottle, this being fitted with a three-hole stopper. In the second hole a plain piece of glass tubing is inserted so that it projects over the stopper and beneath the liquid. The third hole is to accommodate a second delivery tube which leads to the second 8-ounce bottle which has no stopper. Fig. 84 depicts this apparatus. Both 8-ounce bottles should be about one-fourth full of water. The delivery tube from the first to second bottle should pass below the surface of the liquid.

Put about 10 grams of ammonium chlorid (NH_4Cl) on a piece of paper, and on another about 8 grams of calcium hydroxid ($Ca(OH)_2$), recently slaked lime being the best. Pour these successively into the flask, add 20 or 25 cc. of water, and mix the contents by rotating the flask. See whether any odor comes from it. Then set the flask on an iron tripod or ring stand, with asbestos or iron gauze, make connections, and apply heat for fifteen minutes. If there is a tendency to froth up and run over, take away the lamp, and, if need be, pour a little water thru the thistle tube. In case the frothing should extend into the tubes or bottles, clean them out and begin again. Observe fully all phenomena in the flask and try to find an explanation.

When ready to stop the action remove the lamp, take out the stopper, and apply these tests in rapid succession to the gas *in the flask.* They must be made while generation is progressing. (a) Apply a piece of both red and blue litmus to the gas and notice which one is discolored, and conclude what this would indicate. (b) Apply a lighted splint to the gas, in order to test for the combustibility of the gas. (c) Test the odor. (d) Test with hydrochloric acid by pouring two or three cc. of the acid into a dish and dipping a folded paper into it; or the test may be made by bringing the dish to the mouth of the flask or with a tuft of cotton. Dense bluish-white (ammonium chlorid) fumes will appear, the same being a test for free ammonia. Let the flask cool a few minutes after taking away the lamp, then pour in water from a test tube, shake the contents, and pour them into a sink. Any adherent substance may be removed from the flask by using a little hydrochloric acid. Save the liquid in the first bottle for further tests.

EXPERIMENT No. 94:

Properties.—The positive radical or ion of an ammonium salt is NH_4; the negative one OH. The best test for the positive (NH_4) part is to mix a little of the powder to be tested with a equal amount of slaked lime ($Ca(OH)_2$), heat the mixture and obtain ammonia, in case it is an ammonium salt. A simple test can often be made by rubbing in the palm of the hand a pinch of each substance, moistened, and noting the odor. The tests for the negative radical or ion, in addition to the one with litmus, consists in making insoluble hydroxids as given below.

EXPERIMENT No. 95:

Action on Ferr*ous* Sulfate.—Take a small crystal of ferr*ous* sulfate ($FeSO_4$), dissolve in 10 cc. of water by boiling (it may first be pulverized in a mortar, if desired), then filter the solution and add to the filtrat a little of the ammonium hydroxid (the liquid in the first bottle of the first experiment of this paper).

Note the color and state of the product. Also note if there is a precipitate. See whether a solution of sodium hydroxid (NaOH) would give the same result as the ferr*ous* sulfate solution. Try also the action of potassium hydroxid (KOH) in solution.

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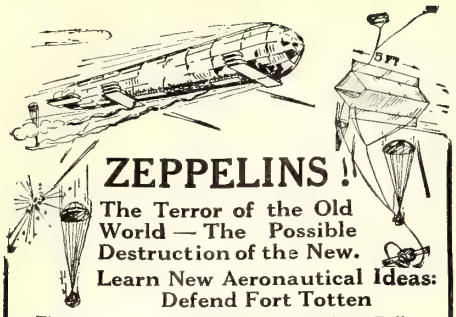
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Five foot complete Model of German War Balloon. No Toy or Fireworks display. Equipped with complete parachute and bomb dropping apparatus, silk Parachute and entire inflating arrangement.

Will positively drop parachute from Height of 1,000 Feet and will Fly One Mile.

Is easily retrieved and is practically indestructible. May be flown in only slight wind attached to Cord or be allowed to take its own course and return to earth on expiration of Gas.

Airship is cylindrical in shape with both ends tapering and the Equipment of the above includes complete wood and Fibre Car, inflating device, Silk Circular Parachute of Large Size with Hemmed Edge, Parachute and Bomb Dropping Apparatus, and is guaranteed to fly one mile and give satisfaction when assembled, for which are also supplied diagrams and directions.

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This kite will carry aloft cameras, Parachute and Bomb at the same flight and will drop them safely and with remarkable precision. Is an exact model of the Man Carrying Kites in Use at the Front Today.

Both of the above will be immediately sent by P. P. or Express, boxed, on receipt of $2.25.

Manufactured only by the
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WE HAVE THE BEST

Send stamp (1c) for our new circular, giving photograph, description, and price of our big outfit

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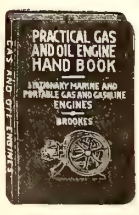
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Dept. 6 1006 Michigan Ave. Chicago

EXPERIMENT No. 96:

The Ammonia Fountain. Ammonia Gas (NH_3). Tests and Properties.—Various tests were applied to the gas ammonia in experiment No. 93. The simplest one is the odor test, which is very characteristic of this gas. Its action on litmus, and inertness to the combustion test, do *not* distinguish it from other substances. The litmus test is a test for the base OH.

To show its action on water, collect a bottle full of it by upward displacement by use of the apparatus shown in Fig. 85, either from a generator or by boiling about 20 cc. of strong ammonium hydroxid. The latter will give the purer and stronger gas. Have the delivery tube from the generator reach close to the top of the inverted bottle. Close the mouth of the bottle with a one-hole stopper carrying a glass tube, as soon as it is filled with gas (which is made apparent when the odor is observed around the bottle), and at once thrust the outside end of the glass tube into a dish or beaker of water, having the bottle in an inverted position till action takes place. (Fig. 86 illustrates the apparatus for use for the Ammonia Fountain). As the name implies, the ammonia will absorb the water from the beaker, thereby drawing it up into the bottle with such force that a miniature fountain will be formed. Unless the ammonia is unmixed with much air the experiment will not be a success. By having a few drops of red litmus solution in the water in the dish or beaker into which the tube is thrust, a double test may be made. Observe any color phenomena when the litmus is introduced into the beaker.

The reader may have heard or read of *reversible reactions* and never stopt to inquire as to their meaning. This experiment is an excellent illustration of a reversible reaction. A *reversible reaction* is one in which the factors become the products and the products the factors. Heating ammonium hydroxid (NH_4OH) gives Water (H_2O) and Ammonia (NH_3). Reverse the experiment by passing Ammonia (NH_3) into water and you have ammonium hydroxid (NH_4OH). Thus the reaction goes either way, according to the conditions, or may go both ways till equilibrium is established.

EXPERIMENT No. 97:

Diffusion and Absorption.—Take two small flasks (125 cc.) each carrying a one-hole stopper, and connect them by means of short glass tubes, connected with a rubber stopper, as shown in Fig. 87. Into one pour 30 or 40 cc. of water and into the other the same volume of ammonium hydroxid. The tubes should not pass below the surface of the liquid, as we are to deal with a gas. Allow them to stand in this manner for a week or so, then test the liquid, both with litmus and *Nessler's Reagent,* in the bottle which at first contained the water only. Observe any results. This would show that the ammonia (NH_3) from the hydroxid (NH_4OH) past over the tube and again formed an ammonia solution with the water which was in the flask.

THAT PERPETUAL MOTION.

(*Continued from page* 407)

only run forty seconds or so at each descending.

Consequently, the dynamo would not have enough time to charge the batteries, regardless of the number of cars or how often they run.

Also the continual charging and discharging of the batteries at such minute intervals, would not give them sufficient time to charge properly, and consequently the cars would not run three minutes, much less for years as was suggested.

EDWARD JAMES VAN ALLEN,
Stamford, Conn.

Let's Nickleplate the "Superstructure"!!

In the first place you must think of the superstructure upon which the track is laid. Without paint and proper care it would soon rot. The cars also would need attention.

Altho the cars charge the storage batteries when going down grade, they would use up a great deal more current going up. At which rate the current would soon be used up. The distilled water in the storage batteries would evaporate, after which the "bats" would not work.

The friction wheel, third-rail contact shoe and belt would also wear out, after all of which the device would stop going.

HENRY A. McCOMAS,
Blue Ridge Summit, Pa.

To "Rub" Or Not to "Rub," That's the Question!!

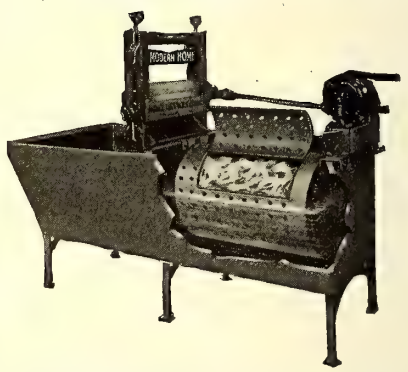
In charging the cells receive a positive and negative charge. Then when the car goes uphill the batteries should discharge, but in discharging the batteries change poles. This would tend to make the car go backwards on the hill, so that the batteries would hinder more than help. The dynamo is not perfect, for it can never cut the lines of force of all its poles and, consequently, can never generate enough power to be 100 per cent perfect. Friction (which is always present), *in rubbing* places would make the car stop.

SIDNEY KILLIAN,
642 Susque Avenue,
Sunbury, Pa.

Oh Carl, How Could You Be So Cruel in 100 Words!!

This device can impossibly keep going for years, due to the fact that no storage battery ever built could or can last for any number of years since its plates or elements would be decomposed by the electrolyte thereby decreasing the efficiency of the cells so greatly that they woul discontinue to do their work faithfully. Another thing is that storage batteries must be charged at an even rate of current, and in this case it would not be. Also the cars, while descending, would be going so fast as to overload the dynamo, *thereby possibly burning out its armature.*

CARL HAARMANN,
New Holstein, Wis.



Washing Without Work

This truly wonderful machine has revolutionized washing. It fits in any stationary washtub and does all the washing, rinsing and wringing by electricity. All you need do is turn on the switch. The clothes are washed cleaner and whiter than ever before and in the most sanitary way.

The machine washes delicate laces and lingerie without injury; also heavy blankets and small rugs. Clothes washed in it last six times as long as those washed on the rubbing board or at laundries.

MODERN HOME WASHER

"FITS IN ANY TUB"

This is the only washing machine of its kind that fits and operates in stationary washtubs and stores in the tub, out of the way, when not in use. It is a great boon in apartments and small kitchens where there is no room for a heavy, bulky washing machine, in the way all the week.

The Modern Home Washer saves its cost many times over each year in washwoman expense and clothes savings. It solves the servant problem and the cost of electricity is only about three cents for a week's washing.

Tested and approved by Good Housekeeping Institute and the Tribune Institute. Awarded a medal at Panama Pacific Exposition. Portable machine for use where there are no stationary tubs.

Electric, Portable Metal Tub Type, complete...$110.00
Electric, Stationary Tub Type, complete..... 90.00
Hand Power, Stationary Tub Type..... 15.00

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Write for Catalog today.

Home Devices Corporation
Bush Terminal Bldg. 5
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UNDOUBTEDLY you have at the present time some things for which you have no further use. Do you wish to exchange them for something, for which you have immediate use? There is no surer and quicker way to do this than by advertising your articles in these columns. The *Very* people, the *Only* people, who could possibly have a use for your things read this journal. More than 75,000 interested people will see your ad. It is furthermore the cheapest advertising medium for you in the country. Dealers' advertising accepted in Opportunity Exchange Columns only.

The rates are: *Three cents per word* (name and address to be counted), minimum space 3 lines. Count about 7 words to the line. *Remittance must accompany all orders.* No advertisement for less than 50c. accepted.

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The Classified Columns of "The Electrical Experimenter" Bring Positive Results.

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CASH PAID for a set of Bound Volumes belonging to I. C. S. Electric Engineering Course (Part Two). H. Walton, Amigari, Ontario, Can.

WANTED—Your old Wireless Apparatus. I also have a $50 Wireless Set to trade for a motorcycle. Enclose stamp. Lawrence Johnston, Fairfield, Illinois.

FOR SALE—15,000 meter coupler, 3,500 meter receiving set, two 3,000 ohm headsets, two 20 ohm telegraph sets, telephone transmitter. Write for photo and description. F. B. Dadisman, Independence, West Va.

HAVE—New Western Electric table fan ($25). Want typewriter and wireless goods. Mack Simmons, Van Alstyne, Texas.

FOR SALE CHEAP—One new Power's 6-A Motion Picture Outfit, used four weeks. Would consider an immediate cash offer. Austin Miller, Erwin, Tenn.

FOR EXCHANGE—$40.00 worth wireless and electrical apparatus. Would like 8 x 10 view camera or other photographic goods. Write for list of apparatus and say what you have. K. R. Sipple, 166 Whitney Pl., Buffalo, N. Y.

FIRST MONEY ORDER GETS THESE BARGAINS—D. C. 500 V. ½ H. P. Standard Dynamo, $24.50. Robbins 1-16 H.P. 500 V. new enclosed motor, $8.75. Both fine for radiotelephones. Smith motorwheel, $27.25. Tubular audion, $4. Mignon Receiving Set, $4.90. P. Edelman, 1802 Hague, St. Paul, Minn.

FOR SALE—Electron Relay and cabinet complete, $10. New Electron Relay, $4. 1 K. W. Glass Plate Transmitting Condenser, $3. 5 H.P. motor starting box, $4. Ralph Leffler, Tiffin, Ohio.

FOR SALE—New 3 speed bicycle practically new; 2 speed Hub; new Camera and 5 x 7 enlarger, developer and printing set. No. 4 Erector; 1 Transformer; 2 motors. Send for description. Clair Miller, Wilmington, Ohio.

FOR SALE—2,500 Meter Loose Coupler; unmounted 43 plate Variable; unmounted Detector; Brandes 2,000 ohm Phones; 1½" Spark Coil; Jove Key. Expressage extra. Walter J. Schneider, R. R. 2, Mason Rd., Hamilton, Ohio.

ABOUT 1,000 copies specifications and drawings for all U. S. Radio-communication patents from beginning to date; will sacrifice complete collection for $55. P. Edelman, 1802 Hague, St. Paul, Minn.

WANTED—An Amco or Tesla Transformer. Have apparatus to trade. Write for my list. Robt. Fairchild, Minden Mines, Mo.

WANTED—One H.P. Gas Engine, Redemotor preferred, good condition, cash. Sell—Harley twin, run four thousand miles, thirteen model, ninety dollars, ready to ride, bargain. Write me. H. P. Rea, Carrollton, Mo.

FOR SALE—15,000 meter Navy Type Loose Coupler, $10; 200 ohm Phones, $5; Galena and Electrolytic Detectors; ⅜" Spark Coil, 75c.; Shocker, 50c., and $3.50 Telegraph Set, $1. Harold Hammer, 3225 23rd Ave., So., Minneapolis.

FOR SALE—Hudson Audion Amplifier Bulb, new, $500; ¾" Spark Coils, $1.25; large Accurate Voltammeter, $2; also chemicals. All answered. J. C. Swimmer, 1904 Park Pl., Brooklyn, N. Y.

WILL SELL OR TRADE—Complete set Cyclopedia of Applied Electricity in A-1 condition. R. O. Miles, Wyanet, Ill.

WANTED—150 ohm relay, Vibroplex, Omnigraph, key, sounder, Audion, 15,000 meter coupler, small coupler, storage battery, high tension condenser, rotary gap, ground switch, rheostat. Cash or trade. Write quick, giving best price, to Geo. Rozum, Mitchell, S. D.

WANTED—For cash or trade, an Edison Phonograph with records. Give condition, terms, etc. Frederick Towns, Winchester St., Keene, N. H.

FOR SALE—$25 Erector Set complete in A-1 condition, used once, $20. A. E. La France, 40 Ely Street, Holyoke, Mass.

"WANT TO SWAP"?

Do you realize that these "Scientific Exchange Columns" are the World's most renowned "Swap" market? "THE ELECTRICAL EXPERIMENTER" prints 79,800 copies of this issue; that means that at least 160,000 readers see this page and probably a great many more. Our readers who advertise here seldom advertise the same thing twice—usually within five days after the issue is out the advertised article has been sold, or swapped. The many testimonials which we print here from time to time are ample proof of the almost miraculous pulling power of three columns.

Look around in your attic or workshop and you will find dozens of good forgotten articles, useless to you now, but very useful to someone else. At a ridiculously low cost you can either sell or swap such articles.

And remember this fact: The U. S. Postal Laws protect you. No one can "do" or cheat you. Of 3,410 "ads" published in these columns during the past five years, only twelve complaints were reported to us, and each and every one was adjusted to the full satisfaction of the complainant.

It matters not if you have old books or magazines, a kodak, electrical or chemical apparatus, scientific instruments, bicycles, typewriters, moving picture machines, air rifles, watches, structural toys, etc., etc. All these and countless others can be speedily disposed of here. Try it and be convinced.

FOR SALE—I C8 Electrical Engineering Course. 9 Vol. in goods condition. Cost $100. The best offer takes them. Geo. Fehrenback, 76 Hancock Ave., Jersey City, N. J.

FOR SALE—Wireless Sending and Receiving Apparatus. Large marble switchboard, miscellaneous other electrical apparatus, books, chemicals. Want vacuum and X-ray tubes AC and DC meters. Ralph Batcher, 131 Hyland, Ames, Iowa.

FOR SALE—$50.00 buys $200.00 complete, good as new, Edison Moving Picture Machine. 135 feet of movie picture film for toy moving machine. $1.25, 30 foreign coins, $2.00. Herman David, 711 South Kedzie Ave., Chicago, Ill.

A SNAP—Owing to dissolution, $40 takes one Edison Motion Picture Machine, good order. Enterprise P. & N. Co., Kewanee, Ill.

SYMPHONY PHONOGRAPH with about $25 worth new Victor and Columbia records, all good, $16. P. Edelman, 1802 Hague, St. Paul, Minn.

FOR SALE—Electric Therapeutic Apparatus Machine. Second-hand, in good condition, used by physicians for rheumatism and circulation. Will sell at a very reasonable price. John Ferguson, 113 West 63rd St., New York City; home, 364 West 57th St.

WANTED—Copy of book "Michael Faraday, His Life and Work" by Sylvanus Thompson. Also an ohmeter of the Roller-Smith type or a Wheatstone bridge; must be in first-class condition, and include galvanometer. H. W. Secor, c/o ELECTRICAL EXPERIMENTER, 233 Fulton St., New York City.

MOTION PICTURE MACHINE, Power's No. 6, no lens or rheostat; automatic steropticon, carries eighteen slides, uses motor; nineteen sets colored song slides; good make snare drum; cash or trade. High-tone rotary $9; Murdock oscillation $2.75. Want reliable wireless goods. New $7.50 Racine A. K. Utility Motor, $6.50. Verner Hicks, Marion, Ill.

FOR SALE OR EXCHANGE—1915 Indian Motorcycle, in excellent condition, 2-speed, 2-cylinder, 9 H.P., cost $275. Full equipment, tires almost new. Will sell cheap. Laverne Bushnell, Hanover, N. H.

FOR SALE OR EXCHANGE—Remington No. 6 Typewriter, $14; $8 Drafting Set, $5; Set of "Hawkin's Electrical Guides," $8. Write for list of other electrical and mechanical books. Want cash or good camera, or what have you? P. Platzer, 119 E. Grand Ave., Chicago, Ill.

FOR SALE—High-grade, second-hand wireless apparatus for sale at a bargain price. Write for list and information. Eldred Hall, Solvay, N. Y.

LARGE WIRELESS receiving set with aerial, $12. Robert Bowers, c/o F. White, Great Neck, N. Y.

TRADE FOR MOTORCYCLE—$200 worth of wireless instruments or sell. Denecke, 1539 Ave. A., New York.

EXCHANGE—Bicycle, toy transformer, and electric train for Brandes Superior Phones, 110 volts a.c. motor or gas engine. Frank Low, Jr., 103 S. Pine St., Pauls Valley, Oklahoma.

SELL OR EXCHANGE—New 3-A Kodak, $36 Meccano, 4-60 Storage. Send for list. Want Thordarson and other apparatus. Huff, 915 Campbell St., Williamsport, Pa.

SMALL screw cutting lathe, 3 speed lathe and a Boley watchmaker's lathe for sale or exchange. Ralph C. Morse, P. O. Box 147, Foxboro, Mass.

FOR SALE—$50 set Harvard Classics, 51 books, new, $30; also 15" spark coil without condensers. If interested write, will send photo of coil and open bids. Any for less than $40 ignored. Harry J. Frenz, 740 Franklin Ave., Wilkinsburg, Pa.

BARGAINS—6,000 meter Navy Type Coupler, $4.50. All kinds of wireless apparatus, all new. Write. Walter Johnson, Salem, Nebr.

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Name and address must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency.

Ten per cent. discount for 6 issues, 20 per cent. discount for 12 issues from above rate. Objectionable or misleading advertisements not accepted.

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July	"	"	"	Oct.	"	"	"
August	"	"	"	Nov.	"	"	"
Sept.	"	"	"	Dec.	"	"	"
Oct.	"	"	"	1917.			
Nov.	"	"	"	Jan.	"	"	.15
Dec.	"	"	"	Feb.	"	"	"
1916.				March	"	"	"
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STOP playing. Experiment systematically with real chemicals and apparatus. Six cents brings catalogue. Clarence Appel, Mathews Avenue, Knoxville, Pittsburgh, Pa.

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Yours truly,

BERNARD BROWN.

BE A DRAFTSMAN—Big pay; tremendous demand. Study at home; complete course; drawing instruments FREE. Our students filling good positions as Draftsmen and Chief Draftsmen with Government and private concerns. We help you secure position when qualified. Columbia School of Drafting, 25 McLachlen Bldg., Washington, D. C.

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MINERALS—Two cents brings catalogue. Clarence Appel, Mathews Avenue, Knoxville, Pittsburgh, Pa.

BIG BARGAIN IN TENNIS RACKETS—We have a small supply of Tennis Rackets, made by one of the largest firms in the country, on hand which we will close out at the following prices:

No. 2375—Extra best Tennis Racket, $5 grade, air dried ash, popular long oval form, concave walnut wedge, superior quality of gut; each, $2.75.

No. 2377—First grade Tennis Racket, second growth ash, walnut and maple throat, very good grade of gut; handle of cedar with leather cap; a $3.25 grade; each $1.85.

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SEND for circular. 12 in. Semi-quick Change Gear, Screw Cutting Lathe. Compound Rest, Power Cross Feed, Complete $200. Western Machinery Co., Cincinnati, Ohio.

CASTINGS for "Machine-shop" Bench Lathe, 6 in. swing C. to C. Complete set only, $7. Louis E. Schwab, 3708 Brooklyn, Cleveland, Ohio.

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STAMPS—75, all different, free. Postage, 2c. Mention paper. Quaker Stamp Co., Toledo, Ohio.

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SEEING WIRELESS SIGNALS

SEE PAGE 442

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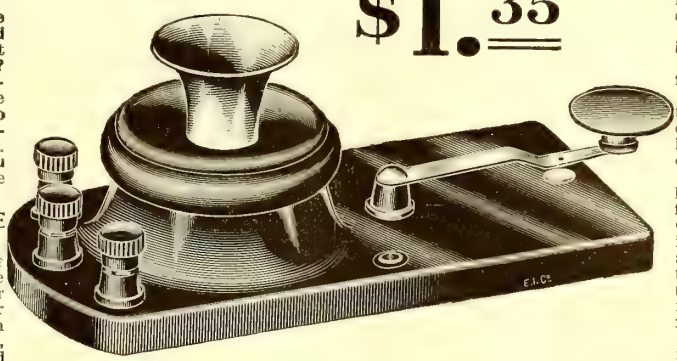
The "Electro" Codophone

(Patents Pending)

Now that we are for the time being, deprived of using our Radio outfits, it behooves us as good Americans to become proficient in learning the Wireless as well as Telegraph Codes. Operators who know the Code are, and will be, in ever rising demand. The Army and Navy need thousands of operators right now.

So far the Government has not been able to obtain any way near all the operators it requires. Not alone does the Federal Government call for thousands and thousands of operators for the army and navy, but nearly all of our many states require operators for the militia. Here is the great opportunity of a life time for you.

Would you rather fight in the trenches, or punch the key behind the lines? Either way you benefit your country. **Which do you prefer?** And it is SO easy to become an operator. You do not necessarily require a teacher, nor do you have to go to a school to learn. 30 days of intelligent study will make you proficient. **Can you qualify** NOW? **Are you proficient?** Can you send and receive when your country calls you?



$1.35

THE "ELECTRO" CODOPHONE

(Patents Pending)

which we present herewith is the outcome of several months of intense study and experimentation of our Mr. H. Gernsback. It supersedes our former Radiotone Codegraph, which comprised a **Radiotone silent Buzzer, a loud talking telephone receiver** and **a key.** As in all of his work Mr. Gernsback strives for simplicity. So he combined the three above mentioned instruments with one stroke into **ONE** single instrument. He combined the Radiotone Buzzer and the loud talking receiver into a single unit, not only mechanically, **but electrically as well.** This involves **an entirely new principle,** never before attempted, and on which basic patents are now pending.

What this remarkable instrument is and does.

The "Electro" **Codophone** is positively the only instrument made that will imitate a 500 cycle note exactly as heard in a Wireless receiver, so closely and so wonderfully clear, that Radio operators gasp in astonishment when they first hear it. And you need no receivers over the ears to hear the imitation singing spark, which sounds for all the world like a high-pitched distant powerful Radio Station. No, the loud-talking receiver equipped with a horn, talks so loud that **you can hear the sound all over the room,** even if there is a lot of other noise.

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FURTHERMORE, this jack-of-all-trades marvel, can be changed instantly into our famous silent Radiotone test buzzer, simply by replacing the metal diaphragm with a felt disc, **which we furnish with every instrument.**

FOR INTERCOMMUNICATION. Using two dry cells for each instrument, two **Codophones** when connected with one wire and return ground, can be used for intercommunication between two houses one-half mile apart. Any one station can call the other, no switches, no other appliances required. No call bell either, the loud-talking phone takes care of this.

AS AN ARMY TYPE BUZZER. Last, but not least, **two Codophones** with two 75 ohm receivers can be used to converse **over miles** of fine (No. 36 B & S Wire), so fine that no one can see the wire. Or you can use a long metallic fence and the ground, or you can communicate **over your 110 volt line up to several miles, using no wires, only the ground.**

Full directions how to do all this furnished with each instrument.

One outfit alone replaces the old-fashioned learner's telegraph set, consisting of key and sounder, which is all right to learn the telegraph code but not the wireless codes.

The "Electro" **Codophone** is a handsome, well made instrument, fool proof, and built for hard work. Contacts are of hard silver ⅛ inch in diameter, that will outlast the instrument. Housing is of metal throughout, horn and key lever nickel plated and buffed. Three new style metal binding posts are furnished.

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Sizes: 6¾ x 3 x 2⅝". Shipping weight, 4 lbs. **$1.35**

The "Electro" Codophone as described, complete

Money refunded if instrument is not as represented or does not come up fully to expectation.

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The "Electro" Radiotone

HIGH FREQUENCY SILENT TEST BUZZER

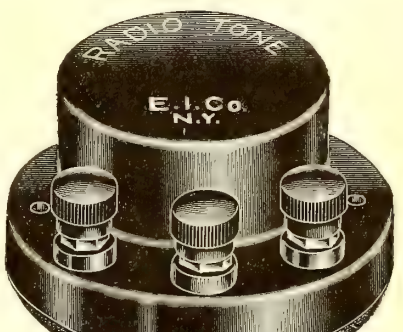
The RADIOTONE is NOT a mere test buzzer, it is infinitely more. Mr. H. Gernsback who designed this instrument labored incessantly to produce an instrument which would imitate the sound of a high power Wireless station as heard in a set of phones. This actually has been achieved in the RADIOTONE. This instrument gives a wonderful high pitched MUSICAL NOTE in the receivers, impossible to obtain with the ordinary test buzzer. The RADIOTONE is built along entirely new lines; it is NOT an ordinary buzzer, reconstructed in some manner. The RADIOTONE has a single fine steel reed vibrating at a remarkably high speed, adjusted to its most efficient frequency at the factory. Hard silver contacts are used to make the instrument last practically forever.

Yes, the RADIOTONE is **SILENT.** In fact, it is so silent that you must place your ear on top of it to hear its beautiful musical note.

You will be astounded at the wonderfully clear, 500 cycle note, sounding sharply in your receivers, when operated on one dry cell. **To learn the codes, there is absolutely nothing like it.** With the radiotone, a key and one dry cell and ANY telephone, a fine learner's set is had. Two or more such sets in series will afford no end of pleasure for intercommunication work. Particularly now that we cannot use our Wireless sets, the **Radiotone** is already in wonderful demand. All the interesting things as described with our **CODOPHONE** (see our ad above), can be performed with the **Radiotone,** a key, a dry cell and a phone.

Radiotone as described.....each **$.90**

IMMEDIATE SHIPMENTS



No. HK 1800

LABORATORY OUTFIT!



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1 **Glass Spirit Lamp.** Size 3½ inches by 2 inches. Uses wood alcohol and is invaluable to the experimenter. Besides being used to heat test-tubes contents as per illustration, it can be used to bend glass rods and tubings, to solder wire, etc.

1 **Glass Filter Funnel.** This funnel is made of heavy glass that will not break easily. It fits accurately in the hole on top of the Filter stand and is provided with a thick rim on the outlet, so that a rubber hose can be attached to it, without slipping off.

1 **Glass Rod,** to be used in stirring and mixing.

10 **Test Tubes,** made from the best imported glass. A new feature of some of the test tubes is that they have a flat bottom and therefore can be placed on any table if desired, needing no special stand.

1 **Roll of Copper Clad Steel Wire.** This wire is to be used to make a number of useful articles as shown in the illustration, such as test-tube holders, tripods to support retorts, etc. We furnish a blue print with the outfit, showing how to make all these wire articles.

Now this whole outfit as described costs you only **$1.25**

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Order one today, even if you don't need it now.

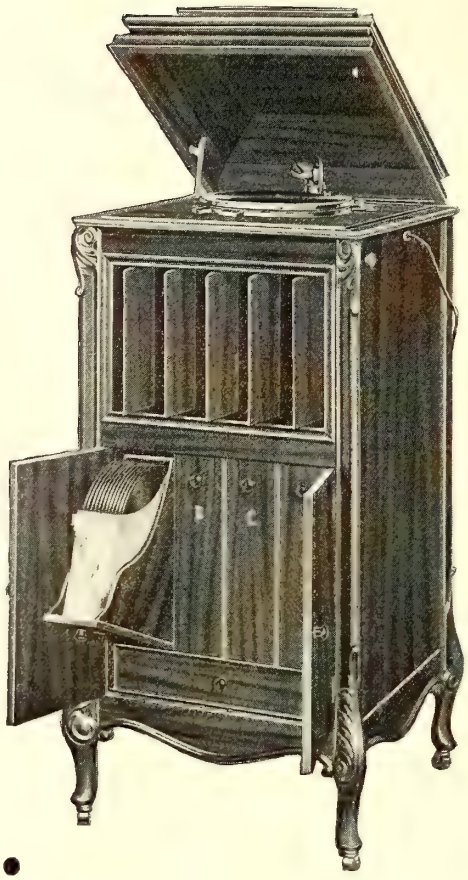
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Imagination Versus Facts

AS is well known, the ELECTRICAL EXPERIMENTER ever since its inception has been heavily indebted to Dame Imagination. Imagination makes the world go round—imagination means progress.

Sometimes we have been lauded for exploiting imagination, more often we have been criticised severely. Harsh things have not infrequently been said about our wholly imaginary writings and essays, and we will probably be thus criticised indefinitely.

We certainly lay no claim to the fact that our imaginary writings always turn out to be correct in the end, but we point with pardonable pride to the fact, that often our supposedly "pipe dreams" come true. Here is a recent, as well as concrete example:

In the early summer of 1915 while the German owners of the Sayville Wireless Station were still operating the latter unmolested, it occurred to us that "all was not well" with that particular station. Certain prominent amateurs mentioned the fact that "irregular" messages were being sent over Sayville. Then early in July 1915 our Government took over the Sayville Radio Station, but the German owners still remained on the grounds.

This partly prompted our editorial entitled *"Sayville"* in our August 1915 issue, in which we desired to convey the idea that even with our Government officials in charge, unneutral messages could still be sent out over Sayville.

This editorial at once brought a violent letter of protest from Dr. K. G. Frank, the then executive head of the Sayville Radio Station. Dr. Frank strenuously denied that Sayville was sending out unneutral messages, and closed his letter by strongly abusing this journal. In our reply (see our October 1915 issue for entire correspondence) we firmly voiced our former opinion that Sayville was indeed sending out such unneutral messages, and we then cited facts. Before proceeding we might mention that Dr. Frank has since been interned by this Government for the duration of the war.

But that unneutral messages actually were being sent out as late as 1916 and perhaps later came as a surprise even to us. Remember our own Government operators were in charge, but the wily Germans did just what we suspected them of having been doing right straight along.

We give below in one column an extract from our August 1915 editorial—an admittedly wholly imaginary case;—in the other column are shown the actual facts as recently disclosed by our State Department. This latter radio message was sent in April 1916 over Sayville, and was in connection with the famous Roger Casement affair. That the imaginary as well as the real message should both be addrest to bankers is rather startling, to say the least.

EXTRACT FROM OUR EDITORIAL, AUGUST 1915.

"Let us imagine the following: A German spy is located on the ocean liner *Adriatic* headed for Liverpool. When two days out the spy learns that the ship, on account of submarine danger, will not dock at Liverpool but at Greenock (Scotland) instead. He then sends a wireless to a stockbroker in New York as follows:

H. P. Frye & Co.,
Wall Street, New York.
Sell at once 2,000 shares U. S. Steel at 58.
John Miller.

When Frye & Co. receive the message they consult their code book and find that it reads thus:

"Adriatic will dock at Greenock."

Frye & Co., then sends this Radio via Sayville:

F. S. Schneider & Co.,
Friedrichstrasse, Berlin.
"Cannot dispose 2,000 shares shares U. S. Steel at 58.
Are bid 55½. Advise."
Frye & Co.

The message is promptly received by the German commander of submarine U-69 not far from the south coast of Ireland.

He reads the harmless message thus:

"Adriatic will dock at Greenock next Tuesday."

With this intelligence the German submarine commander is enabled to change his course in order to successfully hunt his quarry.

This is only one of the ways how the wireless stations at Sayville and Tuckerton can be used successfully to violate our neutrality; there are undoubtedly scores more."

DISCLOSURE BY OUR STATE DEPARTMENT, SEPTEMBER 1917.

"Along the same line is a code message by wireless to Banker Max Moebius, Oberwallstrasse, Berlin, which is interesting chiefly as showing the code method of important communications practised by the German Official plotters in this country. The code translation was found with the copy of the message among von Igel's papers. The original is a German dispatch which being translated into English, sounds like an innocent business transaction viz.:

National Germania Insurance Contract certainly promised. Executor is evidently satisfied with proposition. Necessary steps have been taken.
Henry Neuman.

Not so innocent and harmless as it looks, for what the message really means is this:

"Irish agree to proposition. The necessary steps have been taken."

Truth, indeed, is stranger than fiction, and imagination is often improved upon.

H. GERNSBACK.

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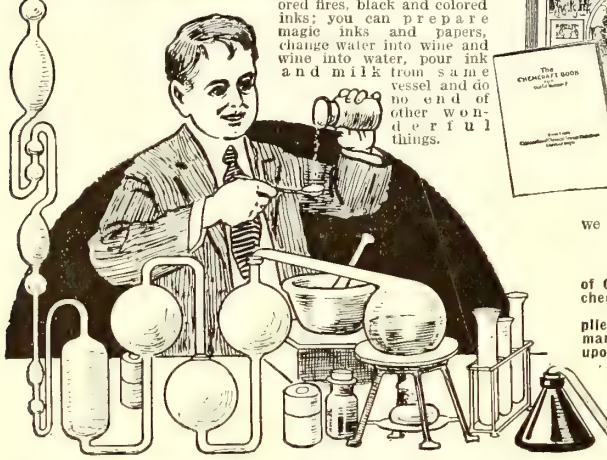
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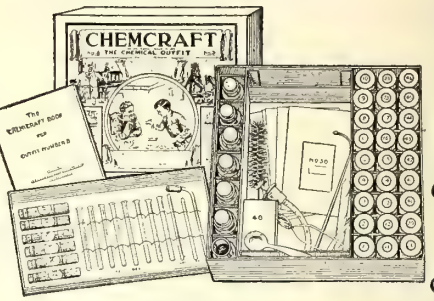
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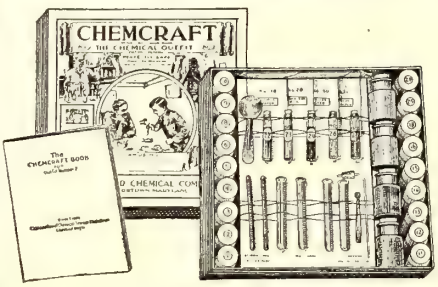


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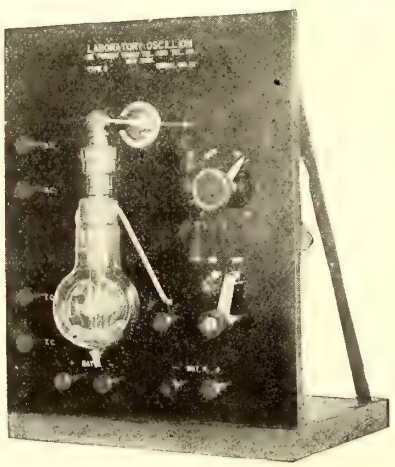
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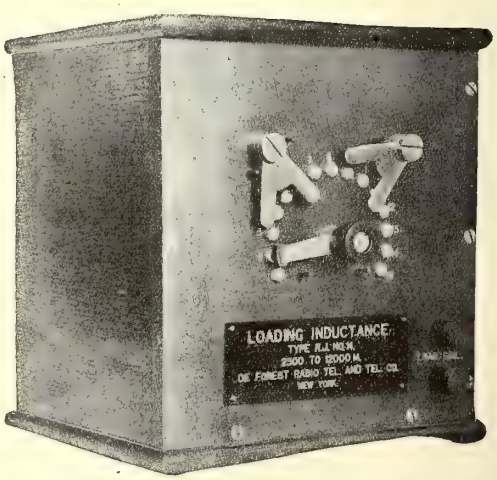
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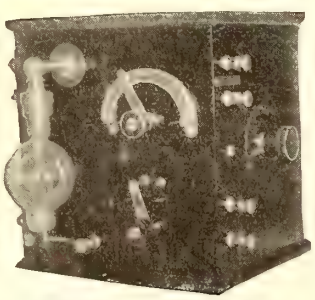
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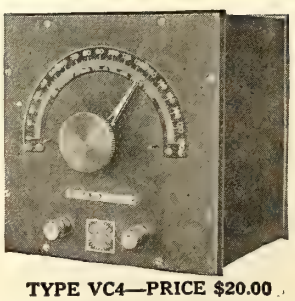


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THE ELECTRICAL EXPERIMENTER

H. GERNSBACK EDITOR
H. W. SECOR ASSOCIATE EDITOR

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Telegraph and Telephone on European Battlefields

IN no war in the past have the electric signaling systems covered so many square miles or such a great diversity of requirements. The commanding general wants to know how a certain division is progressing; an artillery captain wants to ascertain just where his shells are dropping; these and a million other facts must be transmitted every hour of the day along the hundreds of miles of battle-front. And it is really marvelous how the army signal corps have perfected their frail looking wires and instruments, so that they will work under the most unfavorable conditions. Romance, adventure, action—all of these come to the Signal Corps man in the pursuit of his duties more than ever before. To-day he may install a telephone switchboard in a cheerful little town near grand headquarters, situated a dozen miles back of the battle-front. To-morrow he may be stringing wires thru a shell-swept forest. One case which is on record will serve to show the lottery-like chance these men take. An English military lineman had been busy for several weeks in a district near the Aisne battle-front. He had about completed straightening out a perfect jungle of wires and circuits. His captain came along and was pleased to learn that all of the circuits had been tested out without losing a man. The same captain was grieved to hear the next day that this brave lineman, his work done, had been picked out of a pole-top by a stray shell.

At the beginning of the war there were certain dangers connected with telephonic communication, for our foes were not slow to try to catch our communications, and their engineers were soon busily engaged establishing delicate microphones near our telephone lines, so as to intercept messages and learn of our projected actions, says Isidore Recoulier, commander of a section



A Birdseye View of a Modern Battle-field With the Various Telegraph and Telephone Lines Linking the Advanced Trenches With the Artillery in the Rear, Also Enabling the Post Commanders to Communicate at Once With Any Section of Trench Line for Combined Assaults. Note the Large Number of Shell Craters, Reproduced from Actual Photograph.

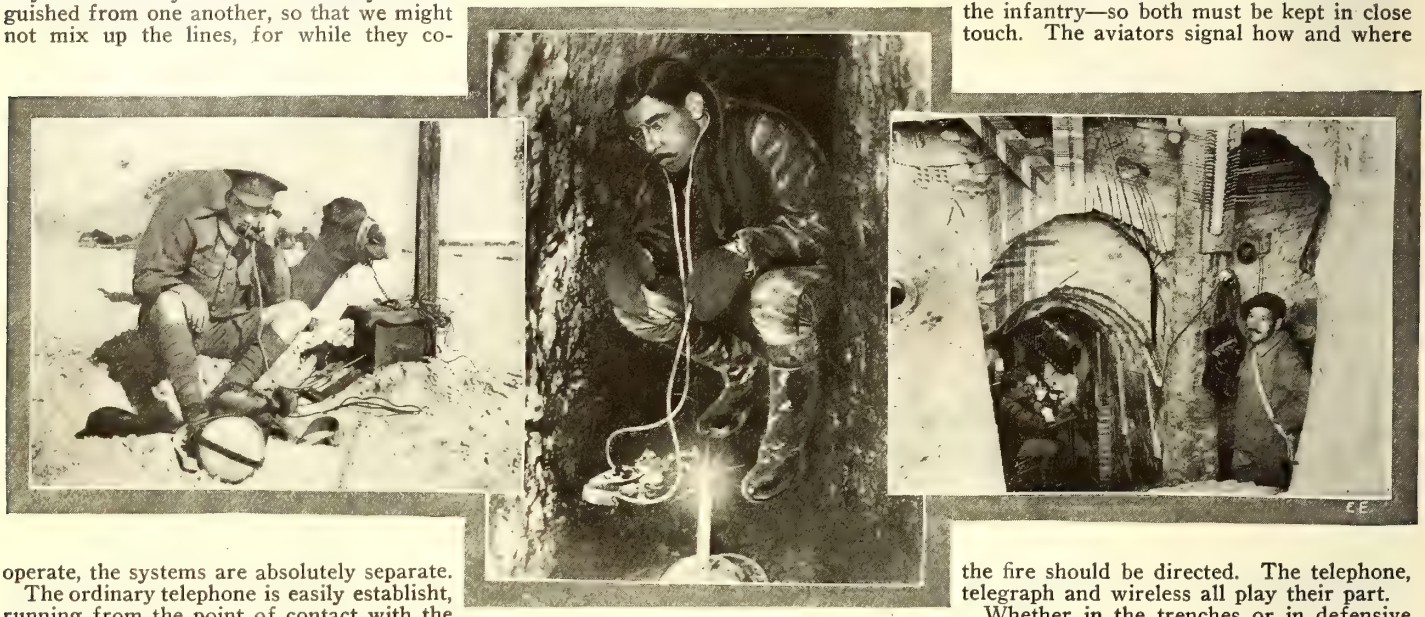
of French sapper telegraphers. We soon learned of this and have now apparatus by which any such "cutins" or listening is practically impossible, for great advances have been made in the arts of telephony since the beginning of the war.

We have had to develop a system by which the telephone wires used by the artillery and infantry could be instantly distinguished from one another, so that we might not mix up the lines, for while they co-operate, the systems are absolutely separate.

The ordinary telephone is easily establisht, running from the point of contact with the enemy to the chief of that sector, and from the sector itself to the commander. When these wires were so simply laid as at first it was easy for the enemy to "listen in," but now the current is returned by special conductors, and the use of spy microphones is almost impossible. The artillery has its telephone system, independent of the other lines, but connecting with the headquarters of attacking and defensive troops. A line is run on the front, in any way that the ground will permit, and kept in order at any risk. Often when the bombardment is heaviest, one of these wires is broken and must be repaired, while shot and shell burst among the engineers. When an attack is in progress the telephone engineers follow the line closely, installing new stations at the first possible moment, so as to keep in touch with the rear and the centre of command. If driven back, this corps has to pick up all material so that it will not fall into the hands of the enemy.

After the cannon, whose fire has been directed by aviators and captive balloons via radio, have smashed the trenches of the enemy, and they extend their fire, the infantry attack begins and, bayonets couched, the men advance. The various units follow each other in obedience to orders from their leaders. These orders are long since decided upon, and in the midst of this tumult all is directed by a general plan. Meanwhile, further to the rear, the generalissimo, the general commanders, the chiefs of the army corps, of divisions and brigades, with detail maps spread out before them, follow the movements and give their orders. All of this has to be done along the wires of the telephone.

The generalissimo is stationed in a house where many lines meet, so that he can be in constant communication with all the rear and the advance. Every chief of service in turn, as well as every commander of a unit, of one or more lines, is ready with a report, awaiting orders. The development of the telephonic communication between headquarters and all parts of the forces has been so perfected that it works without delay. Each army is connected with General Headquarters by a line at the end of which an officer receives all useful information, making it possible for him to follow the least movement of his troops. Near this officer another insures his connection with the aides of the generalissimo, especially charged with conveying orders from the chief of the army. These orders are called "Directives."



Photos from Central News Photo Service

Left.—A Photo From the Egyptian Battle-Front. Advanced English Artilleryman Telephoning Warning of Enemy Aircraft Approaching. Note the Camel.

Center.—A French Officer of Engineers In a Mine Gallery, with Newly Invented Microphone, Detecting the Sounds of German Counter Mining Operations. Men Who Do This Work Are Called "Listeners." Listening Is a Very Delicate Operation. It Consists of Detecting the Direction, Height, and Distance of the Sounds Heard. To Obtain Greater Clearness, Drums Are Used as Well as Special Microphones. As Soon as a Prolonged Silence on the Part of the Enemy Is Noticed After a Period of Rather Hard Work, the Conclusion Is That a Chamber Is Being Loaded, and at Once You Charge Your Own Mine. The Loading of the Mine-Chamber Is Followed by the Operations of Connecting the Fuse and Tamping. The Latter Consists of Blocking Up the Mine-Chamber with Bags of Earth or Sand, so as to Direct the Force of the Explosion Towards the Enemy.

Right.—A Central Telephone Station in the French Trenches at the Aisne.

In its turn the general quarters of an army is connected with general headquarters from which it receives orders and to which reports of each phase of action must speed. Moreover, it is in close communication with neighboring armies as well as with the army corps under its direction.

Each army corps is itself connected with the army of which it is a part, and as follows: From the army corps to division, to the brigade, to regiments, to the trenches as far as the first line and outposts.

This primary circuit allows the sending of orders and knowledge as to how they are carried out.

The telephonic circuits of the artillery are much more complicated. It plays the same part as the former for batteries and groups; but more than this, it serves for reporting on location of objectives and directing the fire. It has to insure the cooperation of the various groups of artillery with one another, and the connection of these groups with the wireless headquarters, which are in direct connection with observers on aeroplanes and captive balloons, as well as with posts of observation on the ground.

It must not be forgotten that the artillery works by concentration of fire. The artillery must prepare the way by battering down forts or trenches for the advance of the infantry—so both must be kept in close touch. The aviators signal how and where the fire should be directed. The telephone, telegraph and wireless all play their part.

Whether in the trenches or in defensive operations the telephone has a great immediate value, and even in advance movements, whenever a halt takes place the very first duty of the engineering corps (telegraphic division), is to establish communication by telephone with the rear. The military telephone is quite different from the regular machine. It consists in its simplest form of a "combination" (microphone and telephonic ear-piece, joined by a hard rubber handle, etc), the branch-box, induction coil box and battery for producing the current. In setting the wires care is taken to prevent "grounding," isolating the wires as carefully as possible. Usually the line is laid by four men; an unroller (of the wire), an assistant, a mounter and assistant. The unroller carries the wire on a bobbin in his left hand, playing the wire out slowly. His assistant keeps the wire straight. The mounter attaches the wire to the point of departure, his assistant hands him the wire as needed, who lays it upon its supports as he advances. When he reaches the end of a piece of cable he tests his connection carefully to the point of departure. He marks by a pebble or bit of paper the point where he has connected each 500 yard cable, in case of breaks. He locates his stations in the safest possible places, out of view of the enemy, or protected as much as possible. If an advanced position must be abandoned, the corps in charge of the laying work takes up the wires as rapidly as possible, removing all memoranda from the station, and beat a retreat with the line.

Wireless has proved of great value for aviators to convey their information to their forces, and only within the last year and a half has the method of communication been perfected. For obvious reasons the construction of the antennae and other parts cannot be described. Suffice it to say that methods of communication between the aeroplanes and the ground have been devised, and they are of such kind that the enemy cannot intercept the messages. The captive balloons use a telephone wire which unrolls as the balloon ascends. Batteries alone are possible in campaign telephony, and special batteries have been devised which are both light and powerful.

Electricity Being Used to Hasten Crops

EXPERIMENTS on a large scale with the use of electricity to stimulate the growing of crops are among the English government's latest efforts to increase the country's home food production. The department of agriculture has taken over a large area near Hereford, where installations have already been set up for the use of ionized agricultural experts under Prof. W. H. Blackman of the Imperial College of Science and Technology who will supervise the experiments.

In the Hereford experiment high tension alternating current is to be used. Spring wheat, barley, oats and clover will be dealt with, and fertilizers of various types will also be used in these experiments.

The method adopted is to stretch over the field to be treated a number of thin wires on poles, something like low telegraph wires, but high enough for loaded wagons to pass underneath. The wires are supported by high tension insulators on posts in long parallel spans thirty feet apart.

"The charge fizzes off from the wires," says one account, "with a sound which is sometimes audible, and with a glow which is visible in the dark. Anyone walking about below the wires can sometimes feel the effect on the hair of the head, as a cobweb on the face. The electricity does not act as a fertilizer but as a substitute for sunlight. The current is only used in the early morning and in cloudy weather." The initial cost of the apparatus for twenty-four acres is about $1,500, and the animal cost, including depreciation and labor, is about $300, which is not so very high.

The present method of overhead discharge from wires stretched over the crops was introduced into England twenty years ago by Professor Lemstrom of Helsingfors, whose book, "Electricity in Agriculture and Horticulture," anyone interested in the subject should consult. The method was modified by Mr. J. E. Newman, in conjunction with Sir Oliver Lodge. These and others formed themselves into the Agricultural Electric Discharge Company, which disposed of a large number of installations both in England and abroad.

Very contradictory results were obtained by the various users of the Lodge-Newman apparatus, and the subject lost much prestige. The results of the company's own experiments with wheat in over a series of years were reported as an increase varying from 0 per cent to 39 per cent. The next phase in the development of electroculture opened in 1911. The British Board of Agriculture gave a grant to Professor Priestley of Leeds for a scientific investigation of these new methods and their value. Professor Priestley collaborated with Mr. I. Jorgensen, an electrical expert and plant physiologist, and with Miss E. C. Dudgeon of Dumfries. In the result it appeared that many technical difficulties existed. At first no favorable results were obtained, but in the last two years, with improved methods, increases of 50 per cent over the ordinary crop have been recorded with oats on Miss Dudgeon's land.

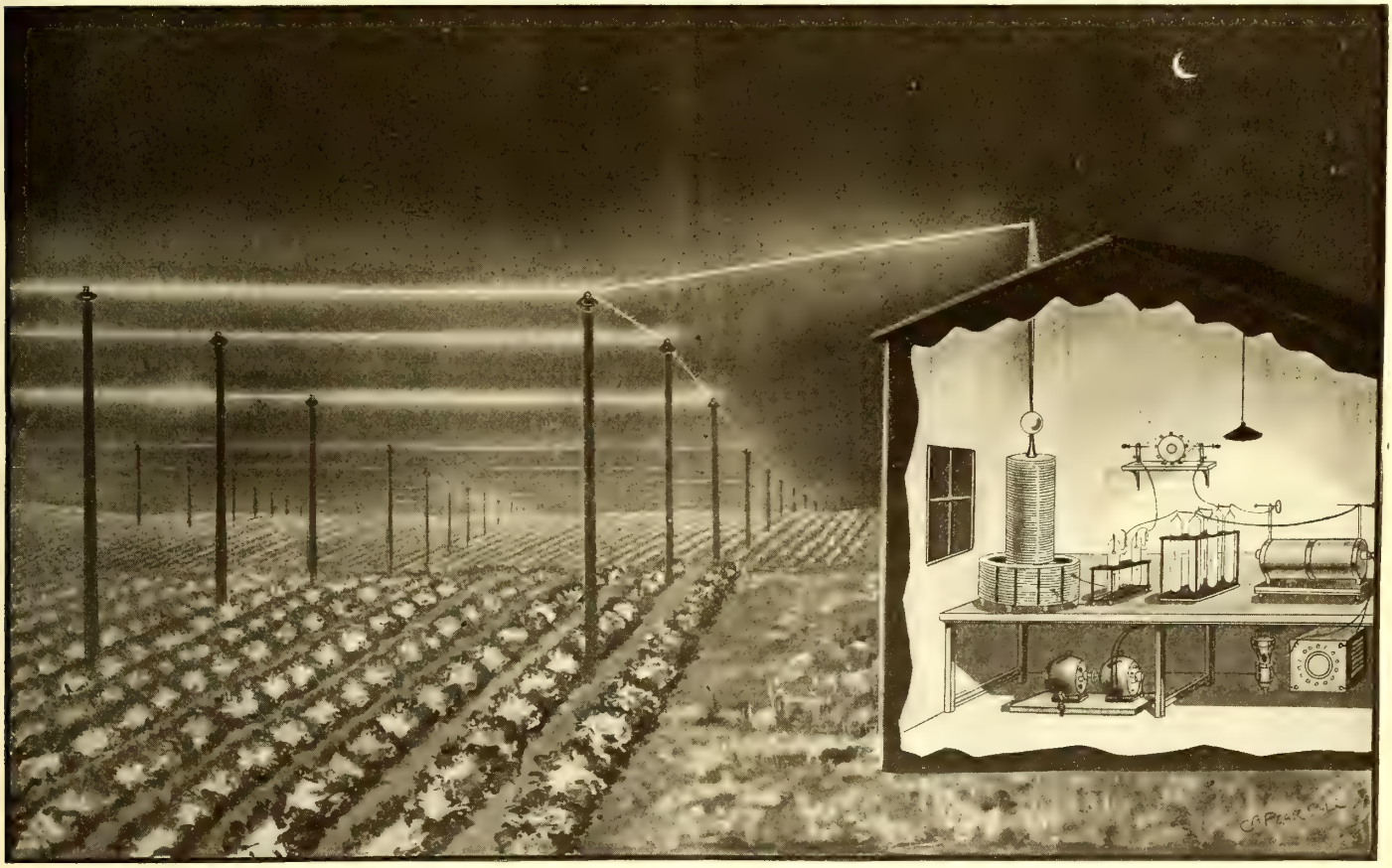
A very complete installation has recently been connected up in the extensive vegetable gardens owned by Sir Thomas E. Roberts, near Carnarvon in Wales.

The engineers of the Carnarvon plant are convinced of several important features which have not been previously noted. They are emphatically of opinion that the ionization of atmosphere is but of secondary importance, though attention is being particularly paid to the influence of prevailing winds to widen the area of influence. They maintain the main effect of the discharge is noticeable on the soil, and that soils heavily manured are more effectively benefited by reason of the latent humidity. The active result upon the soil is apparently due to the release and nitrification essential to the well-being of plant life.

The dark green foliage and the building-up of new tissue is evident proof of the greater vigor and increased growth of the plant. Furthermore, confirmation is provided of the fact that sunlight is detrimental for the discharge to be in operation at the same time (more successful working is obtained at sunrise and sunset); a time-switch can be automatically arranged to switch the current on and off at these times.

This fact also emphasizes the approximate degree of humidity necessary for the success of the discharge, as the amount of dew or latent humidity prevalent at these periods are more or less helpful. Whereas, in heavy rain the discharge is inclined to run to waste, owing to insulation troubles. It must be borne in mind that the intensified and rectified voltage of 75,000 volts to 100,000 volts has to be dealt with in a very different manner to the ordinary electric light voltage, and the methods of control

(*Continued on page* 493)



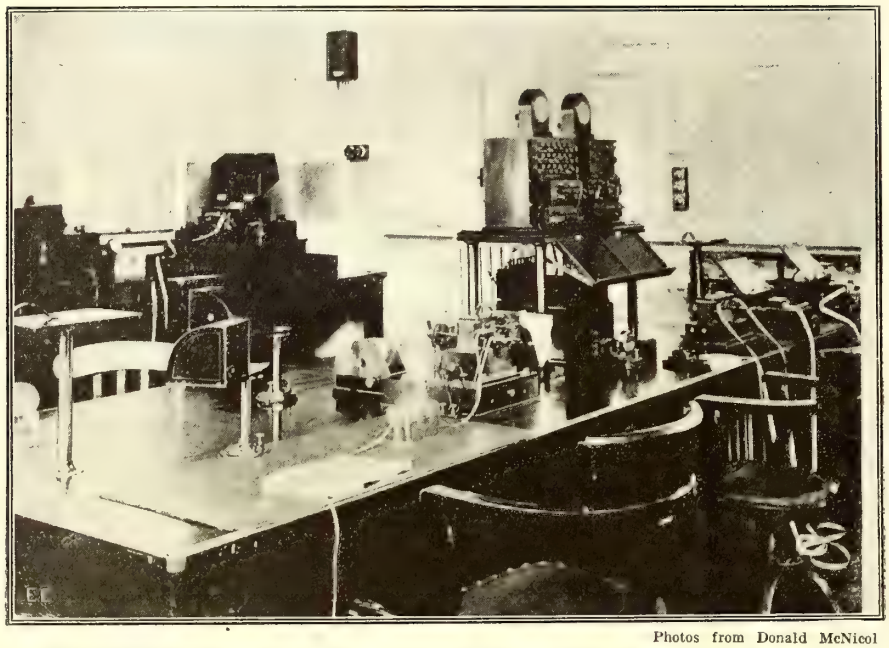
NIGHT-SCENE OF AN ENGLISH HIGH FREQUENCY PLANT GROWER.

In England, More Than In the United States, the Stimulating Effect of a High Tension, High Frequency Discharge on the Growth of Plants, Particularly Vegetables, Is Being Carefully and Extensively Tested Out. Standard High Voltage Electric Generators for This Purpose Are Available on the English Market.

Are Cable Messages Safe?

THE great activity of the Kaiser's sub-sea fighters have led many people to ask the question—"what of our ocean cables?" One of the leading cable experts in this country recently answered this question by saying—"Well, let the Huns cut the cables; what of it? In 48 hours the cable companies would have a fleet of repair boats on the spot splicing the cables, suitably convoyed by naval vessels and this would hold good for either European or American coasts."

People in general are quite unfamiliar with the ocean cable and its maintenance, especially during war times. At present, and in fact since the United States declared war against Germany, the cable companies have taken proper steps to have all land lines closely guarded night and day. A fleet of cable repair ships carrying expert repairmen and engineers are always waiting to dart here and there, as soon as they receive the news that a cable has gone bad or been cut. If the cable ship has only to make repairs along the shore or a short distance out, no naval convoy is required. However, if the cable ship has to proceed to sea, then a naval escort is furnished as a hostile submarine would be an unwelcome visitor, besides causing the cable ship to drop the cable ends, which it possibly had picked up after a long hunt, in its effort to out-run the U-boat. Altho not public knowledge, one of the leading cable companies has lost one of its best cable repair and supply ships, it having been torpedoed in the Mediterranean. The crew was saved, luckily, as the ship was not far from shore.



Photos from Donald McNicol

Fig. 1. What the Interior of a Modern Ocean Cable Office Looks Like. This is the Trans-Atlantic Cable Office at Penzance, England, the No. 1 London Wire, Duplexed, and Creed Automatic Cable Instruments Being Shown.

The accompanying picture, Fig. 1, shows an interior view of the Trans-Atlantic cable station at Penzance, England. The apparatus on one of the circuits extending to London, England, is shown on the table, to the right. The wire is *duplexed*, (*i.e.*, two different messages are sent over the cable at the same time), and is operated in the same manner as the longer Trans-Atlantic sections. In the back-ground is shown a set of "Creed" automatic cable instruments.

The second picture, Fig. 2, shows one corner of the operating room of the Trans-Atlantic cable office at Penzance, England. The two instruments on the right are "Creed" automatic transmitters. As the perforated paper tape passes thru the transmitters, it falls into baskets as shown. Just to the left of the second instrument from the left of the picture, may be seen one of the double-lever hand keys used by cable operators.

The maintenance of ocean cables is one of the most interesting studies. A peculiar fact in this direction is that of the 18 Trans-Atlantic cables now in service there are always two out of order; not the same two of course, but two out of the total number. Thus the cable ships always find something to do, in both winter and summer.

There are now 18 ocean cables linking America with Europe. The cable terminals are practically all under military guard and even the officers of the cable companies are not allowed near the cable land lines or terminal buildings, unless on special business and then only when accompanied by a military guard.

OBSERVATIONS OF ATMOSPHERIC ELECTRICITY AND OCEAN MAGNETIC WORK.

A series of volumes reprinted from the publications of the Carnegie Institute, Washington (U.S.A.), describe in detail the work undertaken by the "Galilee" (1907-8) and the "Carnegie" (1909-1916) in connection with electric and magnetic observations at sea. The three volumes before us deal respectively with ocean magnetic work and atmospheric electric observations, records of which are presented in a very complete and elaborate way. The accurate determination of the intensity of the earth's magnetic field at sea naturally offers special difficulties, such as do not occur in a well-equipt laboratory on land, and magnetic storms can also be reckoned with, altho their effect seems to have been relatively small and transient. In the earlier researches on the "Galilee" the observer had also to contend with the difficulty of a magnetic ship. The design and mounting of the various instruments are described in great detail, and this collection of data presented will no doubt constitute a valuable record.

SUBMARINES SEE WITHOUT PERISCOPES?

The *Revista Maritima* mentions that submarines are now being constructed without periscopes of the ordinary type. Instead of the usual vertical tube arrangement a system of two lenses, one on either side of the vessel, is being employed. It is claimed that this device is much less visible from a distance, altho it has the drawback that the vessel must navigate nearer to the surface. The device appears to be only in the experimental stage.

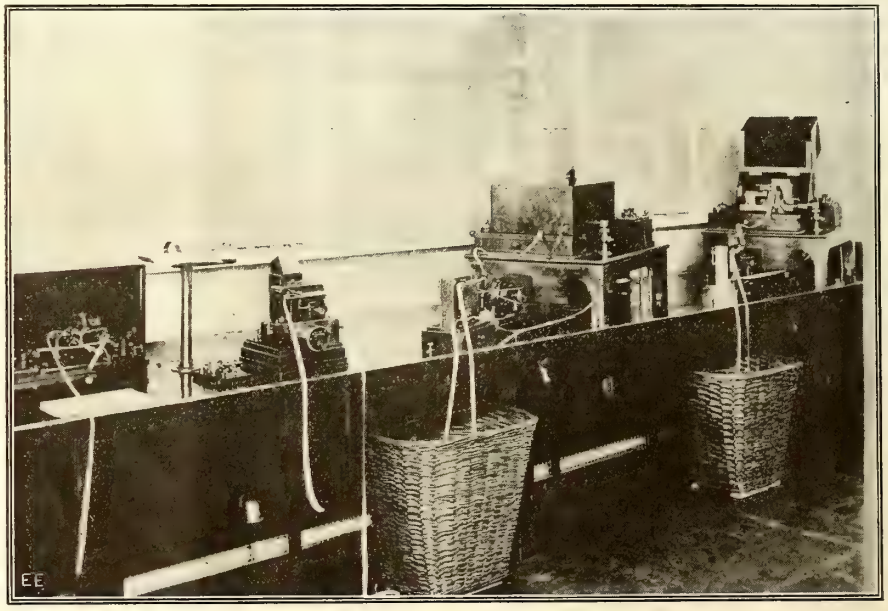


Fig. 2. This Picture Shows One Corner of the Operating Room of the Trans-Atlantic Cable Office at Penzance, England. The Perforated Paper Tape Passes Thru the Automatic Transmitters Which Send Out the Dots and Dashes Thru the Cables.

Locating Underground Ores by Electricity

THE basic problem to the mining industry is the finding of ore in paying quantities. This difficulty has produced many operators of the divining rod, and several other methods have been tried in the effort to determine the hidden ore conditions underground and avoid the expense of drilling or of sinking shafts in barren grounds. The whole subject is of great interest, and the possibilities are so vast that no one need be surprised at the large number of divining-rod operators or their varied methods of working. I have known some remarkable facts about divining rods, but the final results in every case have had no probability of development to a condition of certainty that would warrant a business investment, and almost every operator of a divining rod is afflicted with an over-developed imagination.

In an effort to reach the desired result of being able to determine the position of an orebody under the surface of the ground, the idea of exploring the ground magnetically was conceived, and during the last three years has been developed, first by laboratory work to establish a suitable method, and later by field work to apply the laboratory method to actual working conditions, says H. R. Conklin in *Engineering and Mining Journal*. Patents are pending for this method, which will be of interest in many fields of prospecting work.

If a high-frequency oscillating electric current, such as is used in wireless telegraphy, be confined to a closed circular circuit, a high-frequency oscillating magnetic field is induced within this circuit, and the arrangement becomes a solenoid of practically no length and of large diameter. Any electrical conductor that may be included in this induced magnetic field will have an oscillating current induced within it, and this induced current in turn induces a high-frequency oscillating magnetic field, which reacts on the original magnetic field, reducing its intensity.

The necessary conditions are that the ore or ores sought for shall be conductors of electricity, for the method described enables the location of an electrical conductor, and the fact that certain ores are such conductors makes their location possible. An ore that is not electrically conductive cannot be determined by this method. Native meals, most sulfids and chlorids, but very few carbonats, silicats or oxids are such conductors.

The progress of laboratory experiments was slow and tedious, and the difficulty of adapting these experiments to field work and designing the necessary instruments was even greater. The final satisfactory results are shown by reference to Fig. 1, in which 1 is an alternating-current generator or other source of alternating current, supplying the low-tension coil 4 of a transformer, through a regulating, inductive resistance 5. The high-tension transformer coil 8 is connected to a suitable spark gap *s* in parallel with condensers 9 and 10 and the primary coil 11.

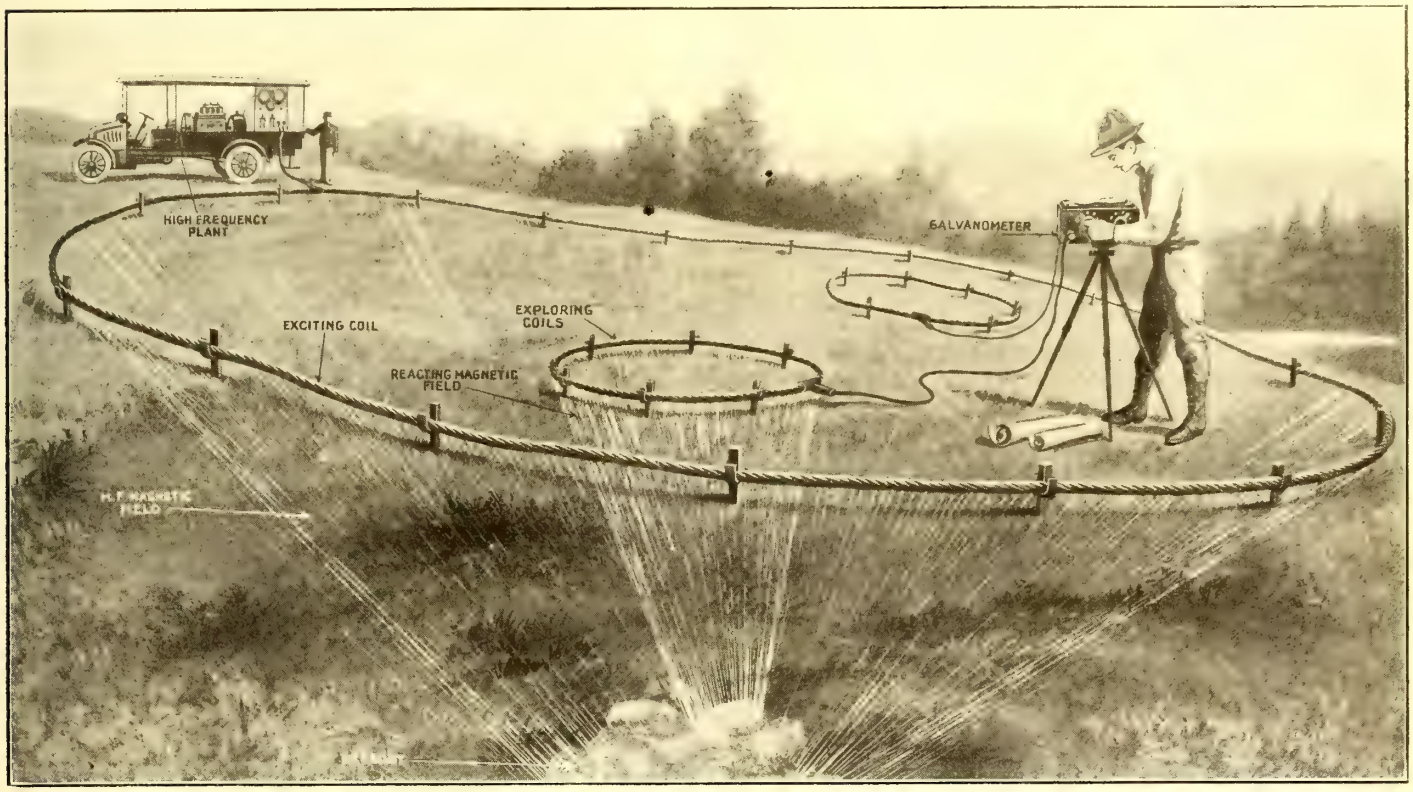
The primary coil 11 is laid in a circle on the surface of the ground, and within it is produced the oscillating magnetic field. This magnetic field decreases toward the center of the primary coil and might be plotted as shown in Fig. 2, in which the ordinates represent change in magnetic flux. Owing to unavoidable variations in the original source of power, these ordinates may vary during observations to an extent greater than their diminution due to the neighborhood of an electrical conductor, so that the measurement of this magnetic field requires a balanced method.

For measuring this magnetic field, two identical exploring coils 12 and 13 (Fig. 1), of suitable diameter and number of turns, are connected in series with two current rectifiers 16 and a sensitive galvanometer 17. By placing one of these exploring coils at a measured distance from the center of the primary coil and moving the other around the center, the induced currents in the exploring coils being opposed to each other, a line, along which the magnetic flux is equal, is established and may be plotted. The location of the movable exploring coil, when the galvanometer reading is a minimum, determines this line, which may be called an isogonic line and is similar to a contour line on a topographic map. In the latter comparison the completed plot of these lines suggests contour lines defining a depression, as shown in cross-section in Fig. 2. Now if the magnetic flux be decreased as at A in Fig. 2, due to the presence of a conductor of electricity, the contour lines are drawn out in the direction of the conductor, and the plotted curves are distorted from the normal circular form, enabling the location of the conductor to be determined.

Several sets of actual distorted contour lines, as determined in the field, are shown in Figs. 3 and 4. All were observed with the primary coil two hundred feet in diameter. One of these plots, in Fig. 4, shows the location of a 2-in. iron pipe line buried about a foot underground, and is also distorted by a body of conductor still deeper.

The primary coil is shifted and these contour lines plotted for a sufficient number of centers to determine the general size and dimensions of the body of conductor, after which prospect drilling is done to prove the depth, thickness and quality of the conducting orebody. If the conducting orebody be below and nearly symmetrical

(*Continued on page* 501)



The Latest Feat in Mining Engineering Is the Exact Location of Underground Metallic Ores by Means of Induction. The Larger Coil Is Excited by a High Frequency Current from a Portable Dynamo Outfit. The Magnetic Field Created Affects the Ore Body, Which Reacts on the Smaller Exploring Coils and Indicating Instruments.

Seeing Wireless Signals

OUR front cover illustration shows one of the latest wireless signaling devices perfected by Teutonic experts. With this device the reception of radio messages on a flying aeroplane is made much more positive, inasmuch as the noise from the engine or machine gun does not interfere in the least with it, as is the case where the aerial radio operator has to listen in a pair of sensitive head telephones.

We are indebted to William Dubelier, a radio-engineer of New York City, for the description and photograph of this remarkable instrument, who personally saw this apparatus in the Berliner factory at Vienna, Austria, and besides had the pleasure of observing signals being received from a distant station with it.

This apparatus consists of a sensitive Einthoven galvanometer with a small electric lamp shown at the very bottom of the photograph. The light from this lamp is focused thru lenses on to a small mirror, which in turn reflects the light thru a magnifying glass, the same as in an opera glass. The upper part thru which the observer looks is constructed on the prismatic binocular principle, making the sighting apparatus equivalent to six times its length.

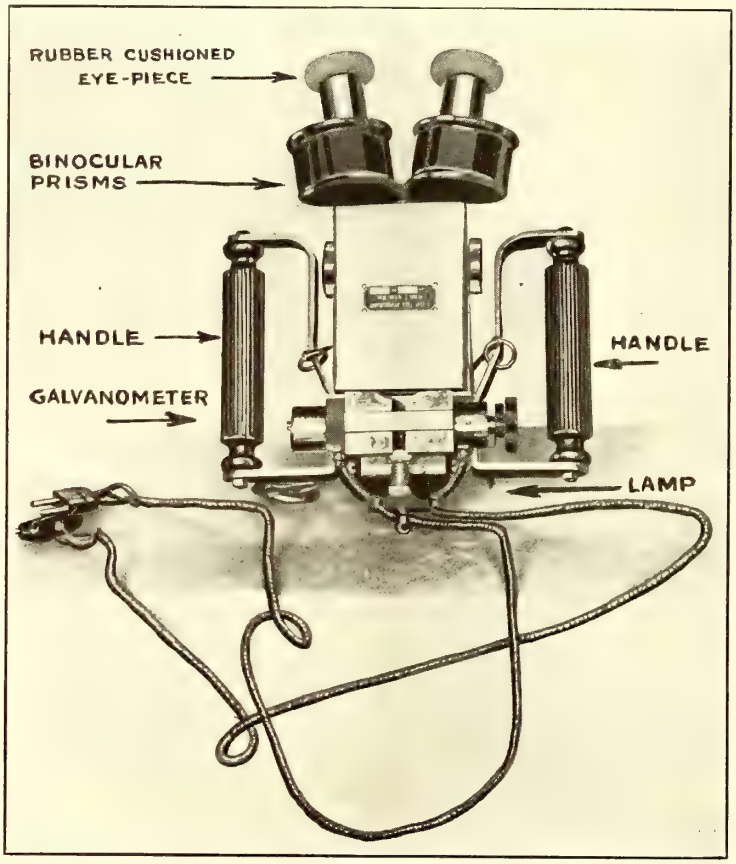
In other words, the observer does not actually see the wireless signal or wave literally speaking; he only sees the effect of the etheric wave, after it has impinged on the antenna attached to the aeroplane, and after it has past thru the tiny quartz fiber suspended between the poles of a strong magnet, and perpendicularly to the magnetic flux lines. If a weak current, such as a received radio signal current, passes thru this quartz fiber, the latter will be displaced from its normal position in a direction perpendicular to its axis and to the magnetic flux lines.

The fine galvanometer string moves in front of a narrow slot, illuminated by the small lamp fed from a battery (see illustration). An optical reproduction of the slit and wire is thrown on the sensitive retina and pupil of the eyes, one of the most sensitive devices we know of. As the messages come in, in the form of telegraphic dots and dashes—short and long signals—the quartz string is deflected back and forth correspondingly; thus the radio operator "sees" the incoming signals. A short deflection indicates a "dot," while a longer deflection represents a "dash."

The apparatus just described and here pictured serves the same function as the detector used in all radio receiving sets. It is usual therefore to connect it with some form of tuning coil or transformer, so that the outfit can be readily tuned to the proper wave length.

As the front cover illustration shows the operator holds the instrument with both hands, or only one hand, if he desires to write down the message received. This he can readily do with a little practise, keeping one eye on the instrument and the other on the message pad as he writes. A good operator can write down a message without looking at his pen or pencil. Besides, it is not impractical to install a light weight typewriter on the aeroplane; and "touch typists" never have to look at the keyboard. Radio and wire telegraphists are daily using the typewriter in just this way, by the thousand.

The principle of the optical and photographic reception of radio signals is not new. The efficacy of the Einthoven string galvanometer in this rôle was quite thoroly tested out by the Poulsen radio experts, both in this country and abroad. The American Poulsen interests—the Federal Telegraph Company of San Francisco—spent many thousands of dollars in their researches on this method of receiving radio signals, the only difference being that the movements of the quartz string were highly magnified and recorded photographically on a moving film. It is hopeful that this work may be taken up again and followed up to a successful conclusion. The United States needs the best it can get for every branch of its military service and it would seem that the apparatus here described and being successfully manufactured in Germany can certainly be duplicated, and no doubt considerably improved, in this nation of vast industrial and scientific resources.



Here is the Latest Teutonic War Device. It Permits the Radio Operator in a Flying Machine to "See" the Wireless Signals. Thus the Engine and Other Noises Do Not Bother Him in the Least.

ELECTRICITY AND WAR IN LAND OF THE "HEINIES."

The "Frankfurter Zeitung" announces that the German Government has requisitioned all electrical machinery and apparatus, and it is not now possible to buy or sell electric motors without special permission.

In an article in the "Cologne Gazette" on a visit to Kiel, where the dockyards are said to be mainly, but not entirely, engaged with repairing work, contains the following passage on copper and electricity:

"Copper is now used in large quantities in all ships, altho, of course, consumption is restricted as much as possible. Especially for steam piping there is no substitute for copper, and it is also needed for all purposes where high resistance to sea water and salt air is necessary.

"Over against the boiler shop is the electrical shop, which becomes every day more important with the increased use of electricity. We have already gone a long way in this direction, altho we have not yet gone quite so far as the Americans, who even drive the screw-shafts of large ships by electric motors. As regards our submarines, it is indeed much the same with us, for our submarines already consist half of electricity. The submarines are also concerned with the accumulator shop, where accumulators are repaired. Repair is not always possible, for the demands made on the accumulators in war are sometimes too great."

BOOKS FOR OUR SOLDIERS.

While furnishing books, magazines and other literature to these men,whom we are beginning to consider truly "our own," we should not forget that there are large forces in France with quite as keen a desire for American literature and with far less chance of having it satisfied. An appeal has just been issued calling attention to this need.

In New York City books may be put in packages marked for the "American Overseas Force" and left with any public library. They should be in fairly good condition. Magazines are wanted—and contributors are requested not to send periodicals more than two-years old.

The type of books our Sammies enjoy? Fiction first; then French grammars and dictionaries, first-year French books, volumes of travel, biography, history; books on aviation, wireless telegraphy, submarines, automobiles and mechanics.

Don't forget that there are men with the overseas forces who have been educated to a taste for the best of literature. "Sartor Resartus," or "God, the Invisible King," will be received as avidly as one of E. Philip Oppenheim's novels. There are men in the army with Harvard and Yale and Cornell educations—and with a corresponding literary appetite. And the army also includes men with little schooling. Consequently you have a broad and almost unlimited field for literary charity, and don't fail to read the notice on the front cover of this journal.

THE ELECTRIC TAXI.

For crowded traffic (ease of control), simplicity, ease of operating and freedom from engine troubles, the electric taxi is coming well into favor.

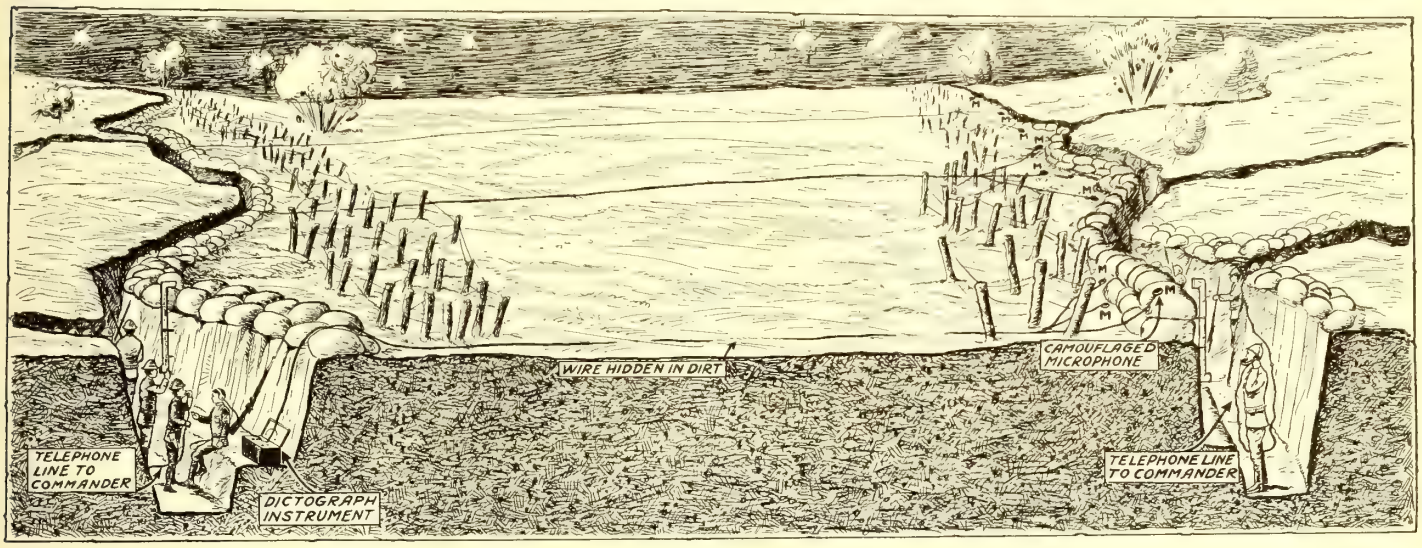
Microphones in Trench Warfare

By H. GERNSBACK

THERE is hardly a spot on earth today where modern science receives as many professional tryouts as in our war trenches. New methods, new schemes, new inventions are being tried out forever, and like many another game it settles down to a game of wits where that side having the most brains and the most ingenuity is likely to win out in the end.

be obtained by what is popularly called the *dictagraph*. But the question immediately comes up, how are the dictagraphs to be placed in the enemy's trenches? Of course, while it is rather a ticklish business, it is not impossible and our illustration shows how it could be readily accomplisht.

We first need our sensitive microphones will not be discovered. It should be remembered that grass or vegetation growing over the microphones as well as over the fine cable will practically conceal both entirely from view. The same is true of dust and sand, etc., which all aid in hiding the microphone. Naturally a microphone of this kind must be rugged and the arrangement should be such that no matter



Listening to the Doings in the Enemy's Trenches By Means of Supersensitive Microphones Is a Recent Idea. It Shows a New Way How to Get Advance Information, as, for Instance, Just When the Enemy Intends to Attack, Etc., Etc.

When two forces are deadlocked against each other and when it becomes practically impossible to pass over the intervening "No Man's Land" with assailing forces, it is of primary importance to know what is going on in the other fellow's trenches. It being impossible to raise the head above the parapet due to continuous bullet streams, the men in the trenches are more or less on edge continuously, as they do not know what is going to happen next. Consequently most of the reconnoitering is done during the night, and to counteract this the enemy uses the so-called *star-shells* which illuminate the landscape for miles around for a period of a few seconds. During this time there is always an opportunity to catch advancing forces or patrols and thus annihilate them.

The thing that a commander is most interested in, is to know just when the enemy is going to leave his trenches to make an attack. If he could know exactly at what time such an attack is to be made, this information would often be of priceless value. Of course, it goes without saying that the enemy is not likely to give away such information if he can help it. Advance posts in advanced trenches, called in field parlance "listening posts," are of course quite satisfactory, but they do not get advance information, and they are simply there to stop an advancing force or to tell the men behind the lines as soon as the attack has started. This listening post is usually a shell hole somewhere between the trenches in "No Man's Land" well fortified with sand bags, and well in advance of the front trenches. It is usually manned by two men, and a machine gun or sometimes rifles only. It has occurred to us that advance information could readily

properly camouflaged so they will have a rather innocent appearance. In other words, they could be made up as cobblestones, pieces of log, or any other object that would not arouse the suspicion of the enemy. It would then be the duty of some of the men to take these thus camouflaged sensitive microphones up to the very edge of the enemy's trench, concealing the microphones behind his parapet and sand bags.

Needless to say in doing so, it is necessary for the party who lays the microphones to clear the barbed wire entanglements, and this is ticklish business. Inasmuch as these wire entanglements are often provided with cowbells and other ingenious tell-tales which immediately inform the enemy that someone is near, the trick can be accomplisht nevertheless. For instance, the microphone may be thrown by hand like a bomb, taking good aim that it does not actually land into the trenches; thin wire trailing from behind the microphone and which should have the same color as the ground, will not be readily detected by the enemy. In this case, the wire would of course lay on top of the barbed wire entanglements, but being very fine it probably would not be observed from the enemy's trench.

Naturally all this work must be done during a dark night, it being impossible to crawl out of the trenches in "No Man's Land" during the day-time without courting certain death. It also goes without saying that the enemy will surely discover some of the microphones in time and shoot them to pieces.

However, it should be possible to place enough of them in such a manner that at least a few will stay in place where they

how the microphone is thrown, it should operate to its full sensitiveness. This, however, presents no unsurmountable technical difficulty, any electrical engineer being capable of designing a microphone of this kind.

Now suppose we have a few dozen of these microphones concealed near the enemy's trench. The wires from them lead to our own trenches, where an operator is to be in charge of the receiving end, listening for any information coming over his wire; chance remarks by the enemy are surely to be made from time to time. But not alone is information such as this of high import, but our commanders need very much more certain information as for instance, when the men in the first trench line are to be relieved.

In trench warfare, the men of course cannot stay in the trenches all of the time, and they are usually relieved during the night-time, which means more or less confusion, "choked" trenches, etc. If our attack can be timed at such a period, it is naturally more easy to win a trench than when the regular forces are in charge. The noise and the talk of the relieving party should usually be loud enough to give such information away over the sensitive microphone.

Of course, a scheme of this kind can readily be improved upon in many ways, and we leave this to our able Signal Corps attendants at the front.

ITALY USES RADIO-TELEPHONES

So successful have wireless telephones proved on Italian warships that the government plans to install them on merchant and passenger vessels.

"Movies" Show Women's Place in War

IN these trying days of strife when on all sides nations are in the grip of war the "movies," as usual, have their full play on the subject. Always of keen interest to young and old, kiddies as well as grown-ups, the photoplays are giving their best to the portrayal of war in all its grim reality. Every detail receives the utmost consideration; especially is this true where the uses of electricity and modern invention are involved.

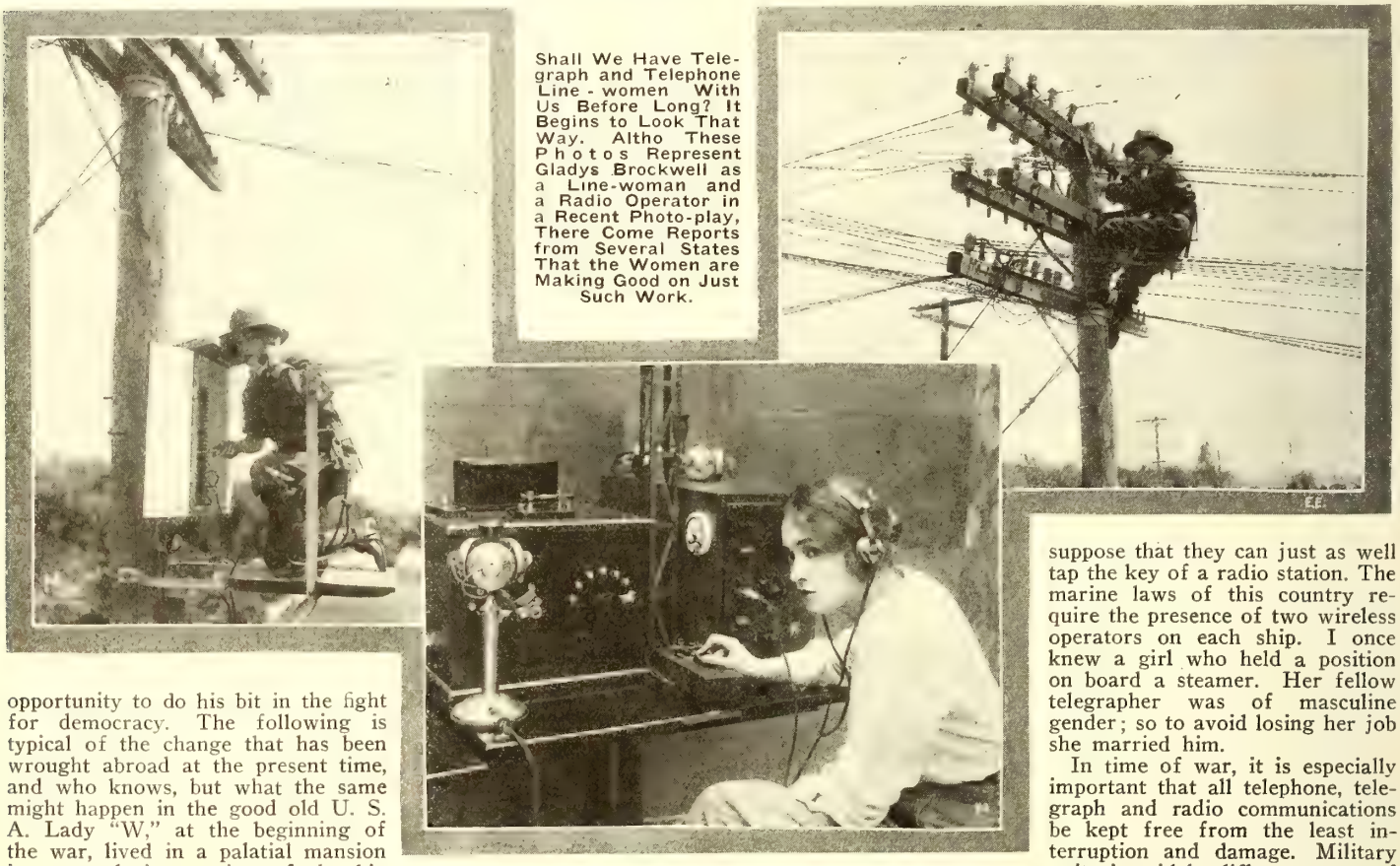
From the large number of photoplays now before the public the following essay and photos have been chosen, showing how women may help at home, by "Taking the Man's Place," and by so doing, allowing every brave and true-hearted American an opportunity to do his bit in the fight for democracy. The following is typical of the change that has been wrought abroad at the present time, and who knows, but what the same might happen in the good old U. S. A. Lady "W," at the beginning of the war, lived in a palatial mansion in an exclusive section of the big metropolis. She sipt her coffee in bed every day at noon, motored about the English capital and gossiped over her tea with other ladies every day at dusk. At dinner she became finical over the *filet mignon*, after which she drove to the opera or to a social function given by one of her friends. She was the kind of a woman who thought life impossible without two maids at least, a manicurist and some one to look after her pet dogs.

Recently one of her friends received a letter as follows: "I shall soon go into the fields, and 'do my bit' along with the other women who have turned farm laborers. Ever since the horror of this war first broke on me, I have done everything that I could to alleviate the suffering of the poor boys who are stricken by it.

"My home, as you already know, has been turned into a hospital. I, myself, have nursed many wounded men back to health. I have spent days and often nights rolling bandages, mending and disinfecting clothes. Now I believe I am needed in the fields, and I shall probably be among the Sussex dairy maids by the time you receive this letter."

This was the war's effect upon Lady "W." It is typical of what has happened thruout Europe and what must certainly occur in this country, if the war continues two years longer.

Already women are training for various vocations and are replacing our first quota of the Grand Army. As a "lineman," the woman will fit in very nicely, having held the reputation of working wires so long that making a profession of this pursuit will not be new. It is true, they will be very much up in the air about it, as anyone can see from the accompanying photographs, which show a fair female lineman—beg pardon, linewoman—one Miss Gladys Brockwell, in the Fox photoplay, "Taking the Man's Place." Seriously, however, acting as telephone and telegraph linemen is not a completely foreign occupation. Of the 38,000 persons now employed in this occupation, 600 are women.



Shall We Have Telegraph and Telephone Line-women With Us Before Long? It Begins to Look That Way. Altho These Photos Represent Gladys Brockwell as a Line-woman and a Radio Operator in a Recent Photo-play, There Come Reports from Several States That the Women are Making Good on Just Such Work.

Many dangers are encountered by the man whose task it is to see that the electrical communication lines are not broken. He must climb to the top of the highest pole, cling among a nest of wires with a narrow belt as his only support. While there, he must see that all apparatus is in working order. He has often to go into lonely stretches of the country, where at any minute, he is liable to be attacked by fierce beasts or still fiercer men. He must also expose himself to rigorous weather and he frequently spends the night among poisonous marsh gases.

All of these hazards the women are willing to encounter. They have heretofore given many instances of moral courage. Physical courage, which is a much commoner thing, they will be capable of showing when the time comes we are sure.

Then again as a "Wireless Operator," the woman can very well fill positions in this interesting and fascinating art. There is a fifteen year old girl now living at San Raphael, Cal., who has received a first grade commercial radio operator's license from the United States Government. Her name is Kathleen Parkin, and she took up the work after becoming interested in it in the physics laboratory of the high school she attended. Wireless operating, in fact, seems to be a form of employment peculiarly adapted to women. Girls hold the majority of places at telephone switchboards and quite a number in telegraph offices, so it seems reasonable to suppose that they can just as well tap the key of a radio station. The marine laws of this country require the presence of two wireless operators on each ship. I once knew a girl who held a position on board a steamer. Her fellow telegrapher was of masculine gender; so to avoid losing her job she married him.

In time of war, it is especially important that all telephone, telegraph and radio communications be kept free from the least interruption and damage. Military units in widely different parts of the country must be acquainted with the movements of their troops. Orders from the commanding officers must be sent immediately to subordinate officers of the line. Old men and young boys will be incapable for all the jobs, and Uncle Sam will be forced to turn to the women and ask for their help. One thing seems absolutely certain:

When the call comes, the women will be ready!

One of the newest New York hotels is electrically equipt from top to bottom. Hardly an electric appliance of the many which contribute so much to happy, comfortable living has been omitted. Electric refrigerators, dumb-waiters, stoves, fans, vacuum cleaners, 'phones, calls of all description, the most improved and modern lighting, and a host of other electrical appliances. This model hostelry is called Hotel des Artistes, and, as the name implies, is especially conducted for artists, illustrators, writers, and those of allied occupations.

How Big Electric Men Work

By GEORGE HOLMES

EDITOR'S foreword.—The present article, especially prepared for "The Electrical Experimenter," is one of great interest to all of us, and particularly to electrical readers who follow the lives of big men in their reading. It is not often that one has the unusual opportunity of observing at close range just how such men as Edison, de Forest or Pupin accomplish the day's duties. Besides making interesting reading you will find in the following paragraphs some of the principles involved in the working out of these men's goal—Success!



DR. LEE DE FOREST, the well-known radio engineer and inventor, is one of the greatest radio students today. Besides being president of his own company, now extremely busy on war orders, he still finds time to carry on researches in wireless. When I asked Dr. de Forest how he tackled the day's problems, he said:

"My daily work begins promptly at eight o'clock. I first go over my mail and decide what matters require immediate attention and what can be postponed to more leisurely moments. Before beginning my dictation I go rapidly thru the Laboratory and Shop to check up the various jobs and see what progress has been made, and what are the needs in the way of information or advice of the men in charge of the various jobs. This is to avoid any delays which occur if I postpone this work until thru with my office work for the day.

"I then shut myself in the office and endeavor to do at once all the dictating which has to be done for that day. I am usually thru with this work by nine-thirty.

"I then go carefully over the work in the Laboratory, Audion and Oscillion Departments. In these days when we are so rushed to get out instruments of various types urgently needed for the Army and Navy, I frequently help in the testing of the apparatus. I find this keeps me most intimately in touch with the exacting requirements which must be met in this Government apparatus. Occasional faults in design present themselves, or some careless or hasty work on the part of some of the employees which must be corrected before it goes further.

"About noon I am usually ready to make a second trip of supervision thru the factory. Lunch hour consists of eating a few sandwiches while seated at my desk, and usually consumes less than fifteen minutes. This affords me a good opportunity to check over my memoranda as to various matters which will require my attention during the afternoon.

"It is frequently necessary, even in these busy days, to go to New York City to consult with my Patent Attorneys, manufacturers, chemists, or engineers with whom we are doing business or obtaining materials from. These outside trips are always confined to the afternoon and I make every effort to so arrange them that I can get back to the factory before closing time in order to go over all the mail of the day, checking up and signing the correspondence, and laying out the necessary tasks which are to be undertaken the next morning.

"The present program permits practically no experimental or research work during working hours. All such work has to be now limited to nights and Sundays, altho it is really surprising how much of this development work can be done here and there between times when testing out standard apparatus, etc., provided only that this development work is along strictly similar lines, such as improvements in the design of Audions, or Oscillion tubes, refinements of circuits, improvement in mechanical and electrical designs, etc.

"Under these circumstances most of the details of data-making, quantitative measurements, etc., must be left to my assistants whose time can be uninterruptedly devoted to their individual tasks.

"My reading and study work are limited to hours at my home, which fortunately is located fifteen minutes by automobile from my Laboratory. This work is always done at night and is usually terminated between eleven and twelve o'clock.

"It is a source of genuine regret that in these exceedingly busy and strenuous times my duties do not permit me to concentrate as has been my habit and delight for days and weeks at a time on some problem or investigation. It is only by such concentration that revolutionary results are obtained but under the circumstances which surround us this form of work must unfortunately be postponed to more tranquil times."



PROF. MICHAEL I. PUPIN of Columbia University, a striking figure in the electrical world and instructor of Electro-Mechanics at that Institution, is an unusually busy person as is general with men in the public eye. His pleasing personality and good will towards all who know him is remarkable, when one considers the numerous tasks that confront him in the course of a day.

Aside from the various classes at the University and time devoted to various technical meetings, etc., he still has time for experimentation and research. At the time of the author's visit to his wonderful laboratory at Columbia, Prof. Pupin and his assistant were engaged in experiments on a new form of rotor for high frequency alternators.

Regarding his general layout or plan of work, he said among other things—"That 'Big' men do not plan out their day's work, but just take it as it comes"—which saying is very true when one considers the numerous problems that arise daily in the work of such a man. Of course, there is always a schedule kept as to the classes to come and the series of experiments to be conducted, but usually there is much that has to be taken care of just as it comes.

Taken all in all, Prof. Pupin is one of the busiest personages ever interviewed. However, from appearances one would never judge him to be one of the leading scientists of the day, as he takes his work coolly, quietly and deliberately, even in the most strenuous periods and is always pleased to meet a fellow experimenter and chat for a few moments on topics of electrical and scientific interest.



THOMAS A. EDISON, master electrician, chairman of the United States Naval Advisory Board, holder of more patents than any other man living, inventor of the incandescent lamp, phonograph and motion picture machine—how does such a dynamically active human genius get thru the day's work?

In answer to this question as to the routine followed by Mr. Edison in going thru the day's work, it may be said that the term "routine" would scarcely be applicable in his case. In other words, Mr. Edison usually has in progress a number of investigations and experiments which he is either conducting in person or with the aid of his large staff of experimenters.

One or more of these investigations or experiments may be the subject of a strenuous campaign continuing day and night without intermission, while others may be along lines of work requiring months and in some cases even years of experimentation. As an instance of the latter class, there was one case where Mr. Edison had an expert experimenting upon one single line of phonograph recording, under his supervision, for 15 years before arriving at satisfactory results.

Altho Mr. Edison is a good business man, as well as an inventor, he does not keep a calendar of engagements, Directors' meetings, et cetera, but figures on having all the time there is, day and night, for his experimental and inventive work, leaving it to his son, Mr. Charles Edison, and his assistant, Mr. W. H. Meadowcroft, to watch out and see that he attends to the comparatively few appointments that have been made for him.

He never attends to the details of opening any mail. There is a tremendous stream of letters flowing to him constantly, but these are opened for him, and only those requiring his personal attention are brought to his notice. His assistants strive to save him in every detail that is possible, especially when he is on one of his strenuous campaigns, during which he will often average 20 hours work a day for a long period of time. During these campaigns everything is boiled down to the extreme point, in order that he may be enabled to concentrate his attention on the work in hand to the utmost possible limit.

His days and nights are crowded with work, and he has no regular schedule that could be called routine. He devotes all his thought and energy to the work which is in hand at the time, and he has no thought whatever for the clock.

Ordinarily, he comes down to the Laboratory right after breakfast and plunges immediately into work the moment he arrives, oblivious of all else that is going on around him. It must be noted, however, that he will find time to keep in close touch with his extensive business interests by occasional consultation with the various managers and a rapid examination of reports of the operations of the various departments, his capacious memory enabling him in this way to keep his finger on the pulse all the time.

No man exists who is happier than Mr. Edison when he has some new problems to solve.

Something New in Microphones

THE microphone or sound wave transmitter now used in all standard telephone and similar apparatus, has, to all practical intents and purposes, remained the same for many years in its general make-up. That is, it has comprised a metal or mica diafram about three inches in diameter, and when the voice waves in the air impinge against this diafram, they cause it to vibrate on its full diameter as an axis. When this occurs, a small carbon button, secured to the center of the diafram, is caused to exert a varying pressure against a number of small carbon grains held in a carbon cup in juxtaposition to the aforesaid carbon disc carried by the diafram. The accompanying illustrations show something quite new in the realm of microphones, which has just been invented by William and James Birrell.

The new transmitter here illustrated is the result of much research work by these engineers, who have made a close study of this instrument, and its operating principle is rather one of *agitation* of the carbon granules between the carbon electrodes, than it is of *compression,* as in the old type.

It is quite remarkable what this new form of microphone will do. For instance, the diafram may simply be held in the hand as shown in one of the accompanying illustrations, and the transmitter will talk loudly and clearly over a telephone circuit of considerable length. It has been tested out on actual telephone circuits up to 107½ miles in length; this circuit consisting of 100 miles of standard metallic line and 7½ miles of farm line, which latter was mostly barbed wire fence. In another test, on a telephone train dispatching circuit near Chicago, this transmitter was successfully tested out on a 443 mile stretch of line, and the voice was remarkably clear and distinct, regardless of the fact that a number of train dispatching telephone stations were connected in on the line at the time.

This transmitter can be placed in any standard telephone microphone chamber, such as found on desk stands or wall 'phones, and all that is necessary is to remove the old transmitter parts, including the bridge arm, and placing the new transmitter of the type herewith shown inside the chamber, using the old damping springs which had been left in position, as the means of holding it in place. With this simple change, and connecting one cell of dry battery at each end of the line, into which 35 miles of cable had been connected, the spoken voice emerged clear and distinct.

One of the illustrations herewith produced shows an interesting and most remarkable test made with this transmitter, in which it was submerged in a small fish aquarium filled with water, and also containing several gold fish. Wonderful to relate, and contrary to what might invariably be expected with such a delicate device as the microphone, this particular instrument succeeded in transmitting the voice perfectly thru 35 miles of artificial cable, while it was submerged, and moreover, *with the mica disc covering the carbon grains punctured, so as to allow the water to enter the carbon cup.*

One of the illustrations herewith, shows a young lady making this test, the sound waves passing first thru the air and then thru the water to reach the submerged microphone.

With respect to the resistance of this new microphone, a number of tests gave its value at 50 ohms, when the receiver was removed from the hook, and with no talking or other noise in the vicinity. As soon as voice waves impinged on the transmitter, its resistance increased to from 105 to 110 ohms, and it proceeded to vary between 110 ohms and 60 ohms, the resistance not returning to the normal 50 ohm value at any time. The current consumption with four dry cells in circuit with the microphone, varied from .09 ampere with no talking to .04 ampere when talking started. When but one dry cell was tested in circuit with the microphone, the current consumed varied from .02 ampere to a little under .01 ampere.

Most important of all, this microphone is one of the simplest, if not the simplest ever devised, considering its extremely high efficiency; which compares favorably with any of the standard microphones now in use. It has but twelve parts in its make-up, and the arrangement of these parts is apparent from the accompanying photograph. One of the most interesting facts about this transmitter is that *no mouthpiece is necessary,* even when talking over long circuits with it, as is invariably the case with all of the usual microphones with which we are familiar.



Left: Even When Submerged the New Transmitter Gave Perfect Transmission Thru Surface of Water. Center: A Casing Is Not Required for Talking. Right: Front and Rear Views of New Microphone Showing Construction Details.

WOMEN ELECTRICAL ENGINEERS.

One hundred and fifty young women will study to become electrical engineers at the State Agricultural College of Kansas the coming year. Because of the war many engineers have left their positions and it will not be a great while before the shortage will be keenly felt. "Women are being employed as power plant operators in the large central stations of Europe," said Clarence E. Reid, professor of electrical engineering at the college, "and have been found entirely satisfactory.

"None of the machinery in these stations is operated by hand, but is all controlled by various forms of electric motors set into operation by the touch of a button or by electro-magnets or air pressure controlled in the same manner, so that physical strength is not at all necessary. Work of this kind is far less exhausting than many forms of work in which women are now engaged, for central station operators may use seats and have more variety of movement in their work. Desirable qualifications for entering upon engineering study comprise ability in mathematics and interest in scientific study."

Electrical heating blankets are now offered to those who sleep out-doors, for hospital and sick-room use, for elderly people or those with poor circulation. These blankets come as large as 6 x 5 feet; have three temperature controls, ranging from 82 to 112 degrees. The cost of running is almost negligible. The item of lightness as compared to much heavier bedclothes is an important consideration.

HOW AFRICA GETS THE WAR NEWS.

The war has, from the first, been brought right home to Africa. The four German colonies, over which the war extended, have an area more than four times as great as Germany; and there has been long and hard fighting in all of them except in Togo. Outside and within these areas of actual warfare live thousands of whites who are intensely interested in the European struggle. It may surprise many to know that not a few of these whites, even in the depths of Africa, are receiving the essence of the news every day and are well informed as to the most vital facts of the day's war history.

Even the Sahara Desert is now partly belted by a telegraph line, a French enterprise, with wireless extension to Timbukto. Thus this once mysterious city of the Sudan is now in touch with the great events of the day. The Belgian Congo is efficiently served by the French cable to Libreville and the land line to Stanley Pool, where navigation of the Upper Congo begins. The news is then wired up the Congo to the mouth of the Kasai River, 370 miles above the mouth of the Congo, and then by wireless to Stanley Falls, 870 miles above the Kasai.

THE MAN WITH THE MAGNET.

Almost, if not equally, as famous as the immortal "man with the hoe" is the "man with the magnet"—the man we see in all of the leading industrial plants now-a-days. The illustration shows a powerful 12-inch electro-magnet handling a 1,500 pound steel billet in the plant of the Duplex Metallic Co., Conshocken, Pa. It lifts the billet just as easily as a man would lift a 25 pound sack of flour. At the touch of a switch the magnet loses its magic power and the billet drops or lays where it is. Attached to traveling cranes, the amount of work one of these electro-magnets in the larger sizes can accomplish in one day is quite astonishing. They will unload a freight car full of pig iron in less time than a gang of men and at a fraction of the cost. The larger sizes of electro-magnets are capable of lifting single pieces weighing as much as 60,000 pounds, or 30 tons. Such a giant electro-magnet as this measures 62½ inches in diameter, consumes 72 amperes at 220 volts, and weighs 7,500 pounds, net.



Here We Have the "Man With the Magnet," Who Is Almost as Famous Nowadays as the Immortal "Man With the Hoe." The 12-Inch Electro-Magnet Is Shown Lifting a 1,500-lb. Steel Billet.

ELECTRICITY AS FOOD: MR. HOOVER PLEASE NOTE.

M. Bergonié, the eminent French doctor, has solved the high cost of living by means of diathermy. In other words, he claims to have made electricity take the place of food. Applications of the electric juice will furnish the body with nourishment. He has tried his idea on a man weighing only 110 pounds, who had not been receiving sufficient nutrition. In a short time this man was fat and sassy. Electricity did it. It furnishes the heat for the body which is usually furnished by food.

The poor man who owns an eighty horsepower Mercedes and cannot afford to buy food and gasoline both, and is slowly starving to death, can go out in his garage and three times a day, disconnecting the wires of his storage battery, can consume all of the electricity that he needs. This will take the place of breakfast, dinner and supper, or breakfast, luncheon and dinner, depending, of course, upon the man's station in life. When an automobile party is stranded nineteen miles from a garage all of the members of it can be fed from the batteries in the car.

Whole families may be fed from an electric lighting chandelier in the parlor and this will save the trouble of cooking. And then electricity will not smell up the house like corned beef and cabbage does.

However pleasant it would be to get a breakfast from an electric belt or get a ten-course dinner from the batteries in the telephone, we fear there is a catch in it somewhere and it will probably be some time before powerhouse banquets will become a reality.

TELEPHONE IN COCOANUT STARTLES NATIVES.

Modern home comforts are not exactly familiar to Sulu Islanders, according to a report publisht by the Society for Electrical Development.



From the Philippines Comes an Interesting Electrical Stunt That Fooled the Islanders. The Yankees Simply Dropt a Telephone Receiver in a Cocoanut Shell, Which Hung Outside the Building. When the Cocoanut Started to "Talk"—Well, Say.

"While in the Government employ in the Philippines," says this writer, "I was stationed on the island of Pasilan, which is a small island in the Sulu Archipelago.

"We frequently had them entertain us with their native dances, and in turn would fill them with wonder and awe with a phonograph which we had in our outfit. We found it necessary to put up a telephone line between two buildings that were a little distance apart, using two magneto sets. One day I found a rather large cocoanut under a tree near the bamboo hut we were living in, and conceived the idea of making a cocoanut talk. So I emptied its contents and hung it on the outside of the house opposite the phone, so arranged that we could put the receiver thru the grass wall and drop it into the cocoanut.

"We invited some of the natives to see the wonderful cocoanut that we could make talk, and with the aid of an interpreter at the other phone who understood their language, we had a lot of fun. Some of the natives were so frightened they left the village. Next day a delegation returned and directed us to destroy the talking cocoanut, under penalty of immediate attack. They did not like to have so uncanny a thing around. There was much rejoicing when we consigned it to the flames.

Historic Electric Apparatus

By H. WINFIELD SECOR,
Assoc. A. I. E. E.

THE present article is an endeavor to refresh the minds of our electrical students with the antecedents of the wonderful present-day electrical inventions. Like every invention or science, the art of electricity has had its full share of struggling inventors and laugh-producing inventions.

The early inventions in electrical science here discust are not necessarily the very first effort made in each respective line, but are those which are given credit historically, being the fundamental ones from which all later practical applications developed.

One of the first electrical phenomenon experimented with, was that of *static electricity*. Fig. 1 shows the first static machine as devised by Otto Von Guericke, of Magdeburg, Germany, in the year 1630. The illustration shows Von Guericke and also his machine, which consisted of a globe of sulfur fixt upon a rotatable spindle so that it could be revolved rapidly by means of a crank. Powerful static electric shocks were obtained from this relatively crude device by pressing against the surface of the sulfur ball with the hand, while it was being turned.

The *Voltaic pile* illustrated in Fig. 2 was invented by Alessandro Volta in 1775. This device was the first to produce what is properly known as *voltaic* (also called galvanic) electricity. This battery was made by placing a pair of discs of zinc and copper in contact with one another, then laying on the copper disc a piece of flannel or blotting paper, moistened with brine; then another pair of discs of zinc and copper, etc., each pair of discs in the pile being separated by moist conductor. Such a pile, if composed of a number of such pairs of discs will produce electricity enough to give quite a perceptible shock, if the top and bottom disc terminal wires be touched simultaneously with the moist fingers. Volta is given credit for laying the foundation of all present day batteries.

The first *electric telegraph* of which we have historic record, and also that on which most writers and authorities agree, is that of George Louis Le Sage, a Frenchman residing in Geneva, Switzerland, and who built his first telegraph in 1774. The Le Sage telegraph system employed 24 wires, placed in a trough in the ground, the wires being suitably spaced and insulated by means of glass partitions at frequent intervals. Each wire represented a certain letter of the alphabet. As is known, gold leaf is extremely sensitive to minute electric impulses, and so we find that Le Sage placed a small piece of gold leaf at the end of each wire. To send a signal over any particular wire corresponding to a certain letter of the alphabet, a small static charge was sent thru the wire by touching it at the transmitting station with a glass rod which had previously been electrically excited by rubbing it with silk. This system was rather limited in its application, as it is very difficult to insulate a static charge for any great distance.

The next serious form of electric telegraph devised was that of Soemmering, bearing the date of 1808, Munich, Germany. This is the machine illustrated in Fig. 3. It operated on a very ingenious principle; viz., that of the electrolysis of water by the passage of an electric current thru it. This inventor used a wire for each letter, the same as Le Sage, and to send a signal over any certain wire, but the wire in this case could be of considerable length. With this system it was but necessary to pass a small battery current thru the proper wire, which caused the water in the indicating device at the opposite end of the line to be decomposed, this indication being evidenced by the production of a large amount of (hydrogen) gas bubbles in the water.

In the present article, describing historic electric apparatus, you will find many facts not generally known. For instance, did you know that the first electric telegraph was actually worked in 1774, by Le Sage, a Frenchman residing in Geneva, Switzerland?

Did you know that incandescent electric lamps, employing a carbonized paper filament burning in a vacuum were successfully constructed as far back as 1845? This lamp was invented by a Yankee—Mr. Starr of Cincinnati, Ohio. The first successful arc lamp with automatic carbon feeding mechanism was built about the same time, by an Englishman named Wright. The history of these electric inventions is a real romance.

The first *electric motor* is undoubtedly of interest to every electrician. Early in the 19th century a number of philosophers became much interested in the effect of electric current carrying conductors, especially in their reaction when placed in the field of a magnet. With respect to the first electric motor devised, credit is invariably given to Michael Faraday, who devised the first electro-magnetic rotation apparatus in the year 1822. Barlow in 1823 produced the rotation of a star wheel placed in the field of a strong magnet as shown in Fig. 4. These devices were very crude and simple however, and developed infinitesimal power. Undoubtedly the first electric motor employing electromagnets wound with many turns of wire, and also comprising a motor which utilized both permanent steel magnets and electromagnets, was that perfected by Prof. Joseph Henry, of Princeton University, in the year 1831. Henry produced *reciprocating* motion as well as the *rotary* motion by electro-magnetic means. Henry's motor of the vintage of 1831 is also shown in Fig. 4. This was the forerunner of the present-day electric motor of which there are many hundred thousands in use in all parts of the world. Henry's device interrupted the battery current by its oscillating or rotary motion in an intermittent manner in either case. It is interesting to note that Henry called his motor a "philosophical toy." In studying the history of electric motors and dynamos it is well to keep in mind this first electro-magnetic motor of Professor Henry's, which fact will be further touched upon in the present article, as it had a very important bearing on certain other inventions.

The *dynamo*, which produces electricity by rotating an inductor or series of inductors in the field of a powerful magnet, was first studied on the basis of a peculiar phenomenon. The first experiment in this field reverts back to what is known as Arago's disc. This consisted of a brass or copper disc which, when rotated at considerable speed and placed below a magnetized compass needle, caused that needle to be dragged around. These "Arago's rotations," as they were called, were supposed to be some kind of mysterious *magnetic rotation*, until Faraday proved them to be due to induction and simply obeying a basic law of electro-magnetism. The next definite step in the development of the dynamo as a producer of electricity by electro-magnetic means was in 1831, when Faraday made his first experiments with a revolving copper disc placed between the poles of a very powerful magnet. In some of these experiments, a copper disc was allowed to dip in a trough containing mercury; the electric current being taken from the axle supporting the disc, and from the mercury trough in which the disc dipt as it was rotated by means of a crank handle.

About a year later Pixii devised an electro-magnetic dynamo as shown also in Fig. 5, which involved the use of a revolving permanent steel-magnet placed below two iron cores containing coils of wire. By means of driving gears and a handle as shown in the illustration, Pixii was able to produce quite strong alternating currents with his dynamo as the permanent magnet spun around below the magnet coils at high speed.

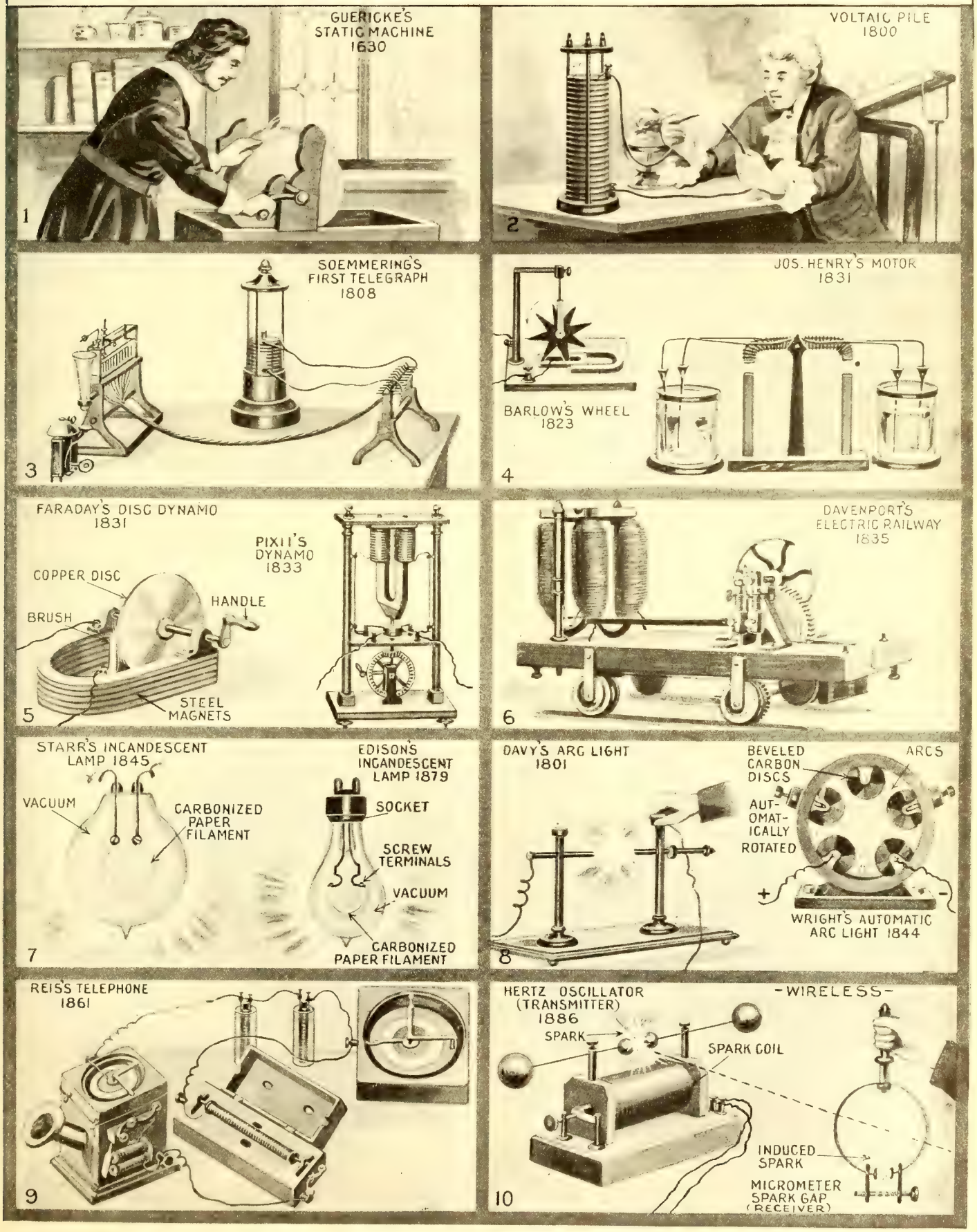
The *trolley car*, with which we are all familiar today, and which moreover seems so simple that it would almost appear to have always been with us, instead of passing thru many stages of evolution, was distinctly an American invention. Going back to the work of Prof. Joseph Henry and the electric motor, it is recorded that Thomas Davenport, a New England philosopher who was residing in Vermont, went to see one of Prof. Henry's powerful electro-magnets in operation at a manufacturing plant where the magnet was in use for the purpose of removing iron from clay and other materials. This was about the year 1833, and Davenport was much imprest by the great power of the then new electro-magnets, one of which he saw demonstrated by lifting a heavy steel anvil when excited by three battery cells.

Davenport did much thinking on this subject and at once started building models of electric motors, and he is given credit for producing the first electric railway in 1835. History records that Davenport actually made *over one hundred models of electric motors* in the period from 1835 to 1840. These included motors of every conceivable type and variety, both with electro-magnets and permanent magnets. He exhibited an excellent model of his proposed electric railway in Boston in 1840. Davenport, so we learn, was not an educated technician or true philosopher of the college-bred type, but was a natural born genius, and it is said of him that he surely realized the wonderful basic principle which underlies every electric motor and dynamo today; *i.e.*, that to obtain the maximum and most satisfactory results, there shall be two distinct magnetic fields employed, one of which shall be of *permanent polarity*, and the other of which shall be of *constantly changing polarity*.

The first *incandescent electric lamp* has been a bone of contention for a great many years, and much mystery surrounds the early days of the incandescent lamp. Most historical electrical treatises give credit for the first incandescent lamp to Sir Humphrey Davy, who exhibited this type of illuminant (first demonstration in 1802) in

(*Continued on page* 499)

HISTORIC ELECTRIC APPARATUS



(For descriptive text see opposite page.)

The Marvels of Radio-Activity

By JEROME S. MARCUS, B.Sc. (Ch. E.)

PART III.

Emanations.

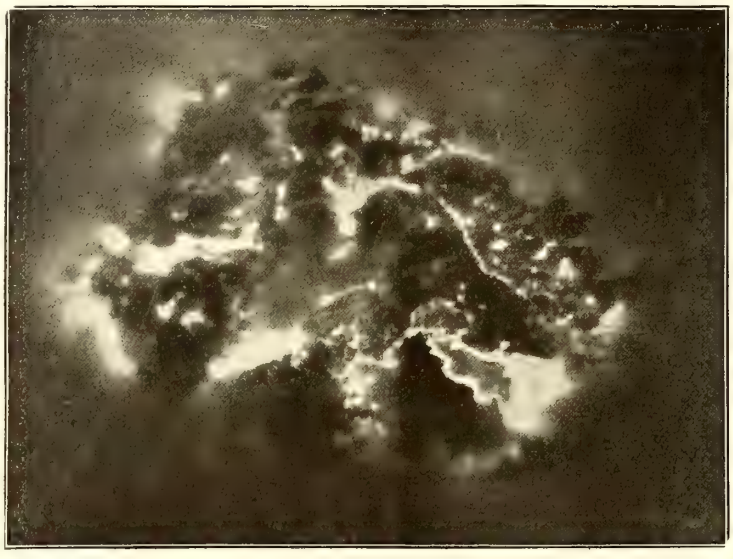
THE substances Thorium, Actinium, and Radium possess, in addition to the ray-giving properties, that of emitting continuously a radioactive gas or *emanation.* These emanations all possess the property of ionizing a gas and, if sufficiently intense, of producing marked photographic and phosphorescent action.

The activity of the radioactive gases is not permanent, but disappears according to a definite law with time, namely a geometric progression. (See Fig. 1.) The emanations are distinguished by the different rates of losing their activity. The length of time necessary for the activity of a given amount of substance to drop to half value is called the "period" of the substance. The Actinium emanation has a period of only 3.7 seconds, Thorium emanation—54 seconds, and Radium emanation—3.9 days.

An Actinium compound wrapt in a thin paper and placed on a screen of phosphorescent zinc sulfid will, in a dark room, show the phosphorescence surrounding the active body on all sides. A puff of air will remove the emanation and the glow dies out, but fresh emanation is given off and the glow reappears. (Due to the present high price of rare chemicals, this experiment will prove too costly for the average experimenter.)

Radioactive waters derive their properties from the emanation held by them in solution, gathered by the passing of the water thru and over rock matter containing radioactive minerals. But on coming to the surface the emanation is released and decays. So it is evident that the "radium waters" advertised are in the main common fakes, and the only way to drink real radium waters and to derive the therapeutic values is to get it at the spring.

Emanations are similar to all other gases —they can be transferred by gas currents, and can be separated from air or other gases by extreme cold and condensation. Rutherford and Soddy showed that under ordinary conditions the temperature of condensation of Radium emanation is—150 C. or 240 degrees below zero Fahrenheit.



A Piece of Pitchblende from St. Joachmisthal Photographed By Its Own Rays. The Pitchblende Was Spread Evenly Over Black, Opaque Paper Covering the Photographic Plate.

Radioactive Changes.

As has been said before, the radioactive materials in giving off rays change into entirely new and distinct substances, *e. g.,* emanation results from the element; another substance results from the emanation. While in the majority of cases the products break up either with the emission of the *alpha* or *beta* particles, some "rayless" ones have been found by scientists.

These different products decay according to their periods, but are constantly being formed by the next lower material, hence an equilibrium will be obtained. The effects generally noted in the study of radioactive materials are then, the combined effects of all these products in an equilibrium of activity.

These products differ physically and chemically from the parent matter. The radiation is due to the atomic structure, or better to the atoms themselves, as the most powerful physical and chemical agencies have no effect. In 1903 Rutherford and Soddy put forth the following simple explanation: —The atoms of the radioactive matter are unstable, and each second a definite fraction of the number of atoms present breaks up with explosive violence, in most cases expelling an α or β particle with great velocity. As an illustration, if an α particle is expelled during the explosion, the resulting atom has decreased in mass, and possesses different physical and chemical properties than the parent atom. So a new substance has appeared as a result. Now, this new matter is itself unstable and it in turn breaks up, the process going thru the series until a stable atom (*i. e.,* one stable to our conception of time), is reached.

The breaking-up process has been figured out mathematically and reduced to a law of radioactive change which is applicable without exception to all radioactive matter. It appears to be an expression of the law of probability, for the average number breaking up per second is proportional to the number present.

Looked at from this point of view, the number of atoms breaking up per second

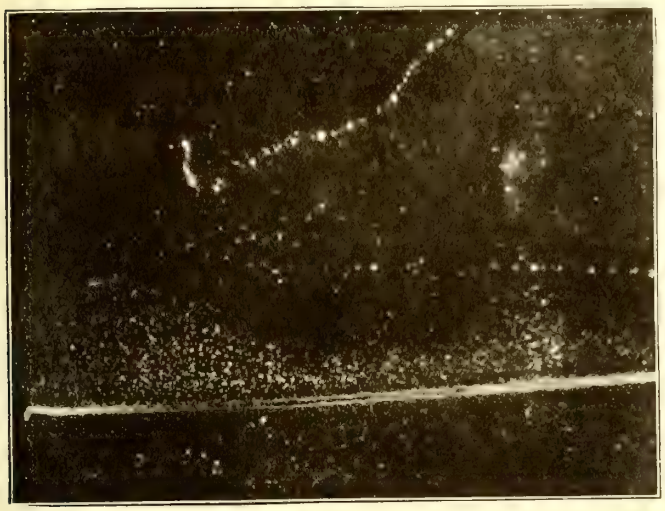


Chronic Articular Rheumatism With Deformity. A.—The Maximum Mobility Before Treatment With Radium Mud.



Chronic Articular Rheumatism With Deformity. B.—Maximum Mobility After Treatment With Hot Packs of Radio-active Mud.

should have a certain average value, but the number per second should vary from second to second within certain limits according to the law of probability. This variation in the number of atoms breaking up from second to second becomes more marked in the weakly radioactive matter, where only a few break up per second.



Representation by Wilson of the Difference Between the A- and B-Rays Very Plainly Shown. In the Middle, a B-Ray of Extreme Velocity with Very Few Electrons Is Seen.

The following table gives the products, the rays emitted, and their periods:

PRODUCT	RAY	PERIOD
Actinium	Rayless	
Radioactinum	* $\alpha + \beta$	19.5 days
Actinium X	α	11.8 days
Actinium Emanation	α	3.7 seconds
Actinium A	β	36 minutes
Actinium B	α	2.15 minutes
Actinium C	$\beta + \tau$	5.1 minutes
Radium	α	1760 years
Radium Emanation	α	3.86 days
Radium A	α	3 minutes
Radium B	β	26 minutes
Radium C	$\alpha + \beta + \tau$	19 minutes
Radium D	β	17 years
Radium E	β	5 days
Radium F (Polonium?)	α	140 days
Radium G (Lead?)	—	—
Thorium	—	About 10^{10} years
Thorium 1	Rayless	5.5 years
Mesothorium (Thorium 2)	$\beta + \tau$	6.2 hours
Radiothorium	α	737 days
Thorium X	α	3.6 days
Thorium Emanation	α	54 seconds
Thorium A	β	10.6 hours
Thorium B	α	55 minutes
Thorium C	α	Very short (?)
Thorium D	$\beta + \tau$	3 minutes
Uranium	α	5×10^9 years
Uranium X	$\beta + \tau$	22 years
Ionium	α	?
Radium (?)	—	—

* α = Alpha ray; β = Beta ray; τ = Gamma ray.

It is extremely difficult to analyze the change and distinguish the various products. It must be proven that the new substance has distinctive physical and chemical properties, and that the substance under consideration came from the one preceding it, and breaks up into the one following it in the series. In general, some property, either physical or chemical, has been found which allowed the material to be separated and removed, and then studied independently. In some cases ordinary chemical means are used, in others electrolysis, fractional crystallization, differences in boiling point, etc.

An interesting method of separation is that investigated by Russ, Makower, and Hahn, and which depends on the recoil of an atom which breaks up on the expulsion of an alpha particle. The residual atom acquires sufficient velocity due to the shooting out of the particle to escape and be deposited on bodies in the near vicinity. This is especially marked in a low vacuum. For example, Actinium A, deposits Actinium B, by recoil, while the recoil of Actinium C from Actinium B deposits it. So the three can be separated and observed.

Boltwood, in his investigations, set forth a lot of evidence to show that Radium is derived from Ionium, and that Actinium is a further member of the series. This makes the three groups of elements members of one family. Rutherford explains that in some part of the breaking-up there is a complex action and Actinium comes off as a branch. There is, however, no grounds for the connection of Thorium to the other groups.



An Automatic Atomizer of Radium Emanation in the Form of an Electric Table Fountain. The Emanation Thrown Off in a Room Can Be Inhaled.

Induced Activity

Curie showed that Radium possest another remarkable property. The surface of any body placed near Radium, or still better, immersed in the emanation, acquires of itself a strange activity. The author has seen a container of Radium salts give all the experimental results of a radioactive substance after the salts had been removed. Like the emanations, this induced activity in a body decays with time, but at quite a different rate from that of the emanation itself.

Rutherford showed that Thorium possest a like property. He showed that the bodies made active behaved as if a thin film of intensely active matter were deposited on the surface. The active matter could be partly removed by rubbing, and could be dissolved off by strong acids. When the acid was evaporated the active matter remained behind.

It was shown that induced activity is due to the emanations, and could not be produced were no emanation present. The induced activity on bodies is due to a deposit on non-gaseous matter derived from the transformation of the emanations, *viz.*, the transformation products as shown in the table above. Therefore, each emanation will give a different deposit with a different rate of decay. The period for

(*Continued on page* 485)

SIR OLIVER LODGE ON "ASTRONOMY" VS. ELECTRICAL THEORY OF MATTER.

Sir Oliver Lodge, in a recent technical paper on this subject, gives a number of arguments which are summarized as follows:

1. That motion of matter thru ether has a definite meaning, apart from relative motion with respect to other matter.

2. That an extra inertia due to this motion is to be expected at high speeds, in accordance with the FitzGerald-Lorentz contraction.

3. That this extra or high-speed inertia is not part of the mass, but is dependent on the ether and hence is not subject to gravity.

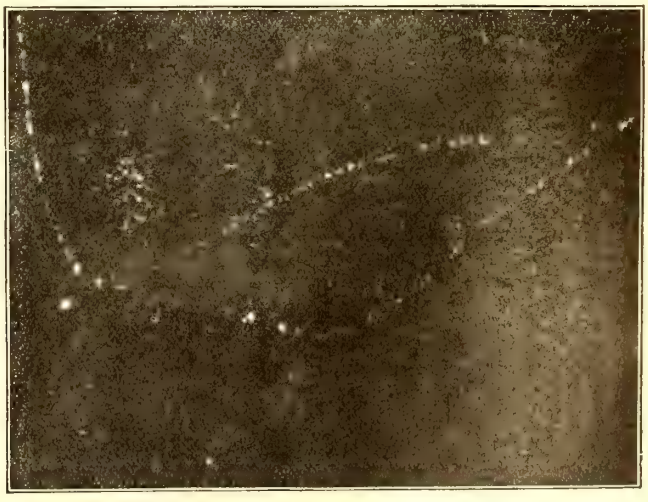
4. That from this reasonable hypothesis astronomical consequences follow which may be detected when cumulative.

5. That under certain specified conditions merely a small change in eccentricity is to be expected as the chief result, in certain others an apsidal progress or regress is to be expected.

6. That the outstanding discrepancy in the theory of the perihelion of Mercury would be accounted for by attributing a certain value to a component of the true solar motion thru the ether in the direction of the planet's aphelion path.

7. That using this value for the solar-plus-stellar drift, viz., two or three times the earth's orbital velocity, a result can be obtained for the perihelion of Mars, subject to a hypothesis about direction.

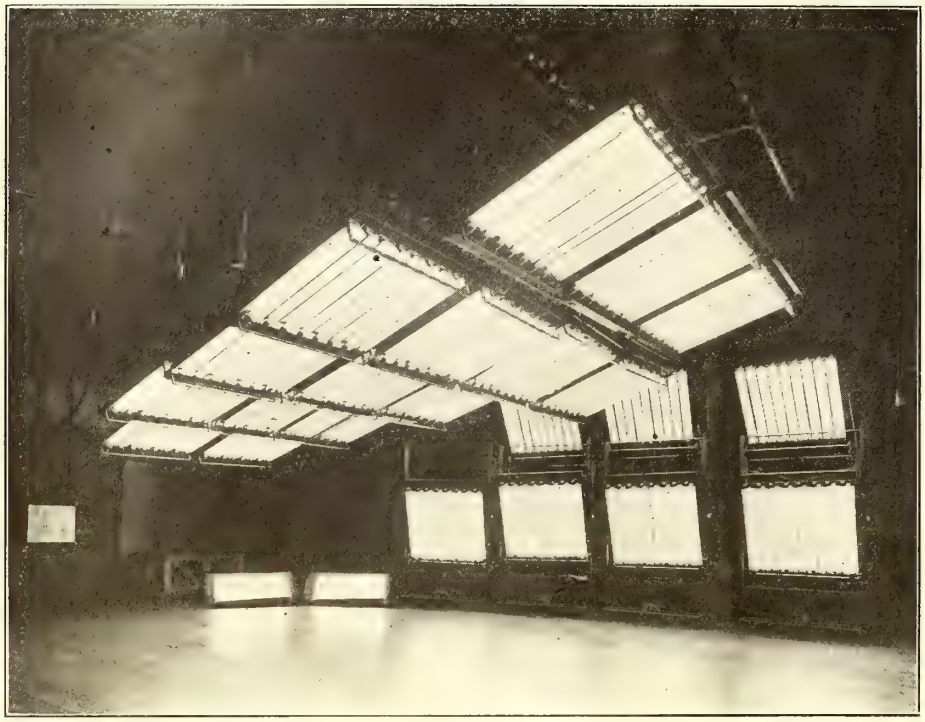
8. That by discussion of discordances in the elements of different planets an estimate may be formed of the magnitude and direction of the locomotion of the solar system in its invariable plane.



Representation of Electrons After Wilson. The Electrons, Which Consist Solely of Gamma Rays, Have Been Produced From Secondary Beta Rays After Complete Absorption of A- and B-Rays.

177,000 C. P. Mercury Vapor Lamps Light "Movie" Studio

On a large stage, the cost of lighting for taking 1,000 feet of film, which would mean about two day's complete work with the lamps on for about two hours, would amount to $7.50 for current and $1.50 for maintenance, or a total of $9 for 1,000 feet, whereas the entire cost of the film may have run from $1,000 to $4,000, depending on the subject. In other words, the best lighting can be obtained on the average for less than one-half of one per cent. of the entire cost of the film. Considering the fact that some actors are paid $1,000 a week and over in salaries, or about $50 per working hour, every single minute of their time that can be saved by proper lighting is instrumental in reducing the total cost of the film.



The Powerful Battery of Mercury Vapor Lamps, Aggregating 177,000 Candle-Power, as Used to Illuminate a Modern Moving-Picture Studio Stage. Over 200 Mercury Vapor Tubes Are Used in this Installment.

Some interesting features are embodied in the recent installation of a complete artificial lighting system by mercury vapor lamps in the new studio where "Rothacker" films are made, in Chicago, especially in the methods used for control and handling of the lighting equipment.

The overhead structure adopted for this purpose consists of a double-girder crane, running on tracks supported by the side walls of the studio and spanning the 52-foot width of the building. The two girders of the crane are separated 26 feet but are rigidly fastened together by a series of I-beams, parallel to the length of the studio, from which the overhead lighting equipment depends. The whole crane system travels on four flanged wheels, moved at present by hand-operated continuous chain and gear mechanism, altho provision is made for electrical traverse.

Overhead, top or skylight effect is obtained from five rows or "skylight frames," each frame consisting of eight 50-inch automatic-starting mercury-vapor tubes with porcelain-enameled reflectors to direct the illumination downward. The back row, that is, the row over the rear of the set and farthest from the camera, has three frames (24 tubes), the second row four frames, the third three frames, the fourth row three frames (one has five tubes only) and the fifth row two frames.

These frames ordinarily slant away from the camera and toward the set, forming a practically continuous plane at an angle with the floor. However, they are not supported rigidly in this position and may, by a simple crank and cable device on each row, be raised, lowered or changed in angle with respect to the floor. In addition to this movement all rows of frames, excepting the second, may be moved on the crane itself, in the line of its travel, to a point where either end frame of any row will assume a position past the side girder. This is necessary to facilitate photographing diagonally across the studio.

Side illumination is furnished by lamps on stands. Four of these are equipt with eight 50-inch mercury-vapor tubes each, three with nine each and two with four each. The entire studio equipment consists of 208 mercury-vapor tubes, aggregating 177,000 candle-power.

A POWER SUBMARINE CABLE.

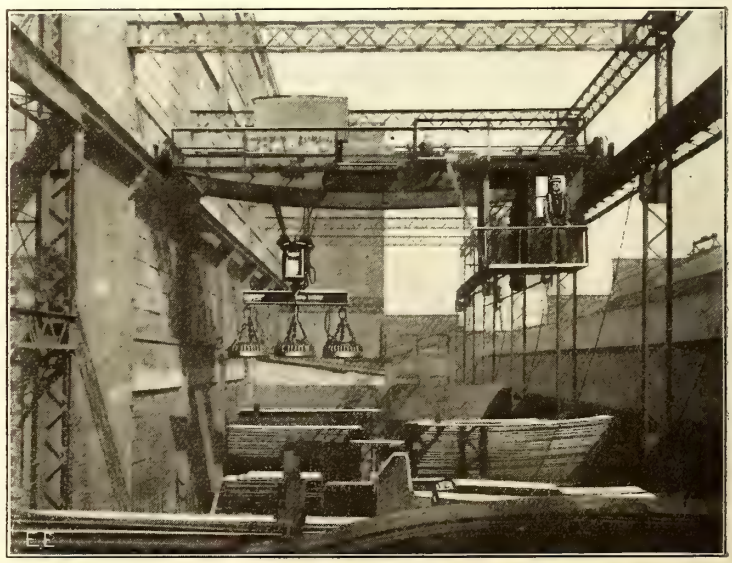
A power cable transmitting power from Sweden to Denmark is the longest submarine cable of its kind, having regard to the pressure at which the transmission takes place. The power is received by the electricity and tramway company at Hellerup, near Copenhagen, and is transmitted by the South Sweden Power Company, at Malmö; the generating power station is on the Lagan River, about fifty miles northeast of Helsingborg. The cable, which is 3.35 miles long, is of the three-conductor type, insulated with impregnated paper. It was tested at the works at 87,500 volts, and carries current at 35,000 volts. The jointing of lead-covered paper-insulated cables at sea is not at all a simple matter, according to *The Electrician,* and all sorts of precautions had to be taken both with regard to regulating the movements of the ship and its laying machinery, and also with regard to the exclusion of moisture from the joints. The greatest depth at which a joint is laid is 120 feet.

AN ELECTRIC CRANE AND MAGNET WITH SWIVELING DEVICE.

By Frank C. Perkins.

The accompanying illustration shows an electrically operated traveling outdoor crane with a clever swiveling device equipt for lifting magnet service at work in an Ohio steel plant. This electric crane has a capacity of 10 tons and a span measuring 29 feet. The upper lifting beam of this crane is equipt with an electric motor, which is under the control of the crane operator, so designed as to swivel the lower beam and load. In order to prevent the upper beam swaying laterally or longitudinally, due to starting and stopping the traveling motions of the crane, or rotationally due to swiveling the lower beam, a special arrangement of ropes has been adopted for the suspension of the upper beam.

It is pointed out that in consequence of these arrangements and of the use of the gigantic magnets, it has been found possible to dispense with the services of a ground man, all functions being performed by the operator in the crane cage, and electric power is employed to great advantage not only for the operation of the crane but for picking up the iron and steel material and its movement, with the least possible manual labor and expense.



To Reduce to a Minimum the Cost of Labor in Handling Steel and Iron Plates, an Ohio Plant Utilizes Three Large Electro-Magnets Suspended From a Swiveling Beam Carried by a Traveling Crane. The Plates Can Be Released in Any Position.

Bucking The "Lodge Goat"—Electricity

TIME was, fellow Shriners and brother Elks, when the always mysterious "degree team" thought they had performed their work well and effectively if they succeeded in scaring the candidate out of about seven years' growth by causing him unexpectantly to fall into a tub full of cold water. But the electrical genius has become legion. Wherefore we find that lodge and other secret society initiations are now really electrifying and the proud candidate is made to actually "feel" that he is "warmly" welcome.

The harmless and extremely amusing electrical stunts for such festivities here illustrated were created in the fertile brain of one John J. Odenwald. He has spent much time in working up these stunts for the use of various organizations and one or more of them will surely prove welcome to any degree team. The stunts are easy to perform and provide a maximum of clean fun.

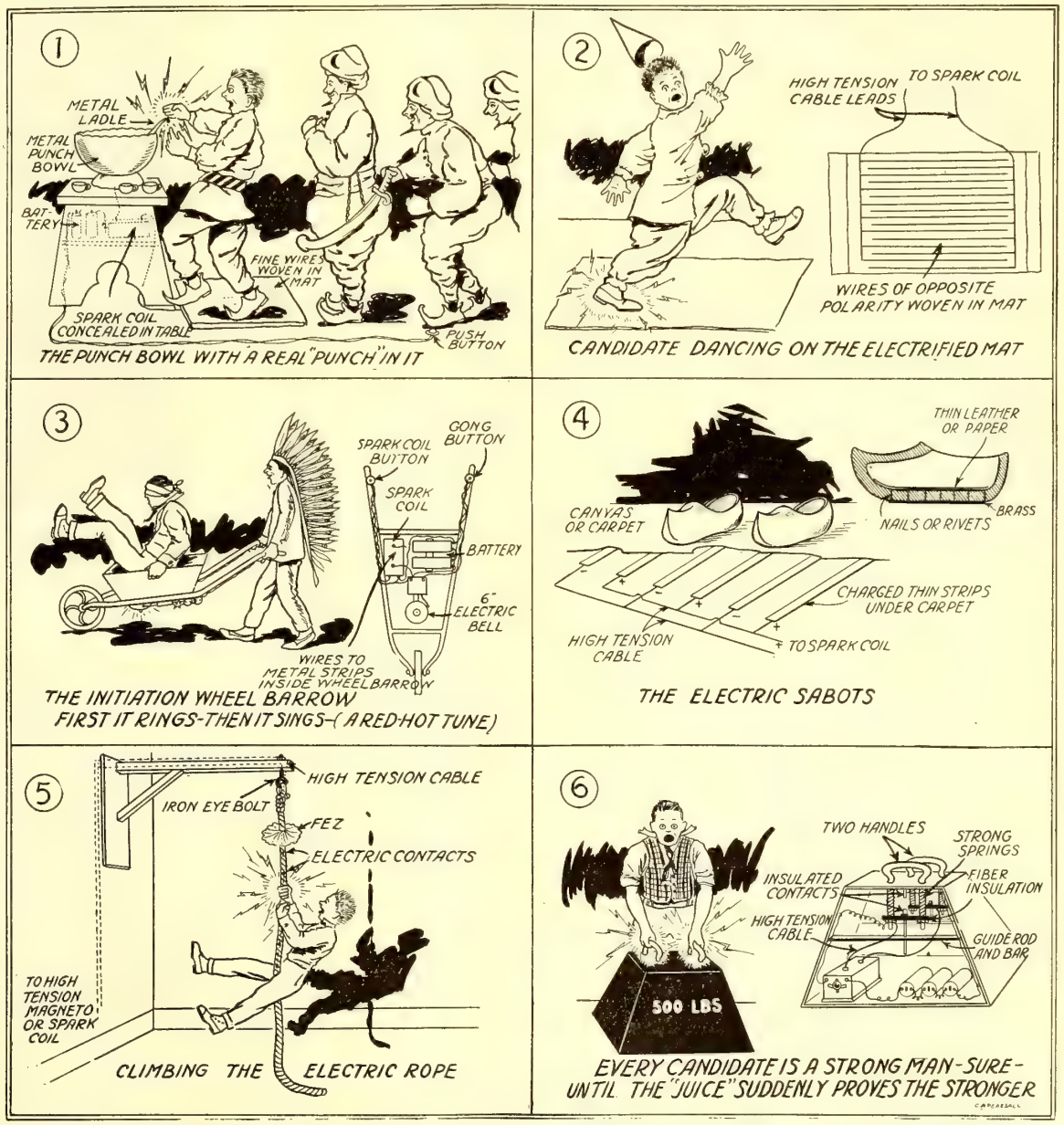
Imagine the gasp of astonishment from the candidate when he serves the punch by special request. "'Tis a proud moment in me life," as Mr. Dooley would say, when Mr. Candidate steps to the punch bowl. Upon touching the ladle he receives a lively electrical jolt which shows him that the liquid has a real "punch." The illustration shows how this trick is readily carried out by means of a small (½" or ignition) spark coil, battery and push button. Use high tension rubber covered cable to connect up the secondary circuit, and if possible do not cross these cables, as "leaks" may develop.

Another is a harmless looking rug in which are woven electrical wires and terminals secretly connected to a high-tension spark coil which makes the initiate do some lively stepping when everything is in readiness.

Then there is the electrified wheelbarrow on which the candidate is brought into the presence of his new brethren. On approaching, the person who is wheeling the barrow quietly presses a secret button in one of the handles which operates a six-inch electric bell to warn everyone to clear the path. This also serves to direct attention to the startling and "shocking" event which happens when another secret button is prest that causes the candidate to arise with great alacrity, due to some very sudden applications of high-tension charges manifesting themselves in the seat of the barrow. Another device is a pair of Dutch sabots, or wooden shoes, which are very harmless looking and yet when worn cause the wearer to suddenly become a dancer of very funny jigs. These wooden shoes are easily charged by placing a metal strip inside and outside of the sole as indicated. These are riveted thru the sole and made as inconspicuous as possible. The inside strip should be covered over with thin leather or paper. Alternately charged metal strips are placed under a canvas covering on the floor. Let the candidate do a few steps—then switch on the current and you will learn some brand new steps that would astonish even Vernon Castle.

Just to prove that the candidate is of good physique, introduce him to the climbing rope, upon which it is customary to place about 15 feet or so above the floor a fez or other suitable object, which the novice is expected to climb to and bring down. After climbing the rope some four or five feet, current from a magneto is suddenly applied to hidden terminals in the rope which makes the candidate come down with considerable speed.

And who doesn't like to pose as a regular "strong man"? Everybody. As a shining light in the initiation festivities we have with us the magic weight—labeled 500 lbs., say. The candidate is introduced to the weight and told he surely can lift it as it is made of a mystic metal, sent from Hindustan. To his surprise he can lift it; but, zowie!! When the handle travels its full length, it throws in a spark coil which lightens his burden at once.



Every Lodge and "Secret Order" Man Will Find These "Electrical Initiation Stunts" of Timely Interest. They Are All Easy of Application and Harmless in Their Effects. The Electric Stunt Can Be Worked Where Clumsy Mechanical "Goats" Would Fail Miserably.

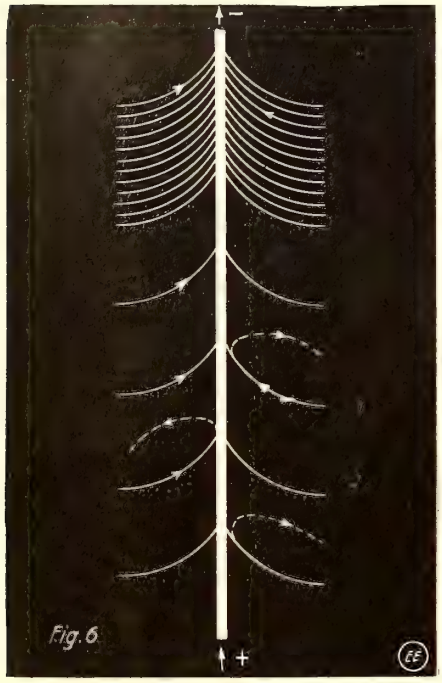
INDIANA UNIVERSITIES TO TEACH RADIO COURSE.

For the young man who inhales with zest the tale of the daring exploits of the wireless operators on the trans-Atlantic liners and the work wireless does in saving ships from submarines the colleges of Indiana this fall have opened up attractive courses. Wireless telegraphy courses will be offered at Indiana, Purdue and De-Pauw universities and all young men and boys are permitted to enter. The announcement was made today by State School Superintendent Horace Ellis. The work is a part of the war vocational education program.

The Cause and Nature of Magnetic Currents

By F. F. MACE, Superintendent of Public Schools, Dallas, Texas

IN two previous articles, "Magneto-graphs" and "Currents About Magnets," having proven by magneto-graphs and other experiments that there are actual currents surrounding and entering magnets and solenoids, we may now take up the cause and nature of these currents. In the article "Currents About Magnets" it was mentioned that logically we should begin with an experiment in regard to *currents surrounding a charged wire.* We return now to this experiment in regard to currents surrounding a charged wire, where we should logically have begun, and study the origin of these currents, their nature, the creation of electro-magnets, and the logical explanation of the phenomena connected with magnetism.



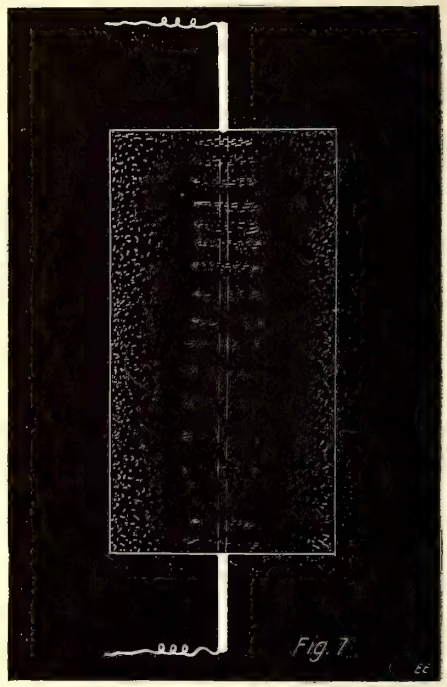
Interesting Chart of the Motions Followed By a Suspended Magnetic Body Near a Charged Conductor; the Body Moves Inward Toward the Wire as Well as Forward, Thus Proving the Existence of Currents Moving Inward and Forward, in the Direction of the Current.

It is well known that a wire bearing a current is to a small degree a magnet: that iron filings will cling to its side. But it has been asserted that the "lines of force" of the magnetic field surrounding such a wire are concentric circles. That under certain conditions they have this appearance, that circular lines of filings may be made to appear about the wire, is not due to any real circular nature of the lines of force, as this circular field is now understood, but to other causes. The real cause of this circular appearance and the true direction of these lines of force—*currents*—will be shown in the following experiment:

Support a wire in a horizontal position and pass thru it a heavy current of electricity. Suspend a small piece of iron wire or a small iron ball by a thread of unspun silk or a hair near, but not touching, the charged wire. The iron will not only be attracted toward the wire, but it will also move forward in the direction which the current in the wire is flowing. Often this motion is such as to form an ellipse, the longer axis of which points diagonally to the wire and forward in the direction of the current's flow, the iron returning along the outer curve. If the position of the thread and the suspended iron be changed along the wire a series of curves will be formed as shown in Figure 6. This, as in the case of magnets, proves the existence of currents moving inward toward the charged wire and forward in the direction of the current flowing in the wire itself.

That these are actual currents is again proven by the photographic plate. Photographic plates exposed above or about such a charged wire under the same conditions used to produce magneto-graphs are darkened everywhere within the field, the degree of darkening shading off towards the edge of the field. Owing to the direction of these currents it is difficult to produce a clear magneto-graph (that is, clear images of objects placed upon the plate), but even this has been accomplished to some extent. Further experiments will probably give better results.

Not only can the existence of these currents be further proven, but it can be shown that these currents are propagated in waves and the amplitude of these waves can be measured. Support a sheet of glass or paper horizontally over a wire and sprinkle upon it fine iron filings as evenly as possible. When an electric circuit thru the wire is alternately closed and opened by means of a key, the filings will be formed into nodes across and at right angles to the wire and the current in the wire. It should be especially noted here that these nodes form at the first closing of the circuit and that they do not change position thereafter, merely becoming more marked with successive alternations by the collection of more of the filings. The appearance of these nodes in the filings is shown in Figure 7. This shows that the current in the wire passes along it in a series of impulses, thus producing a series of similar impulses in the external currents. The production of these external currents is analogous, of course, to the production of currents about any moving body or substance. In sound, when we see nodes formed as in Figure 7, we recognize wave motion and are able to measure wave lengths by the distance between nodes. *In this case, also, we recognize wave motion and are able to measure the amplitude.* It is somewhat difficult to arrive at an exact result on account of the irregularity of the particles of the iron filings and because of their more or less uneven distribution in sprinkling them upon the surface; but careful and repeated measurements and countings show that these nodes average 17.8 to the centimeter, with the current used, and that they vary but little in the distance from node to node. As a node indicates half a wave length, the waves passing over the wire are approximately twice .5618 mm. (i.e., 10 mm. divided by 17.8) or 1.1236 mm. in length. Doubtless more accurate results than this can be obtained and it is barely possible that the wave lengths may be found to vary



An Experiment Made By the Author With Iron Filings Sprinkled on a Glass Plate Placed Over a Charged Conductor, Which Proved That "Wave Motion" Was Present By the Formation of "Nodes."

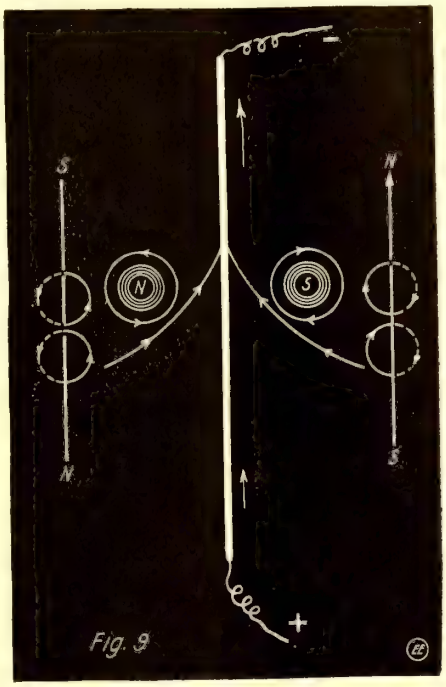
with the strength of the current and the nature of the conductor used. It is sufficient at this point to show the wave nature of the current in the surrounding field and the approximate wave length. This wave motion, this alternate impulse or impulses, readily account for the concentric circles about the wire. A series of impulses moving upward and inward and repeated at regular intervals and at the same location, these currents moving upward and inward as do the currents about the wire, would produce exactly this result. That each separate impulse or wave has its origin at an equal distance from the wire on all sides accounts for the concentric appearance of the field about the wire as will be seen by Figure 8, where the upward currents are shown passing thru a sheet covered with iron filings. The production of these inward and forward currents about the charged wire, produced by the current in the wire, are in exact accordance with our knowledge of the effect of a moving body, such as a projectile thru the air.

With the direction of these currents in mind, and remembering the spiral nature and direction of the currents surrounding a magnet, see how exactly these accord with the action of a magnetic needle placed in the magnetic field of a wire bearing a current and how clearly and logically it accounts for the action of the needle. When

The author of the present article has, to many minds, opened up an entirely new field of experimentation with his "magnetic currents." Particularly would this appear to be the case in the previous articles in which Mr. Mace showed some excellent photographs taken by what he calls "magnetic currents" and which he produced by placing a magnet close to a covered photographic plate for a period of several weeks in total darkness, when the outlines of several objects lying on the photographic plate were actually photographed thereon.

Many years ago (1851), however, quite similar phenomena to these outlined were observed and explained at great length in a scientific work by Baron Von Reichenbach, who claimed that it was possible to "see" the magnetic force about magnets, and to which the name of "odic flame" was given.

a magnetic needle is placed within the influence of a wire bearing a current of electricity upward, the needle points to the north when on the east side of the wire, to the west when on the north side of the wire, to the south when on the west side of the wire, and to the east when on the south side of the wire. In the first position, to the east of the wire, with its center at the point of tangency of a concentric circle, the currents surrounding the magnet on the side nearest the wire will be moving in the same direction as the currents drawn towards the wire and upward as shown in Figure 9, in which are shown the currents moving upward and toward the wire and on the right, or east, a magnetic needle with its south pole indicated and the currents surrounding it moving in the same direction as the currents moving toward the wire. At the left, or west, of the same figure is a needle with its north pole pointing south showing the currents about it also moving in the same direction as the currents toward the wire. In both cases there are four conditions tending to keep the needle in this position with its center tangent to the circle. The currents on the under and inner side of the magnet will be re-enforced by the currents moving toward the wire and these currents will tend as far as possible to set themselves in parallel directions and these forces acting upon the equidistant ends of the needle will be equal and the needle will be in equilibrium as a tangent with its center touching the circle. The spiral currents emerging from the center of the magnetic needle are strongly drawn into the currents entering the wire and thus the center of the needle becomes the natural center of equilibrium. The currents about the magnet on the lower and inner side are moving in the same direction as the currents entering the wire and a partial *ether-vacuum* is formed and the tendency of the needle is toward the wire but so long as the ends are equidistant the equilibrium is maintained with the needle tangent to the circle. On the upper and outward side of the needle the currents are moving counter to the currents entering the wire and a *condensation* is set up tending to force the needle toward the wire but so long as the ends of the needle are equidistant equilibrium is maintained with the needle tangent to the circle with its center touching the circle. Move the needle



How the Author Explains the Action of a Magnetic Needle (Compass) When Placed in the Field of a Charged Conductor.

on the right 1 mm. directly north. The equilibrium is at once destroyed. The currents tending to re-enforce each other and to move parallel are now acting upon 2 mm. more at the north end of the needle than at the south end. The currents at the center of the needle are further from the point of tangency and the center is drawn toward the wire. The vacuum on the inner side of the needle is acting upon 2 mm. more of the north end of the needle than upon the south end, the condensations on the outer side of the needle are acting upon 2 mm. more of the north end of the needle than on the south end, and the north pole of the needle is deflected to the west until the center of the needle again becomes the point of tangency and equilibrium is restored. The same condition will prevail as the needle is moved along until at the north of the wire the needle will point to the west. Continue, and at the west of the wire the needle will have its north pole pointing south, as shown in the figure. The needle will always set itself tangent to the circle at its center point so that the vacuums and condensations at both ends will be equal, so that the currents surrounding the wire and the magnet will, as far as possible, be moving in parallel directions, and so that the two sets of currents between the wire and the magnet will be moving in the same direction and re-enforce each other. This is in accordance with all known laws of physics—it is what would be predicted of air currents under the same conditions.

So far we have spoken of this motion about the wire and the magnet merely as "currents." Now let us consider what these currents really are. It has heretofore been considered and conceded by physicists that the "lines of force" in these fields are *ether effects;* that they are "lines of tension," "lines of direction," etc., in ether, and that the waves given off into air by an electric discharge are *ether waves.* A magnet works just as well and just as effectively in a vacuum where ether is the only substance present as it does under other conditions. Finally, the action of these currents on a photographic plate in the production of magneto-graphs by the magnet and the charged wire prove these currents to be *currents of ether.*

Granted, that magnets owe their effects to ether currents about them, and there can be no further question in regard to this, how simple and logical becomes the action of the magnetic needle, the creation of electromagnets, and the phenomena of magnetic attraction and repulsion.

If two solenoids or two permanent magnets be placed one above the other with their north poles pointing in the same direction, the currents on the upper side of one and the currents on the under side of the other will be moving in opposite directions. These currents meeting each other will form condensations, will mutually oppose each other, and the reaction will drive the poles apart. This action will continue till the north pole of one is over the south pole of the other, in which position the currents at both poles of the two magnets on the upper side of one and on the lower side of the other will be moving in the same direction, the currents will re-enforce each other; the tendency will be to set themselves parallel to each other, a partial vacuum will be formed and the poles will be attracted towards each other.

Under these conditions the action of a magnetic needle in pointing to the poles of the earth is no longer mysterious. An average child might be led to see the cause. The earth is rotating in ether from west to east. This, and the revolution of the earth about the sun, sets up ether currents moving from east to west about the earth, just as a ball whirling in air has air currents about it. This, as with the currents about an electromagnet, makes the north pole of the earth a south magnetic pole. A magnetized needle then tends to turn so that its north magnetic pole points to the south magnetic pole of the earth as explained in regard to two magnets, so that the currents about the earth and the currents on the under side of the magnet will

(*Continued on page* 486)

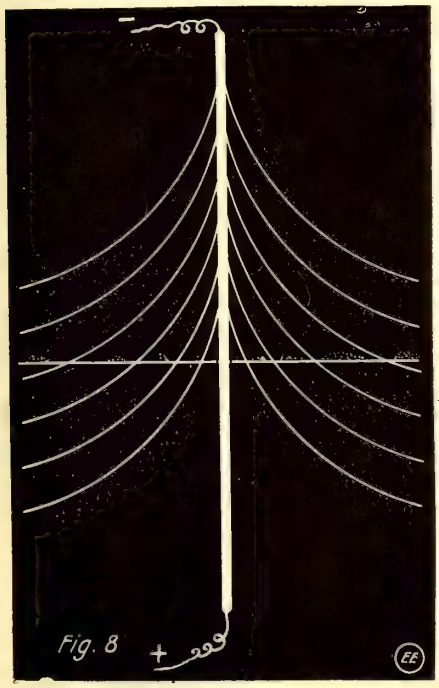
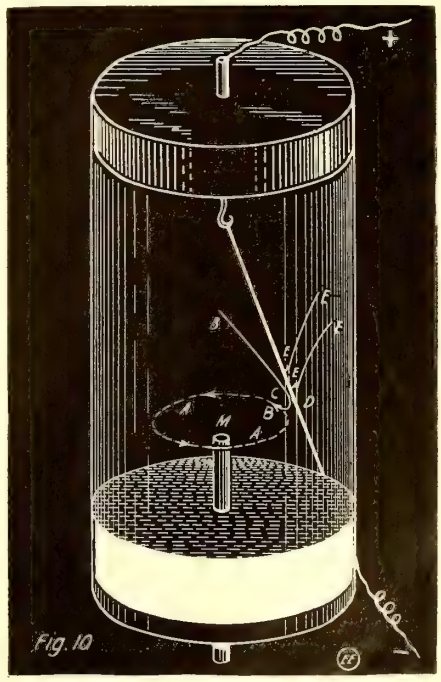


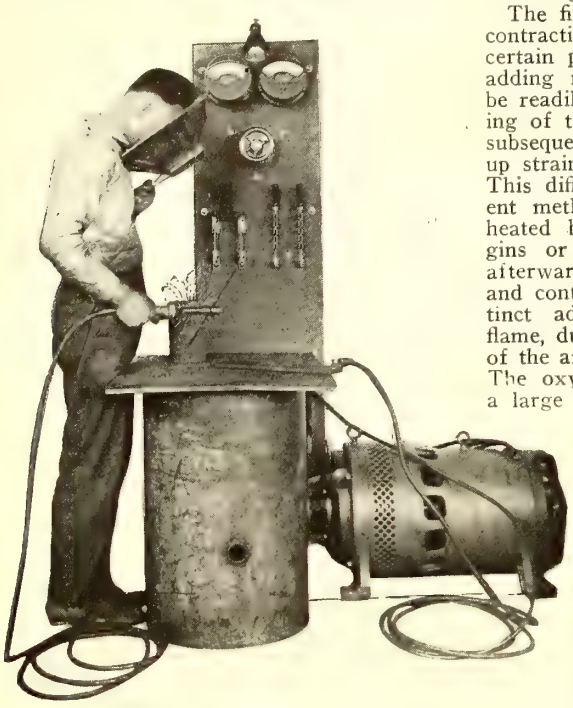
Diagram Showing How the "Wave Motion" About a Charged Wire Produces Concentric Rings of Force on a Plate Containing Iron Filings, By the Upward Movement of the Conductor Currents.



The Well-known Experiment of the Revolving Wire Dipping in Mercury, Is Used to Further Prove the Author's Case of "Currents About Magnets."

WELDING WITH THE ELECTRIC ARC.

Reduced to its simplest terms, the electric arc is a gap in an electric circuit. The current "jumps" or "arcs" across this gap.



Complete Electric Arc Welding Outfit. It May Be Moved From Job to Job When Desired. Note the Glass Shield Which Operative Uses to Protect Eyes From Blinding Glare.

It does this against great resistance because electric current does not pass easily thru the atmosphere. Because of this resistance great heat is produced and the ends of the gap in the circuit become very hot.

Boys have made an electric arc for welding purposes by simply connecting to the leads in a pair of lead pencils each wire of an electric circuit. When the leads are touched and drawn apart an arc is formed and heat is produced which is great enough to melt metals with which it comes in contact. In actual practise this process is of course much refined, as a matter of fact the metal which is to be welded usually forms one end of the gap, or one electrode, and a stick of carbon or a rod of metal forms the other electrode.

The heat produced by the electric arc has never been measured, but it is variously estimated at a temperature of 6.500 to 7,000 degrees Fahrenheit, and is the highest temperature which can be produced at the present time.

The principal advantage of the electric arc for welding is the fact that it produces intense heat at very low cost. Compared for instance with the oxy-acetylene torch, the electric arc will produce effective welding heat at from ten to thirty per cent of the cost of the other method.

The electric arc may be used for welding practically all metals. There are several practical difficulties, however, which are always encountered in welding work. These limit the use of the process for commercial purposes somewhat.

The first difficulty is the expansion and contraction which results from heating a certain part of a piece of metal or from adding new metal in any part. It will be readily seen for instance how the heating of the rim of a metal wheel and the subsequent cooling of that part would set up strains in different parts of the wheel. This difficulty can be overcome by different methods. The whole piece is often heated before the welding operation begins or it may be annealed by heating afterwards. In the matter of expansion and contraction the electric arc has a distinct advantage over the oxy-acetylene flame, due to the fact that the intense heat of the arc is confined to a very small area. The oxy-acetylene flame always heats up a large area around the weld.

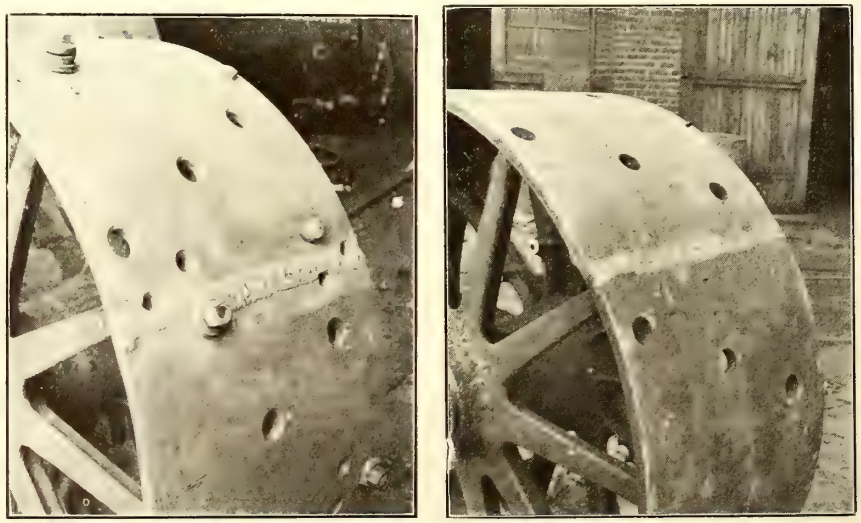
The second difficulty in welding is due to the formation of oxids. Metals at high heat combine with oxygen, the oxids thus formed on the parts of the metal to be welded will prevent the metals coming in intimate contact and a perfect weld cannot result. The welded surfaces, however, may be kept clean by floating the oxid on top of the molten metal.

Let us say that the arc in a given welding example uses 150 amperes current, the voltage of the supply line is 250 volts, and the voltage really necessary at the arc for welding purposes averages 25 volts. Also assume that the current will cost 2 cents per K.W.H.

We will then compare the cost of electric power first, when welding with simply a resistance in the circuit; second, when welding with a 75 volt constant voltage motor-generator, and third, when welding with a 25 volt motor-generator.

We shall then have the above figures.

System	Formula		Current in Arc	Kilowatt hours per hour welding	Cost of Power per hour of welding
250 Volt line with resistance.....	$\frac{\text{Amp.} \times \text{Volts}}{1000}$		150 Amp.	37.5	75 cents
Motor generator, 75 Volts Constant with resistance.....	$\left(\frac{\text{Amp.} \times \text{Volts}}{1000}\right)$	1.25	150 Amp.	14.06	28 cents
Motor Generator Variable Voltage, average 25, no resistance.....	$\left(\frac{\text{Amp.} \times \text{Volts}}{1000}\right)$	1.25	150 Amp.	4.69	9.4 cents



A Good Example of Welding Rolled Steel. The Rim of this Motor Truck Wheel Is Formed by Rolling a Steel Plate Into Shape, Welding the Two Ends Together. The Illustration Shows It Before and After Finishing. The Metal at the Weld Was Cut Down Until It Was No Greater In Thickness Than That in the Plate and Still It Was Sufficiently Strong for this Severe Service. Finished Rim at Right.

AN ELECTRIC AUTO INDICATOR YOU CAN'T MISS.

A New York inventor has recently patented a novel device for indicating the direction proposed to be taken by moving automobiles.

Two lamp bodies are fastened in the middle of the rear mud guards. Suitable bulbs are connected with storage battery or other existing power source and may be



You Can't Miss this Electric Auto Indicator. The Illuminated Hand at Right or Left Indicates Which Direction the Machine Is Going to Take. Works in Daytime as Well as Night.

illuminated by a mechanism placed on the shaft of the steering wheel or near the driver. When the lamp in either lamp body is lighted, a large figure of a hand is shown up clearly. This figure shows as distinctly in the sunlight as it would at night. The hand points the way the car is going to be steered or driven.

Transparency glasses are furnished in the forward sides of the lamp body and when illuminated the direction in which the car is going to be turned can be seen by a car being driven toward it, as well as any car approaching from the rear.

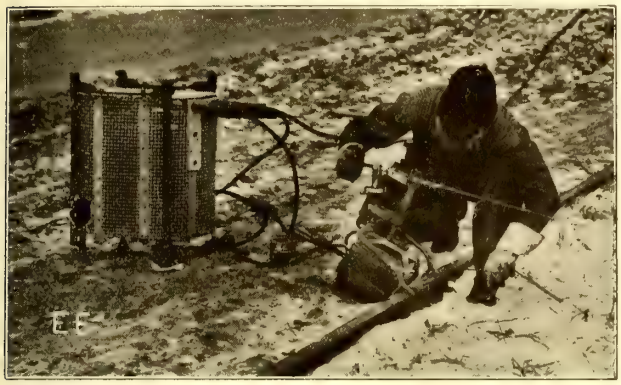
A bell situated at any convenient position on the car is so arranged that it rings at the time bulb lights and continues till the light is turned off.—Allen P. Child.

NEW PHYSICO-CHEMICAL INSTITUTE IN JAPAN.

The "Elektrotechnische Zeitschrift" contains a note on the new physico - chemical research institute being establisht in Japan. It is stated that 2,000,000 yen has been allotted and that the buildings were partially completed by the end of 1916. Among the subjects to be dealt with at the institution are: Electrical and electrochemical researches, testing of instruments and thermometers, research on optical glass, synthesis of colors, rubber and oil, the fixation of atmospheric nitrogen, microscopy of metals, etc. The program also provides for a systematic study of the natural resources of Japan, Korea, Manchuria, etc.

PORTABLE ELECTRIC WELDER BONDS TRACK RAILS.

In order to provide a means of installing electrically-welded bonds, which would be within the economic possibilities of every railway, however small, a Cleveland, Ohio, concern has developed a portable welder. This apparatus is extremely simple, consisting merely of a resistance element, weighing about 200 lbs., and an electric furnace weighing 65 lbs. The function of the apparatus is to make possible the utilization of the current from the trolley for welding the bonds onto the rail with the smallest possible apparatus. By the use of this outfit an electrically welded bond is obtained with a contact having an initial high conductivity, and one which is claimed will not depreciate on account of the elements, etc. In obtaining this union between the bond and the rail, neither an arc nor flame strikes the bond or rail, thus avoiding the danger of injury to the bond, rail and eyes that such methods are liable to introduce. Instead, a heated block of grafite presses against the bond terminal, which produces a true weld and which is accomplisht with neither injury to the operator, the bond or the rail.



Welding Trolley Track Bonds With An Electric Furnace of Special Design. It Works Quickly and Is Portable. Time Per Weld Is About One Minute.

The apparatus is held in position for installing a bond by a yoke which sets over the head of the rail and a chain and hook fastened to the opposite rail. This holds it in a tilted position, so that a part of its weight presses the bond.

The process is as simple as the apparatus. The trolley circuit thru the resistance and furnace to the rail is completed by closing the 200-ampere circuit breaker mounted in the center of the rheostat and controlled from the handle at the bottom. The regulation of the welding is obtained by adjusting the position of the electrode and by the use also of five points on the rheostat for this purpose. A current of from 60 to 125 Amp. is used in making a weld and a separate weld is made for each terminal of the bond. The time required per weld is about one minute.

ELECTROLYTE LEVEL INDICATOR FOR IGNITION BATTERIES.

Our illustration shows a new "Battery Protector" gage and its connections to the storage battery of an automobile.

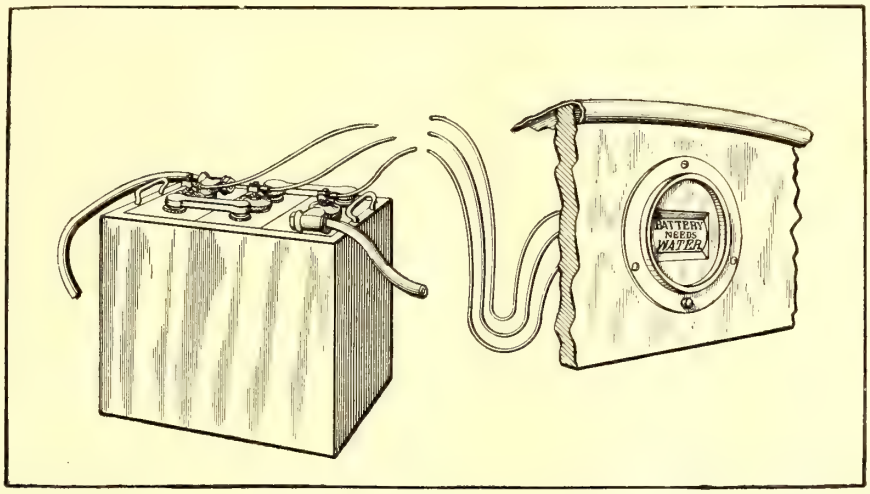
The dial of the instrument shows that the battery needs water which means that the electrolyte in one or more of the jars of the battery has evaporated until the level of the fluid is approaching the low danger point.

When all of the jars of the battery are sufficiently filled with fluid, the instrument will show blank.

Nearly all battery trouble is directly traceable to a condition in which the fluid in the battery has been permitted to evaporate without being replenished, thereby exposing a portion of the plates and resulting in serious danger to the battery.

With this "Battery Protector" installed on your car, you are immediately notified in event the evaporation of the fluid in the battery reduces the level to the danger point and instead of taking the filler cap off the battery every few days to determine whether or not there is sufficient fluid in the jars, you simply watch the gage dial and as soon as the fluid level is lowered (or the battery develops a leak or low cell) you are advised.

There is absolutely no chance of the device failing to indicate the low fluid level in the battery as the device works on a closed circuit and displays its warning signal as soon as the circuit is opened.



Every Battery User, and That Includes Most Every Autoist, Knows What a Nuisance It Is to Keep Tabs on the Electrolyte Level. Here's An Instrument That Indicates Instantly When "Battery Needs Water."

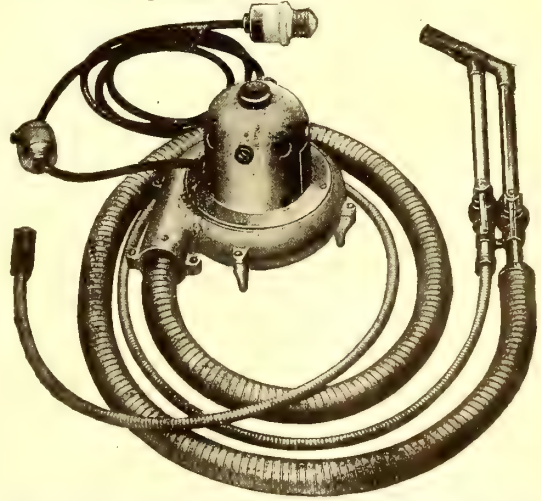
ELECTROLYTIC BEHAVIOR OF TUNGSTEN.

Walter E. Koerner has carried out extensive experiments and research work under the direction of Dr. C. G. Fink, in the research laboratory of the Edison Lamp Works at Harrison, N. J. He recently made public the results of his investigation in a paper read before the American Electrochemical Society. An interesting feature of the paper was that regarding the use of tungsten in cells. In this connection the author states that for the construction of a voltaic cell with tungsten as the negative electrode it is desirable to use an electrolyte in which both the tungsten and the anodic reaction products are most soluble. With a sodium hydroxid solution as electrolyte, mercury or silver may be used as positive electrode against tungsten as negative electrode. The emf. of such a combination using mercury is 0.49 volt, with silver 0.69 volt. Preliminary experiments with tungsten both as fused slugs and as metal powder were promising, especially those with the latter. Another series of experiments was made and is still being continued on the use of tungsten in standard cells, results of which will be announced later.

A NOVEL SELF-CONTAINED ELECTRIC-GAS BRAZING TORCH.

Electrical manufacturers and contractors with small or medium-sized shops where compressed-air equipment is not installed often are at a loss for convenient facilities for brazing small pieces, heating melting pots, annealing and hardening small tools, etc. For these and similar purposes there has been placed on the market the compact combined electric and gas torch here illustrated. The outfit consists of a small motor-driven blower, that furnishes the air blast, a brazing blow pipe, five feet each of armored air hose and gas hose, and a five-foot connecting cord with feed-thru switch and attachment plug. The motor is a universal machine suitable for use on 100-volt direct or alternating-current circuits. The gas supply pipe should be at least one-half-inch size. Using standard illuminating gas with the outfit it is possible to obtain a temperature of 2,300 degrees Fahrenheit, which means that extremely rapid work can be done. The gas and air supply can be readily regulated by means of the cocks in each supply hose. The blower is powerful enough to supply air for four burners.

Woody Island, near the Alaskan town of Kodiak, will be the site of the big radio station the Navy Department is about to establish to connect Alaska with the chain of wireless stations on the Lower Pacific Coast. This will insure against interruption of communication.

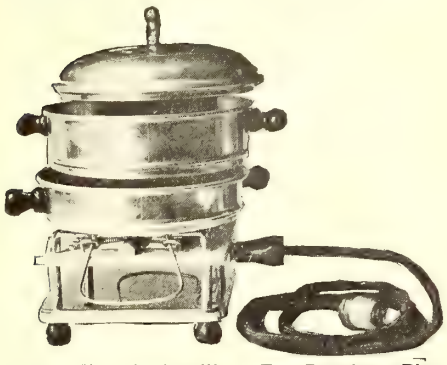


New Combination Brazing Torch, Consisting of Gas Blow Pipe and Electrically Driven Air Blast. It Is Extremely Compact and Needs Only to Be Connected to Gas Pipe and Light Socket.

NEW ELECTRIC STOVE AND STERILIZER.

Perhaps what is one of the more advanced types of electric stoves is now being offered on the market.

A distinct innovation is the structure of



Latest Electric Sterilizer For Dentists, Physicians, Etc., the Electric Heater Being Available Whenever Desired as a Stove or Toaster.

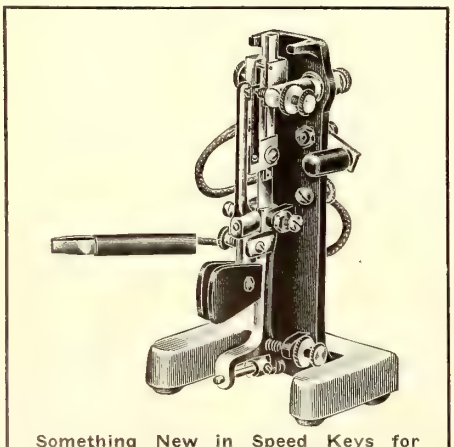
the stove, it being made in a new way, very light, strong and durable. It has all the good points and none of the bad ones. It can cook, broil, toast and do a number of other things as a much needed convenience in the home, and is also adapted to laboratory and sickroom with its sterilizing equipment. With the pans as shown in the photo are furnished racks so that medical instruments, etc., can be placed in the same for thoro sterilizing.

With its number of good features and multifarious service delivered, it should find many friends.

A VERTICAL TELEGRAPH SPEED KEY.

Herewith is shown a new vertical telegraph speed key. The vertical key combines in one stroke extreme simplicity, efficiency, light weight, (one and one-half pounds) and it produces a very superior quality of full, solid, clean-cut dots. In addition may be mentioned the fact that with this new instrument it is next to impossible to run dots and dashes together.

It represents an improved type of single contact instrument and it is so extremely simple that it reduces repairs, adjustments and replacements to a minimum. The key has a remarkably easy touch. Moreover it is unnecessary to change any adjustments about the machine except to slide the speed weight up or down when it is desired to send faster or slower or to adjust the tension springs so that the



Something New in Speed Keys for Radio and Telegraph Operators. It Sets in a Vertical Position, Being Held Upright by a Substantial Base.

"touch" of the key lever feels best. And you can, of course, regulate the lightness or heaviness of dots by turning the contact screw in or out—just a little at a time—until the dots appear to be solid and clear. Otherwise, there are no adjustments to be made.

A REMARKABLE ALUMINUM SOLDER.

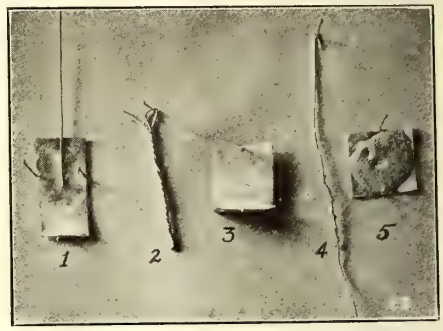
Soldering aluminum parts to one another or to other metals has always proven a very difficult proposition, and this problem has become of extremely vital importance of late owing to the fact that many aeroplane parts are made of this peculiar metal which refuses to unite with any ordinary metal under the usual soldering and brazing conditions, owing to the oxid which forms very quickly on the surface of the aluminum, as soon as it is cleaned preparatory to making a joint.

It remained for Dr. O. F. Reinhold, of New Jersey, to invent a really successful aluminum solder which most important of all, makes a joint which is every bit as strong and generally stronger than the metal itself, which it unites. No flux is necessary with this solder, and it can be melted in the ordinary Bunsen flame.

The accompanying photograph shows several samples of the work which can be done quickly and without the least trouble or preparation of the pieces, and all of which specimens were prepared before the Editors by the inventor.

Specimen No. 1 at the left shows how a piece of aluminum, copper or brass wire can be united to a piece of aluminum sheet so as to form a solid connection, producing in this way an extremely serviceable electrode for use in electrolytic rectifiers or electrolytic chemical determination apparatus.

Specimen No. 2 shows several wires twisted tightly together, but without any cleaning at all and which were firmly soldered in a minute's time with this new



Some Specimens of the Work Accomplisht by New Aluminum Solder. The Joint Is as Strong as the Stock.

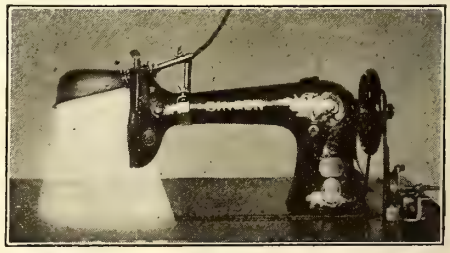
aluminum solder, the solder running thru between the wires and making a first class joint in every particular.

Specimen No. 4 is also a wire joint made with this solder. No. 3 shows a small square piece of aluminum sheet soldered to a similar piece at right angles. Not only was this joint very solid, permitting one to bend the aluminum to any degree without showing the least strain at the joint, but once the top wing shown was soldered on and "set," it was then possible to solder another piece on the opposite side of the longitudinal strip without loosening the solder at the first joint—a truly remarkable characteristic of this unique soldering and welding preparation which occupied eighteen years of the inventor's life in its solution.

Figure 5 shows one of the most novel applications of this aluminum solder which one can imagine, viz., that of causing ordinary *wire solder* to flow and securely take hold on a piece of aluminum sheet. The inventor has outlined a possible and very radical idea in this direction with reference to storage battery construction. He proposes that where a light weight storage battery is desired, that the base structure of the plates be made of aluminum and then coated with lead by means of his new solder. The inventor also claims that his solder changes to aluminum itself.

ELECTRIC LIGHT FOR THE SEWING MACHINE.

The adjustable light fixture here illustrated provides a perfect and directly applied working light. By so doing they increase the efficiency of the operator. By their use all machines can be lighted to save current and to prevent eyesight troubles, the makers state.



Investigation Has Shown That About $40,000,000 Is Lost Annually By all Manufacturers, in the United States, Thru Improper Lighting, and That the Clothing Trades Bear Their Share. Here's One Answer to the Problem.

The lamp can be placed instantly in any desired position or as quickly moved out of the way.

ALL ABOARD FOR THE DECEMBER "E.E."

The Xmas number of The Electrical Experimenter *will fairly teem with good things. It will contain articles of interest to every man, woman and child—to use the language of the "Big Show" barkers. There will be special feature contributions from well-known writers as well as many new ones. If you want to know what to buy or what to make for Xmas, then don't fail to read the "December" issue. Among other feature articles are the following:*

"A New Electric Bomb Dropper For Aeroplanes," by F. R. Lewis, Military Expert.

"Locating Submarines by Radio Waves—A Tested Scheme," by Leon W. Bishop, One of Edison's Electrical Experts.

"The Aurora Borealis; Its Effects on Telegraph and Cable Lines," Some facts on this remarkable phenomenon.

"How to Use High Frequency Currents in the Treatment of Disease," by Dr. Frederick Finch Strong, M.D.

"The Marvels of Radio-Activity,"—Part IV., by Jerome S. Marcus, B.Sc.

"A Revolving Electric Xmas Tree—How to Make It," by John T. Dwyer.

"The Mysterious Voice"—A Clever Home-made Electrical Illusion, by C. A. Oldroyd.

"The Audion vs. the Edison Effect," by George Holmes.

"Radio Transmitting Inductances"—5th paper of "How and Why of Radio Apparatus" Series.

A Funny Electrical Story—"Telling Time by the Stars," by Thomas Reed.

"Experimental Physics"—Lesson 10—by John J. Furia, A.B., M.A.

Action at a Distance as Exhibited in Selenium Crystals

By PROFESSOR F. C. BROWN, PH. D.* STATE UNIVERSITY OF IOWA

ACTION at a distance has puzzled physicists and philosophers alike for centuries. By what means can the Sun act on the earth to heat it, or by what mechanism can the Sun act on the earth so as to be constantly

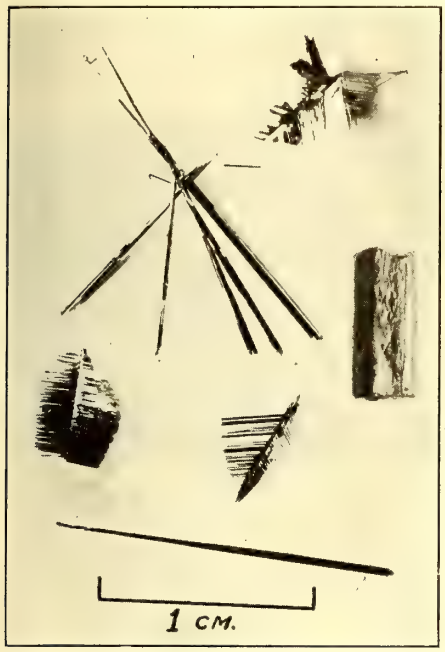
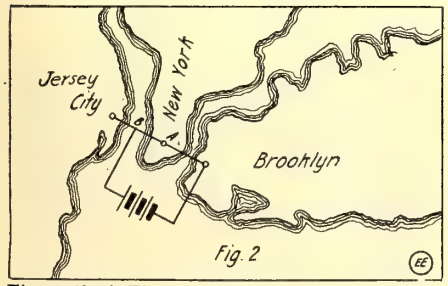


Fig. 1. A Few Specimens of Extra Sensitive Selenium Crystals Used by Professor Brown in His Researches on the Electrical Action Occurring in This Substance.

pulling the latter away from a rectilinear path? Or how can the earth continually accelerate the moon toward the earth? We have had to be satisfied in these latter cases with the knowledge that the mutual attractions between these planes are in accord with the law of gravitation. But no physicist even thinks he knows what gravitation really is. Generally we think that heat on the Sun is a molecular motion, a part of which is transmitted to the earth by consequent waves set up in a hypothetical medium, the *ether*. But grant the necessity of this medium, who knows how these waves are set up by vibrating electrons or molecules! It would be out of place here to discuss all the difficulties that this ether has plunged us into. Primarily this ether was and is required to explain radiation and gravitation at a distance.

How can two charged pith balls which are disconnected, repel each other. There are just two answers possible apparently,



Theoretical Electric Circuit Devised by Author to Show That Changes in Resistance, Etc., of Single Conductor Extension at B Will Not Affect Current in Closed Battery Circuit.

one is that some medium surrounding one ball is set in some state of stress or agitation which reacts on the second pith ball. The other explanation is that the one pith ball acts at a distance when there exists a charged body at the distant point. The action is usually supposed to be transmitted by some method not thoroly understood; something like mental telepathy perhaps. Similarly two magnetic poles act on each other at a distance as will also a current of electricity act on a distant magnet.

Action at a distance in matter is quite a different phenomenon, because it is easy to imagine almost any desired mechanism in matter and because we have become familiar with certain transmitted effects in matter. Thus an earthquake may effect a seismograph on the opposite side of the earth, by a wave sent thru or around the earth crust. A bar of iron if heated at one end will, after a time, become hot at a distant point, by the well known process of conduction thru molecular motion. If a copper wire is supplied with an excess of electrons at one end or merely acted on by electromagnetic forces, there will be manifest certain electrical changes at the opposite end.

But in the instances above the transmission is relatively slow compared with light and gravity. There is manifest in selenium crystals an action that seems to be transmitted much more rapidly than other actions in matter mentioned above. Some of these selenium crystals are reproduced in Fig. 1.

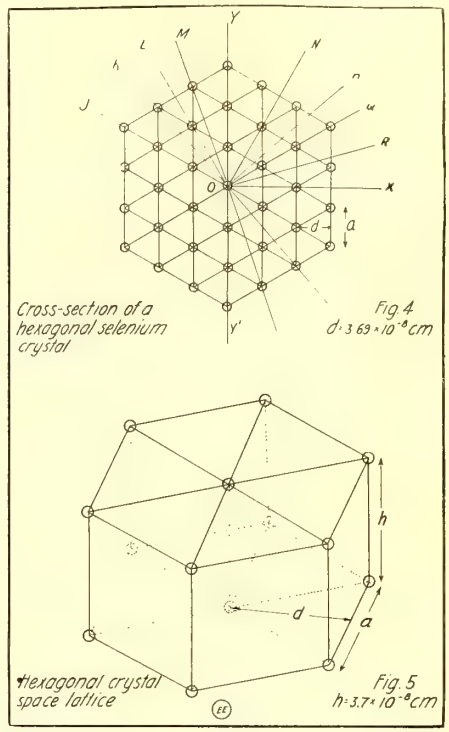
Imagine an electric circuit connecting New York and Brooklyn with one wire forming a part of the circuit projecting into Jersey City as shown in Fig. 2.

Now it is perfectly well understood that if the physical conditions surrounding the wire between the points A and B are altered, the resistance and consequently the current may be altered, *e.g.*, if the temperature rises in the region AB the resistance will rise. But the part of the wire projecting out into Jersey City, no matter how much it might be heated, would exhibit no change of resistance, beyond the region AB.

Now if we imagine the wire projecting thru AB to be replaced by a metallic selenium crystal of the hexagonal system, we have an entirely new situation. Consider the circuit shown in Fig. 2 or Fig. 3. A selenium crystal whose length is about 100 times its diameter, has one end clamped between electrodes in such a manner that the electric circuit is completed. Now if a narrow pencil of light falls on the part of the crystal between the electrodes, the conductivity of the crystal is altered; most of the change taking place within .01 second. This has been known for some time. However, if the same pencil of light falls anywhere along the crystal, the change of conductivity between the electrodes is almost as great as if the light impinged there. Moreover the change of conductivity takes place just as rapidly when the illumination is at one end of the crystal as at the other, so far as measurement can determine. In other words the action of light on the crystal at O is transmitted to P without any apparent lapse of time. At least the lapse of time is less than .01 second. The conductivity itself takes place only between the electrodes and not around the crystal as is proved by the fact that no alteration of the conductivity occurs by breaking off the crystal at any point beyond the electrode contacts. The fact that the transmission of the light action takes place in less than one hundredth part of a second, is ample proof that the transmission is not of the nature of a heat wave.

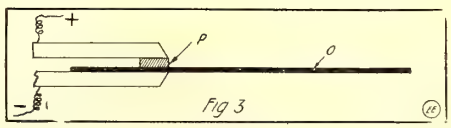
A New Property in Matter

Thus we have found a new property in matter, *viz.*, the illumination of matter at one point and consequent action taking place at a distant point. The magnitude of the distance is probably limited only by the length of the crystal. Thus far this limitation has been about 15 millimeters. The manner of transmission is just about as much a mystery as the transmission of the force action between the Sun and Earth.



X-Ray Analysis Has Shown That the Selenium Atoms Are Situated at the Corners of Triangles, in Such a Manner as to Form Hexagons. The Distance Between Atomic Centers Is of Course Extremely Small.

An X-ray analysis shows the selenium atoms to be placed at the corners of triangles in such a manner as to form hexagons. The distance between the atomic centers as shown in Fig. 4 is 3.69×10^{-8} cm, when measured perpendicular to a regular surface running parallel to the principal axis. These hexagonal plates are fitted one against the other lengthwise so as to build up an acicular hexagonal crystal such as shown in Fig. 5. The distance between these plates as shown by the X-ray spectrum is 3.7×10^{-8} cm. or .037 millionths of a centimeter. From this data and the knowledge of the density and atomic weight of selenium crystals, it is very easy to show that two atoms of selenium are placed at every point in the space lattice composing the crystal.



If a Narrow Pencil of Light Falls on a Selenium Crystal at O, It Acts in the Same Space of Time as If the Light Acted on the Point P. Truly, Action at a Distance.

The light might produce a vibration of the selenium molecules or the planes of molecules and then these planes of molecules would produce motion in the next neighboring planes and so on until the planes all along the crystal were in vibration. In this case the vibration would be

(*Continued on page* 489)

* Paper specially written for THE ELECTRICAL EXPERIMENTER.

Experimental Physics

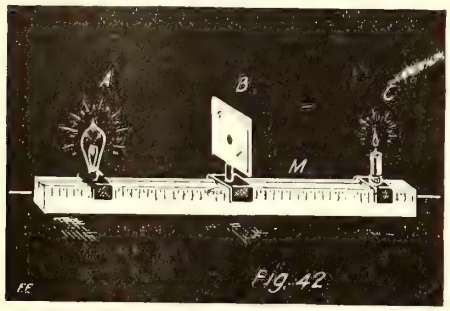
By

JOHN J. FURIA, A. B., M. A. (Columbia University)

LESSON 9.

Light (Continued).

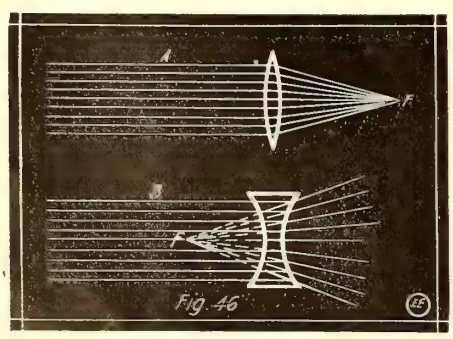
THE second and more important difficulty in the way of the *Wave Theory* of light was that it failed to account for the fact that light is propagated in a straight line. Sound, water, and all other forms of waves with which we are acquainted bend around corners, whereas light does not. The German Band's melodious (?) strains (on the ear) are readily heard from around the corner, but the players cannot be seen, because of this fact. During the last century, however, this difficulty has been removed completely, and it has been found that light has other properties which can be satisfactorily explained by the wave theory and not by any past theory.



A Simple Apparatus for Measuring the Candlepower of an Incandescent Lamp Is Readily Constructed as Shown.

In the preceding lesson it was indicated that if the Wave Theory is to be accepted, we must hold the same view as Huygens, namely that *all space is filled with a medium called the ETHER,* in which these light waves travel. This medium is altogether different from the ordinary forms of matter, for if any of the ordinary forms of matter permeated interplanetary space, the motion of the planets and other heavenly bodies would be retarded, while as a matter of fact no such retardation has been observed by the astronomers during these many centuries, despite the extremely accurate observations that have been made. Hence our ETHER has a density infinitely small even in comparison with such light gases as Hydrogen. The existence of ether is now practically universally assumed by scientists thruout the entire world.

It should be noted at this point that *wireless waves* are also waves of the ether and resemble light waves in many respects. (This will be taken up in detail in a later lesson.)

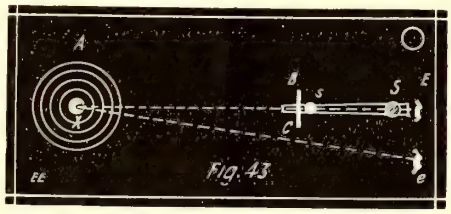


How Light Passes Thru a Convex Lens (A) and a Concave Lens (B). The Point "F" Is Called the Focal Point.

EXPERIMENT 51—

INTENSITY (Brightness) OF LIGHT —Place four candles in a straight line behind an upright pencil, and catch the shadow of the pencil on a white piece of cardboard or other screen. The room should be well darkened. Place one candle up closer to the pencil and not in the line of the four, thus catching another shadow on the screen. If now the one candle is moved, a position will be found when the two shadows are equally dark. Hence the illumination produced at the screen by the one candle and by the four candles is the same. If now the distances are measured from the screen to the candles it will be found that the four candles are twice as far from the screen as the one candle.

This is experimental proof that the **intensity of light varies inversely as the square of the distance,** *i. e.,* the nearer the source of light the greater the intensity or brightness of the light, and greater as the square of the distance, so considerable brightness is gained by even a small distance approach to the source. Intensities of light are usually given in terms of candle-power, one candle-power being defined as the amount of light emitted by a sperm candle 7/8 inch in diameter and burning 120 grains per hour.



How the Sharpshooter Hits the Bull's-Eye Every Time, Even Tho He Places a Piece of Cardboard Over the Front Gun Sight.

An apparatus for measuring the candle-power of an incandescent lamp or other light can be easily constructed and used. M (Fig. 42) is a meter stick or yard stick.



The Various Kinds of Lenses in General Use.

A is the light of which the candle-power is to be found. C is a standard 7/8 inch sperm candle, while B is a small frame having a piece of white paper in it, the center of the paper being spotted with oil or grease. A, B, and C are mounted on small blocks having grooves just large enough so that they will fit the meter stick and slide along it freely. Place C near B, light the candle but not A. If now we look at screen B from the side of C the oil spot appears dark, while if we look at B from the side A the spot appears lighter than the surrounding paper. WHEN THE PAPER IS LOOKED AT FROM THE SIDE OF GREATER ILLUMINATION THE OILED SPOT APPEARS DARK, but when looked at from the side of lesser illumination it appears *light.* Obviously if both sides are equally bright, the spot appears equally bright with the rest of the paper. Hence if A and C are both lighted and moved back and forth until the spot cannot be distinguished from the rest of the paper we know that the illumination reaching the frame from both A and C is the same. Measuring the distances from B of A and C and remembering to use the square of the distances we compute the candle-power of A. This apparatus is known as the Bunsen (after the inventor) or *grease-spot photometer,* and is still used commercially.

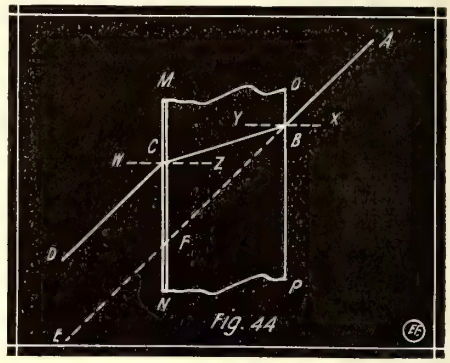


Diagram Illustrating How a Beam of Light Is Bent or Refracted, as A, B, C, D, in Passing Thru a Piece of Glass M, N, O, P.

EXPERIMENT 52—

Several years ago I saw a sharpshooter give an exhibition of excellent shooting. At the close of the exhibition he performed a seemingly marvelous feat. He shot at his target and hit the bull's-eye while he had a piece of paper stuck over the front sight, which apparently was, as he said, the equivalent of shooting with his eyes shut, (since he could not see thru the cardboard). A careful study of Figure 43 will expose his trick. A is the target, BC the cardboard stuck over the barrel in front of the front sight "s," S is the rear sight, E and "e" are the performer's eyes. With the eye E, the performer sights along S and "s," and sight "s" appears on a certain definite spot in cardboard BC. With eye "e" shut, no matter in what position the gun is held, "s" always appears on the same spot and hence nothing could be hit by the performer except by chance. However, the performer contrary to usual custom in shooting *also holds the other eye open.* Hence thru eye "e" he sees the target, provided BC is just small enough so that the straight line "e"-X

(*Continued on page* 490)

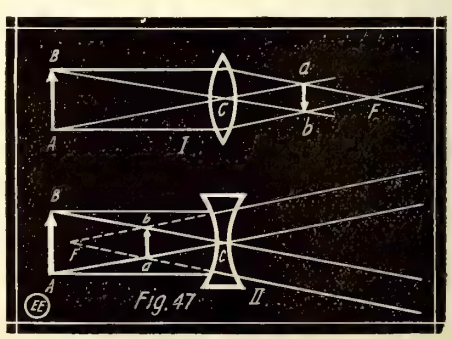


Diagram Illustrating the Factors Entering Into the Determination of the "Focal Length" of Convex and Concave Lenses.

The RADIO LEAGUE of AMERICA

HONORARY MEMBERS
CAPT. W.H.G. BULLARD, U.S.N. NIKOLA TESLA.
PROF. REGINALD FESSENDEN. DR. LEE DE FOREST.

H. Gernsback, Manager W. H. Kirwan, Master of Radio Relays

How Radio Amateurs Can Do Their Bit

By COMMANDER D. W. TODD, U. S. N.
Director Naval Communications and Chief Cable Censor

RECENTLY the Editor of THE ELECTRICAL EXPERIMENTER *asked me for a statement as to how the Amateur Radio Operators of the country can be of most service during the present war. I am very glad to answer this question, and I hope that this matter will reach the attention of a very large number of Amateurs.*

The Navy is greatly in need of radio operators for sea duty, and every opportunity will be given the amateur to serve his country. There was probably never a time in the history of AMATEUR WIRELESS *when it was so easy for a boy to obtain an unlimited amount of training and of practical experience without spending a cent for it. In fact, it is not necessary for a boy to have the slightest knowledge of wireless telegraphy; all that is needed is a desire to learn and a willingness to serve his country in time of need.*

The Navy, which for a number of years has been known as a vast school in itself, has taken special pains to provide adequate facilities for training radio men. Thru the kindness and patriotism of the authorities at Harvard University, the Navy has establisht a Naval Radio School at Harvard, which is now able to take care of 1,500 *pupils. The course is of four months' duration and embraces* MILITARY DRILL AS WELL AS RADIOTELEGRAPHY AND ALLIED SUBJECTS.

However, men are not sent to Harvard until they have reached an operating speed of ten words per minute in the Continental code. This need not discourage those who are interested, for preliminary training is given at no less than nine schools, located at the various Navy Yards. At these schools men are started in from the very beginning and prepared for the course at Harvard.

It is a very simple matter to obtain this free education. There are two ways in which it can be done; men can enlist in the regular Navy or enroll in the Naval Reserve Force. The difference is that enlistments in the regular Navy are for a period of four years of active service; in the Naval Reserve Force, enrollments are also for four years, but the active service is only for the period of the war or such longer time as the President may see necessary; in time of peace, men can resign whenever they desire. In time of peace in the regular Navy, it is possible to secure a furlough without pay for the rest of an enlistment when a man does not desire to serve the whole enlistment. Applicants must be 18 *years old, or if only* 17, *must have the written consent of parents. They must also be able to pass the required physical examination; however, minor physical defects are often waived.*

As indicated above, there is every opportunity for the older amateurs to get a valuable education free, but we must consider those who are not of the proper age or for other reasons find it absolutely impossible to enter the Naval Service. The question is often asked as to how they can be of service, too. There is no doubt in the world that they can be most useful by taking up LAND-LINE TELEGRAPHY.

It is a surprising fact that very few amateur radio operators are familiar with the American Morse code, yet this knowledge is quite essential in many ways. It is one of the requisites for a Commercial Extra First Grade license, for instance. All Navy operators assigned to shore duty must know both codes, for all shore stations have LAND-LINE CONNECTIONS. *It is not to be denied that it means hard work to learn the other code, even after being familiar with the Continental, but anything that is really worth while requires hard work, and since it is quite out of the question to authorize amateur radio stations, spare time during the war may very profitably be utilized thus.*

Any increase in the supply of Morse operators will be of great importance to the country from a military point of view. Every operator not eligible for military duty who secures a position with a commercial company may be the means of releasing a man for duty with our Navy or Army. Both the Western Union and Postal Company are glad to get operators, at salaries ranging from $60 *to* $100 *per month. Women are gladly taken by these commercial companies, if they are competent operators, while they are not eligible for sea duty in the Navy.*

Any amateur who desires further information should present himself at the nearest Navy Recruiting Office, where all features of the service will be carefully explained; any doubtful points should be referred to Commander D. W. Todd, U.S.N., Director Naval Communications, Southern Building, Washington, D. C.

An Interesting, Patriotic Appeal from Stuart W. Pierson, U. S. N., An Old Radio Amateur

U. S. Naval Radio School, Harvard University, Cambridge, Mass.
September 16, 1917.

The Radio League of America,
233 Fulton St., New York City.

Dear Sirs—Noting in the October issue of the ELECTRICAL EXPERIMENTER *the call for radio amateurs to offer their services to the government, I thought it might be of interest to know what I, as a member of the R. L. O. A., think of the Navy after two months of service in same.*

I joined the League shortly after its organization (in 1914) *and offered my services on the application blank. In March of this year I was notified by the Communication Superintendent of the Great Lakes district that I was wanted for the Naval Reserve. Later I enrolled in the same, but was not called at once, so joined the regular Navy and immediately went on active duty. Spent about three weeks at Brooklyn navy yard and was then transferred here to the new Naval Radio School at Harvard University. Outside of the good pay I am receiving and the satisfaction of knowing I am doing my duty, I am acquiring valuable assets that come thru Naval discipline. Of course it is a little hard at first, but as Mr. Herr of the Westinghouse Co., says in the October* ELECTRICAL EXPERIMENTER, *education alone will not insure success. One must have the necessary qualities of courage, tenacity, grit, and the ability to take reverses and hardships cheerfully. These qualities are developed to great extent in the Navy and at the conclusion of the war the Navy man will be prepared to take up his education where he left off with new vigor and he will have the stuff to make good. Of course those who wish to remain in service will also have ample opportunities to get a permanent, good paying position. From almost any angle one cannot fail to see the benefits to be received by joining the Navy. The Navy will be the biggest factor toward bringing the conflict to an end thru the reduction of the efficiency of submarine warfare. As the wireless operator is indispensable to the Navy it is up to the amateur to fill the need. Wishing the League the best of success in its campaign for radio men for the government, I remain,*

Very respectfully,

STUART W. PIERSON, U.S.N.
Formerly opr. of 9PY.

(Continued on next page)

Radio Roll of Honor

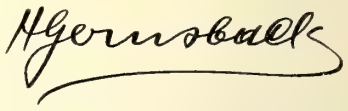
AS promised in our October issue, we are publishing in this issue the names of American Radio Amateurs who have voluntarily come forward in offering their services as radio operators to our Government.

Up to the time of going to press (Sept. 25), 425 applications were received, all of which are publisht in this issue. A fair showing for the first month, but very unsatisfactory as a whole. We want thousands more, and the Government needs these names at once. Amateurs of America! Again we say, come forward. Show your good will and your patriotism. After the war is over, YOU will be humiliated when your friends ask you: *"Why was your name not printed in the Radio Roll of Honor?"*

Yes, we ask you, WHY NOT?

Remember signing the blank appended at the end of this article does not send you into the trenches. Indeed, you may never be called at all for service, but the Government ought by all means to have your name on file in case your services should be urgently required. Read the letter by Commander Todd, U. S. N., publisht above, then read the letter of Stuart W. Pierson, U. S. N.—an old amateur;—this young man is in actual service now and as you may judge for yourself, he likes the work immensely.

Now amateurs, let's get busy, let's show the world, that American Amateur Wireless is a great institution, unparalleled and unmatched in any country. What do you say, fellows?



Radio Roll of Honor

Editor's Note. For obvious reasons, the city addresses of the applicants listed below have been left out. Only the name of the Radio Amateur as well as the State in which he resides have been publisht. Every applicant listed in these columns has pledged his services to his country as a radio operator.

All honor, and our sincere congratulations to every young man whose name appears here.

Alabama
Jas. M. Crump

Alaska
Verne Elliott

Arizona
Irwin Harrison
Fred Roebuck

Arkansas
R. N. Turner

California
Paul Nesbit
B. Ludlow
Harold Jaynes
W. E. Maguire
Robt. Johnston, Jr.
Albert Kober
Ralph Parker
F. Spiekerman
R. Stamback
C. Leslie Stebbins
Jack Hyams
S. Kerckhoff
Robert Kroman
Eldredge D. Barrett
Albert Lauretsen
Jos. Meyer

Colorado
Alison Kurth
Andrew Berglin
H. G. Eyth

Connecticut
Henn Kulikowsk
John T. Biot
C. D. Ryder
Geo. E. Hoke
N. V. Bradshaw
Thos. W. Cumming
Dan Latham
C. G. Hallstrom
Arthur A. Johnson
T. E. Johnson
F. W. Abbott

Delaware
Raymond Phillips

District of Columbia
A. L. Blakeslee, Jr.
J. C. Conner

Florida
E. J. Mazurewicz
T. H. Moore, Jr.

Georgia
A. W. Church
George Wilby
Hugh Schliestett

Idaho
Charles Cherington

Illinois
Joe Aiken
James T. Murray
John Ralph Watkins
D. E. Peebles
Owen Jarboe
J. D. Kingsley
H. R Ferguson
Eugene E. Amory
W. G. Asmus
G. Waldo Ball
R. J. Beuerman
R. W. Bowen
Morrill C. Des Isles
Eugene Ericson
Louis Flader, Jr.
Arthur U. Gardner
Wesley Harmeyer
D. V. Johnson
Chas. J. Keenan
Arthur Larson
Fred C. Leemann
Michael M. Ostropol
William E. Preece
Alex. Sieber
H. E. Smith
J. P. Smarski
Henry Williams
Harold Newman
Chas. F. Enz
Geo. E. Burritt
Frank L. Brittin

Indiana
Roland J. Brown
M. B. Lowe
Wilbur Conrad
M. J. McKee
H. S. Ogden
Howard Moore
Robert Throckmorton
Fred L. Wehr

Iowa
A. V. Molyneux, Jr.
A. S. Osgood
Guy L. Beech
Oscar J. Kost
Virgil Elliott
Joe Aiken
A. S. Bolen
H. W. Evens
H. L. Phillips
Donald A. Laird
Tyle W. Barthel
Huffman Healy
A. B. Church

Kansas
Ernest C. Brown
Russell Mannel
Wm. H. Ritter

Kentucky
John Allen Evans
Elby Becker
B. Wagner

Louisiana.
Walter C. Leahy

Maine
C. M. Sinnett, Jr.
W. Q. Rittall
Harold La Bree
Harold F. Cates
Francis H. Sleeper
J. M. Stanley, Jr.
Richard Saunders

Maryland
M. Biser
J. A. Trabrandt
Fred L. Wehr

Massachusetts
B. M. Spencer
Randolph G. Webber
J. W. Buswell
Wm. E. Blake
Frank Canney
Gordon G. Goodwin
O. G. Lohnes
Chas. McAuley
S. U. Marie
J. H. Nixon
F. J. Rumford
Rolland Adair Gould
Chester L. Keene
Ernest R. Hood
Geo. A. Sweet, Jr.
Geo. E. Varnum
James Cashman
Wallace Hune
Richard A. Stearns
Crocker Mann
David Merriam
John T. Corcoran
Manuel L. Goularte
Leo E. Wüta
Frank Danforth
O. M. Black
F. E. Bern
Francis Durant
Donald Scott
Wm. L. Delaney
M. Mac Leod
H. L. Sawyer

Michigan
Leon Hansen
C. D. Rickel

AMATEURS!
IS
YOUR
NAME HERE?

N. Schlaack
Wm. H. Kibbe
Wm. Forbey
David M. Goodman
Roy Flint
Earle Moyer
Sam Blumenthal
Harold L. Fleming
Ole B. Ritchey
Harry H. Lee
Fred B. Daniels
W. Knowles

Minnesota
Arthur W. Stevenson
Robert Ramage

Missouri
E. D. Muhleman
Lester L. Sanks
Carl Menke
J. Y. Parsons, Jr.
P. Polson
Fred Schillig
Harry Longmire
Cyrus R. Truitt
A. Eppenauer

Montana
Roland Ward

Nebraska
Gordon S. McKenzie
Joe W. Havlicek
H. Havlik
Donald Burdick
Douglas Binghardt

New Jersey
Thomas W. Braidwood
Chas J. Monroe
L. N. Houbroyd
D. B. Templeton
Russell W. Finger
Theo. Chamberlain
Stephen Jussel
S. F. Warner
H. P. Lang
Edwin Lentz
Fred F. Dennis
George F. Harrington
Joseph O. L. Higmegee
Daniel J. Corin
Wm. A. Floyd, Jr.
W. E. Cranston, Jr.
Howard Bering
H. A. Enderwoods
Elmer C. Diehl
Milton Heizmann
W. G. Hunt
Alfred C. Mills
Alfred C. Oechler
Clarence Rossnagel
Joseph F. Grece
Clarence A. Taylor
Geo. Thomas
Fred Walch
Edwin Herrmann
Maxted Clinch
Chas. Hampton
L. & L. Turner, Jr.
F. Franklin

New Mexico
Jos. S. Rhodes, Jr.

New York
Warner G. Palmer
Don Baxter
F. Van Duzer
Earl Paddock, Jr.
Carleton Brewster, Jr.
Robert Anders, Jr.
G. M. Babcock
Geo. D. Burns
T. D. Callan
J. Carlsen
Ed. B. Dyer
Chas Falco
Geo. M. Ferguson
E. G. Gehret
R. C. Gillies
W. E. Haeussler, Jr.
H. C. Hoehle
F. C. Krummel
Albert O. Leitch
Arthur Lowe
Harold McLea
P. Neyland
John E. O'Brien
H. L. Osterby
Peter Pappas
Clifford R. Paul
Jos. Peterson
J. E. Adams
Chas. Ramsgate
James T. Ruddy
Harold Sorensen
John Timmons
Prentice Warren
M. F. Bohneberg
John Quinn
Orimel W. Saxton
C. Benjamin
Paul Widmer
Conway Sheevin
Clarence J. Roberts
James Welch
D. B. McKinney
R. H. Collignon
Ernest Hemann
Walter S. Strong
Sam'l Christie
Leonard J. Edick
R. A. Clapp
Howard A. Crowe
George Grant Felt
W. L. Miller
George Miller
Earl H. Ivanson
Clifford McDonald
Lester C. Palmer
Frank Russell
Fred. A. Shelley
R. Anderson
J. H. Appel, Jr.
Theodore J. Berger
David Carruthers
James Caulfield
Arnold Conard
M. Conroy
Monte Cohen
Clifford Cox
Arthur Davidson
A. Saenz de Calahorra
Harold H. De Palma
C. F. Doebler
Alan C. Dunn
Alex. Elkin
C. B. Embler
Alfred Farago
Wm. Glameyer, Jr.
A. A. Goldon
Alfred H. Hausrath, Jr.
Chas. Hettenbach, Jr.
F. E. Hubbard, Jr.
Donald B. Jackson
Fred. Katz
H. D. Kauffmann

North Carolina
H. E. Norwood
G. T. Finger
O. C. Pate
B. W. Laws

North Dakota
Harry Holmberg
A. R. McKenzie
C. Crawford

Ohio
Harold H. Foltz
Ralph Frase
J. W. Mintz
Jack Gritton
C. B. Wilke
Walter Kottmeier
Jerry John Manning
Louie Mansfield
L. H. Reiner
Donice Hinton
Wm. G. Finch
Carl P. Goetz, Jr.
J. F. Riehle
Ed. K. Ackerman
Russell G. Anderson
Marvin Bower
Harry Bubb
E. A. Call
Louis Charnicky
Fred. D. Frey
John Garse
Robt. Gottschatt
Richard Koenig
Jack Patterson
Ladiman Stasting
P. C. Helwig
Wm. F. Justus
J. E. Purcell
F. M. Reeves
Gilbert Vogel
Loren Wilcox
Elmer Wright
P. S. Gregory
H. W. Jones
W. Bernard Merrick
Bert Osborne
Stephen Spitler
C. J. Linxweiler
Lloyd Rider
Carl Eberhart
Paul Loub
Wendell Ashcroft
J. L. Leppert
Ned Eachus
John Frazier
C. M. Osmbaugh
Miles Bruning
George S. Yerigan
Wm. F. Ball
Chas. Frank
J. B. Stewart

Oklahoma
Donovan Tool
Varnahale Jones
Warren C. Clark

Oregon
Alfred J. French
Morris Knapp
A. D. Rimyard
Arthur E. Gibbs

Pennsylvania
J. S. Bernhard
Blair Cunningham
Roger B. Hernandez
Wm. J. Kreis
J. A. Welle, Jr.
Jno. P. Cunningham
Wm. S. Schmidt
Robt. McKee
Paul Elliott Fischler
Stanley Phillips
J. L. Kirk
Marvin Madden
Otto Von Kories
H. J. Cramer
Chas. J. Mehing
Sam'l S. Szeinbach
Wm. S. Louchheim
Ernest Walker
Daniel Jones
R. W. Hornung
A. L. Rockefeller
R. Ellis Jinkins
H. N. F. Craige
John H. Weikel
Wilbur J. Murdock
E. L. Petit
F. H. Riordan
Geo. M. Albright
H. G. Brantigane
Leroy Mickay
B. J. Bisciotti

Rhode Island
Ed. B. Davis
Earl C. King
Lewis J. Boss
Thomas S. Healy
Kenneth Hiorus

South Dakota
Howard van Benthuysen

Tennessee
Conrad E. Roberts
Geo. O'Neil Sutton

Texas
W. H. Tilley
Edgar Crampton
L. B. Dobbs, Jr.
James L. Autry, Jr.

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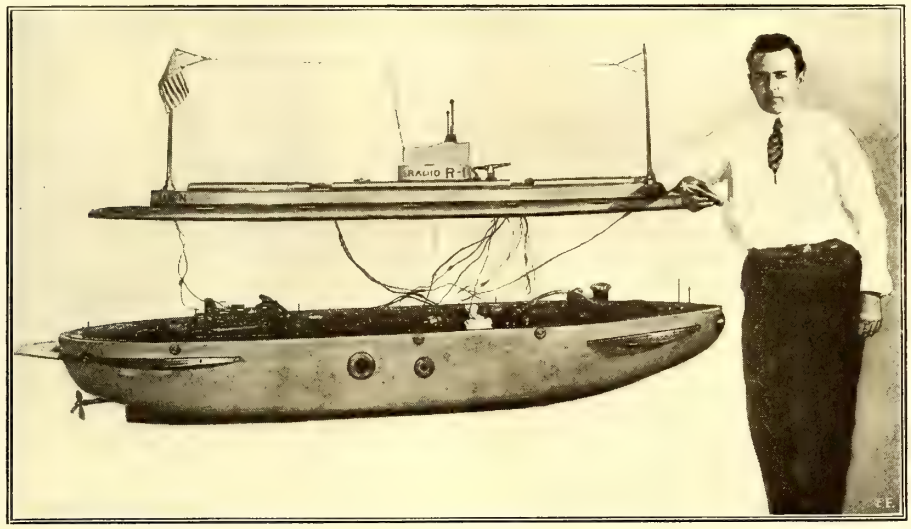


New Radio Submarine to Foil U-Boats

THE illustration shows a new submarine controlled by wireless which may rout the Teuton U-boats. It is Robert Morton's model of a wonderful radio diver invented in his Los Angeles laboratory.

Recently Mr. Morton, using an 800 pound model of his invention, held an audience spellbound while he demonstrated it in a huge tank. The model swam the length of the tank as Mr. Morton touched the key of the wireless transmitter. Another touch reversed the propellers and the model returned to its base. Then an ether wave opened the valves of the little craft and it sank until only its antennae were showing. A tiny torpedo attached to the bow was then released by wireless and sped to the end of the tank.

"I can make a fifty foot submarine on these lines," the inventor said, "fill it half full of nitroglycerin, guide it into the Kiel Canal from an aeroplane and destroy every ship within a mile, or it can be guided into the mine fields of Helgoland, blow it up and sweep the entrance to the German base clear of mines. It simply means using the submarine as a huge mine."



One of the Latest and Most Promising Models of a Radio-Controlled Submarine, With Which Its Inventor Hopes to Blast His Way Thru German Mine Fields to Their Naval Base Itself.

[*Those interested in radio-controlled vessels should read the article in the October issue, page 390, entitled—"A Radio Controlled Model Boat," by H. C. Van Benthuysen and Max I. Black.—Editor.*]

WIRELESS LOG OF A SEA CRIME.

A succession of wireless calls telling the story of a sea tragedy, in which an unknown steamship was the victim of a German submarine, are recorded in the log of a neutral vessel which arrived "in an Atlantic port" recently from a "Scandinavian port."

The calls were recorded while the neutral vessel was passing close to the Irish coast, on her way to this port, and begin with the international "S O S," followed by the message:

"We are being chased by a submarine."

Ten minutes later, the log shows, the following was heard: "Hurry assistance; we are being shelled."

A lapse of 15 minutes followed, then the entry: "Ship is on fire and sinking; captain ordered men to lifeboats."

Five minutes later comes the final message thru the air: "We are done for," giving also the position of the ship.

The neutral vessel, forbidden by regulations to go to the rescue, relayed the call and in about 20 minutes picked up a radio from an American destroyer, reading:

"We will reach you in one hour."

PERSONNEL OF A RADIO SIGNAL COMPANY.

A radio company of the Signal Reserve Corps is commanded by a captain and is composed of the following personnel: A captain and two first lieutenants, mounted.

The enlisted men are a master signal electrician, technical expert of the radio company, in charge of making repairs and adjustments to wireless telegraph apparatus.

Six sergeants, first class; one assists the captain, handling questions of supplies, finances, etc., and five radio operators acting as leaders of the five sections of the company.

Nine sergeants—a supply sergeant, a stable sergeant, a mess sergeant, one engineer for the gas engines and five acting as first assistants to section leaders.

Fifteen corporals, one farrier, one saddler, one company clerk (office work), two mechanics (miscellaneous repair work) and ten operators assigned to sections.

Thirty-five privates, first class; two trumpeters, two drivers and thirty-one privates assigned to sections. Six privates, one horseshoer and two cooks.

All are mounted except one mess sergeant, two mechanics and two drivers. The arms carried are automatic pistols.

WOMEN MAY ENTER THE WIRELESS SERVICE.

Women are entitled to the study of wireless telegraphy, the same as men, in the class organized by Prof. Harvey Anthony of the Muncie, Ind., high school, and it is hoped that many will file their applications.

A communication received recently by Prof. Anthony from the war department urges that more women be enlisted in the service. The letter reads that women telegraphers are in demand by the government for both the army and navy. They will not be taken abroad however. Their assignments will be at shore stations.

MANY STUDENTS TAKE U. S. WIRELESS COURSE.

Many students are taking the course of radio telegraphy in the U. S. Radio School, Parkway Building, Philadelphia, Pa.

More than 300 students are taking the course. The school is under the direction of Lieutenant G. Y. Cadmus, U. S. R. C., and was established when the government decided to educate a corps of several thousand radio operators for marine service.

According to reports issued by the staff of instructors the end of the first six months' course will see more than 400 operators graduated from the school, who will be licensed as second-class operators. It is also said that a number of the men will be recommended for the special course in radio telegraphy given at Princeton University.

Previous to the graduating of the present class of students at the radio school in the Parkway Building, enrollment for the second class will start. According to plans announced by those in charge of the school, preparations will be made to accommodate more than 500 pupils. The government will need more than 5,000 wireless operators for marine service within two years.

A WORLD'S RECORD: RADIO HEARD 13,000 MILES.

A radio message has been intercepted half way around the world at last. Using an Audion, radio operator J. L. Davies at Radio Awarna, Invercargill, New Zealand, has accomplisht this feat. In a recent letter to Dr. Lee de Forest, the well-known radio authority, Mr. Davies says in part:

"In my experimental work at present it may interest you to learn that using Audion bulbs of the double grid, double plate type, I am daily receiving stations antipodally situated in respect to this station. Distances of 13,000 miles are covered and some of the many stations at about that distance that I pick up are Eilvese, Germany; Eiffel Tower, Coltana, Las Palmas, etc., Eiffel Tower is easily copied on the typewriter, owing to the geographical position of my station." The distances mentioned are indisputably world records.

BEING A NAVAL WIRELESS MAN.

By Howard S. Pyle.

Electrician Radio, U. S. Navy.

AS I sit here on watch in the early morning hours, I think of many things and my thoughts naturally turn to the good old amateur days "back home" where we used to "cuss the other fellows" for QRM more than we would OK for bix from the whole "Ham tribe." Those were indeed the "Happy days" but are now temporarily a thing of the past. But why should we lose the fascinating recreation of listening to the song of the spark? Why? I asked myself that question when we were closed down and decided not to. I hiked myself to the nearest Marconi office and got an assignment—back on the dear old air again and—contented. But commercial service today is not what it was before the war. Very little bix I found, handling only four or five messages an entire trip of eleven days and on a passenger boat with a full passenger list too. To the real dyed-in-the-wool "Ham," this business of three or four "msgs" a week is not particularly attractive for the more bix the better, as we get a chance to operate then. I felt that way about the commercial game so, knowing many of the fellows who had entered the Navy service, I decided to look into the thing. None of them appeared to be over-enthusiastic about Navy wireless.

I almost felt sorry for them for I never have considered pounding a key work, so I went farther. The Navy Yard was my next port of call and there I had a talk with the DCS (district communication sup't), a Naval Lieutenant. He offered me an assignment to NPD and painted a word picture of the place which, altho not making it appear a particularly attractive berth, yet seemed to offer great opportunities in the wireless game so I entered the service as "Electrician Radio" and received orders to report to Tatoosh Island, NPD, at once for active service.

After a succession of circumstances I found myself at the Island—a large rock of about 17 acres extent. A government weather bureau, lighthouse and wireless station just about occupied all the available space and the buildings were of the usual substantial, neat construction characteristic of all Government institutions. I reported for duty and was assigned sleeping quarters which I was surprised to find equal to a first-class hotel, as I had imagined it to be rather a primitive life on the Island. Quite the contrary, tho, as we have all modern conveniences such as hot and cold running water, electric lights, bath, etc. I also found the enlisted men fine fellows and very congenial; feeling at home with them right away. At "mess" another surprise greeted me in the excellent quality (and quantity) of the food served. Altogether my first day was a succession of surprises. I found the "Electrician in Charge" a man of the highest type and he gave me my first day to *get acquainted.*

The following day I broke in, taking a regular watch, which is varied each day so that no operator has the same watch in succession, permitting a full night "in the hay" every fifth night. I was given the Mid-watch or from midnight to 4 A. M. (we only work 4 hours a day) and found no business that 'eve, which was indeed lucky as it gave me a chance to get used to the outfit and forms of Government transmissions. However, since that time I have found each watch busy enough to satisfy me without rushing a fellow.

On the whole I am well pleased with Navy wireless and am considering staying with it at the close of hostilities.

I also know that I am doing my bit for "Uncle Sam" and want to urge every amateur and operator to enter the service if at all possible, as The Navy is in great need of wireless men and it is your chance to serve your country. In addition to this you receive the best training in the art that is possible, for the Government does things right.

"Upholding the Stars and Stripes and the EXPERIMENTER."

I remain (what we would call a 100% American) ARTHUR J. BARRON.

SUCCESSFUL LOOSE COUPLER BUILT FROM "E. E." SUPPLEMENT

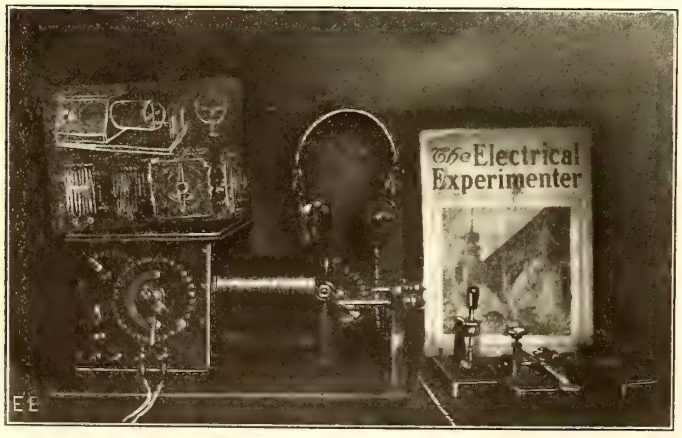
Herewith is a photo of the Receiving Transformer I built from the Blue-print *Supplement* of the EXPERIMENTER, but the photo does not give the instrument justice because it does not show the color and workmanship, but it is a "beauty" and it is a 5,000 meter instrument.

I am building an Oudin high frequency coil as described in the May EXPERIMENTER and expect to have it completed soon.

I sure do like the "E.E.", I would not take a hundred dollars for the copies I have on hand if I could not get any more like them; they have helped me up to where I am now, I am an *Electrician* by trade and an EXPERIMENTER after work hours. I am building nearly all of my apparatus.

I have been reading the "E.E." for about two and one-half years and when I want to learn something that I don't know I consult the EXPERIMENTER and I nearly always find it.

The EXPERIMENTER is the experimenter's "STAND-BY."



Now and Then We Do Hear from Our Readers. Here's the Fine Loose Coupler One of Them Built from a Description Given Some Time ago in "The Electrical Experimenter."

FIRST WOMAN RADIO OPERATOR GRADUATES AT HUNTER COLLEGE, N. Y.

The women of America are rapidly coming to the front in military affairs, as witness the accompanying illustration of Miss Elizabeth Rickard, first radio graduate of Hunter College, New York City. This institution has a very enthusiastic wireless class who are blest with every provision for quickly assimilating the intricacies of radio telegraphy. The Marconi Wireless Telegraph Company of America presented the college with a standard commercial radio transmitting and receiving apparatus. Special instructors have been provided also, so that the girls who graduate here are fully equipt to take up commercial or naval duties. The U. S. Navy Department has intimated that women radio operators may be placed in charge of land stations, and in this way relieve badly needed men operators for active duty on board ships or abroad. The new merchant fleet which the Shipping Board is now building will also require a large number of radio operators. The outlook for radio operators is therefore very bright and after the war there will be plenty of work also for many years to come.

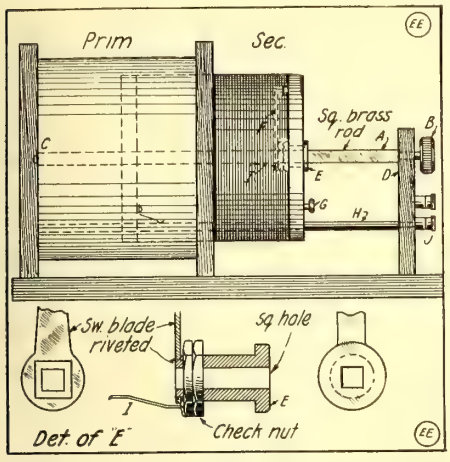


The First Woman Radio Operator to Graduate at Hunter College, N. Y. Miss Elizabeth Rickard Is Her Name and Uncle Sam Has Awarded Her a "First Grade Commercial License" as Radio Operator. Let Us Have More of 'Em.

Miss Rickard entered the Wireless Class for women at Hunter College in April, 1917, and was detailed to the Marconi School for intensive training in May. She past the test given at the Marconi School in the first week of July and received complimentary mention of her paper, her instructor saying it was the best submitted out of a class of 20 men and 3 women. On July 12th she went up for her Navy test and received the highest possible rating and was granted a First Grade Commercial License. Miss Rickard had done nothing in wireless before the first of January, 1917. She showed unusual ability.

A DUST-PROOF COUPLER-SWITCH.

Herewith is a sketch of a dust-proof secondary switch for loose couplers which has proven highly satisfactory, besides greatly improving the appearance of any



A Good Way to Build Dust-Proof Coupler Switches. The Square, Revoluble Shaft Turns the Sleeve to Which the Switch Blade Is Attached.

coupler. It also does away with expensive switch points as any old ones will do, as they are not seen. The blade is swung by turning the square brass rod A by means of knob B. This square rod goes thru bushing E or a counter bushing inside of E, which has a square opening. The switch blade is securely fastened to it. The entire switch and secondary move along the rod, but when B is turned, the switch rotates accordingly. A spring (I) may be used to make a better contact. The secondary may be moved more easily if a knob G is mounted handy as shown.

Contributed by NEVIN BRENNER.

PENDULUM OPERATED BUZZER TEST.

It may be attached to any clock, but one tector buzzer test by other means than a hand or foot-operated key, thus leaving the operator entirely free to manipulate the instruments. By utilizing the pendulum movement of a clock a very reliable automatic tester can be had and the operating expenses are nil.

It may be attached to any clock but one having a pendulum speed of about fifty to seventy beats per minute is preferred. If the clock is in the operating room it will operate the buzzer direct, otherwise a relay should be used.

Secure a piece of silver foil around the pendulum. Obtain a very thin spring several inches long (about No. 32 B & S gage) and wrap silver foil at one end. The other end is secured to the woodwork of the clock in such a manner that the pendulum just barely makes a contact on each swing. This can be ascertained best after the buzzer has been connected. Two leads are taken from the buzzer circuit, one is grounded to the metal frame work of the clock, the other is connected to the spring. Care must be observed that the spring is not too short or it will interefere with the proper working of the clock.

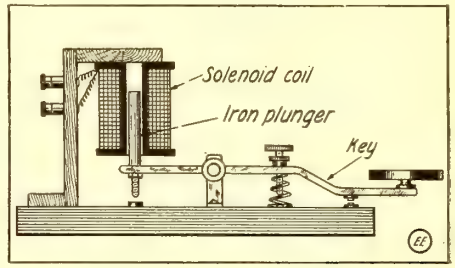
I have used an arrangement as described and found it "always on the job" when switched on. It also can be connected to your own radio transmitter to give imitations of NAA, etc. Of course a relay should always be used where heavy currents are to be handled.

Contributed by CHARLES M. FITZGERALD.

MAKING AN OMNIGRAPH OPERATE STUDENT'S HAND.

Train the hand as well as the ear to learn the code rapidly and proficiently. Receiving the dots and dashes thru the hand opens a new path. Rig up a telegraph key so that the lever may be worked up and down by a solenoid or sucking coil as per diagram. The solenoid is connected with a code machine such as the Omnigraph and the key adjusted to work like a sounder; then grasp the key as for sending, but let the key operate the hand instead of the hand operating the key. Combining this operation with regular sounder or buzzer practise enables one to become expert on the double-quick. Try it, "hams."

Contributed by FRANK COPEMAN.



A Clever Scheme for Learning the Code Easily and Quickly. A Magnetic Solenoid Connected to an Omnigraph and Battery, Works the Key. Thus the "Telegrapher's Touch" Is Acquired Unconsciously.

Development of Aircraft Radio in the Navy

By BENJAMIN F. MIESSNER
Expert Radio Aide U. S. N.

That the Navy realizes the necessity of organized scientific research of its special problems and the development of special apparatus to meet its peculiar requirements, is clearly manifested by the establishment of an excellently equipt radio laboratory at the Navy Aeronautic Station, Pensacola, Fla.

While radio signaling over the earth's surface is largely a standardized art now, aircraft radio, altho already an accomplisht feat, has thus far been largely a matter of cut-and-dry guesswork unguided by accurate scientific data. This laboratory, in addition to its work of testing aircraft radio apparatus submitted by commercial manufacturers, under both laboratory and service conditions, is gathering valuable scientific data pertaining to the peculiarities involved in radio signaling between isolated points above the earth's surface, and between such points and the earth's surface, as distinguished from the usual over-land or over-sea signaling. It is also developing special radio and other apparatus for naval aircraft. Being in extremely close touch with the actual aircraft conditions and requirements, this laboratory presents unusual opportunities for thoro study and development.

The naval officers having jurisdiction over this work are Lieutenants E. H. Loftin, District Communication Superintendent, stationed at New Orleans, La., and P. N. L. Bellinger, Head of Experiment and Test Division at this station.

Altho the laboratory has been in existence but a few months and is not yet fully equipt, several important problems have already been attacked and satisfactorily solved. Among these may be mentioned:

(1) The development of a simple interseat telephone for pilot-student or pilot-observer conversation on airplanes under the conditions of full power flight. This work was undertaken because commercial apparatus had proven entirely unsatisfactory. Two types have been developed, the first of which requires no external battery or power source, and which incorporates extreme simplicity and ruggedness in its construction, is suitable for use under the moderate noise conditions encountered on low powered airplanes; the second of these, which requires an outside battery, may be used under the most severe noise conditions obtainable on present airplanes without exhaust mufflers. These telephones, which are in daily use for instruction purposes, reduce by nearly one-half the time required for qualifying student pilots, by permitting constant coaching from the instructor, and are invaluable for pilot-observer communications for reconnaissance, spotting, or other flying in two-passenger airplanes.

(2) An exhaustive study has been made of the noise conditions affecting radio reception on airplanes. A special instrument, called the *Noisemeter,* was devised with which accurate measurements of various airplane noises have been made. Thousands of measurements have been made in determining the noise-making qualities of various aeronautic motors, the efficiencies of muffling devices, the intensity of the noises at varying distances and at varying motor speeds, the distribution of the noises in different directions, the efficiencies of radio headgear for eliminating airplane noises, the effects of airplane noises on the ears, the noise-making qualities of air at varying velocities, etc.

(3) Exhaustive measurements and tests are being made on every conceivable form of airplane antenna to determine the advantages peculiar to each type.

(4) The most recent development is an entirely new type of radio transmitter, which constitutes what is perhaps the greatest advance thus far made in aircraft radio. With an outfit having a total weight of only *five pounds,* designed particularly for spotting work, a signaling range of from *ten to twenty miles* is easily attained. The space considerations are negligible. With another larger outfit, weighing only about *ten pounds,* a range of from *fifty to seventy-five miles* is obtainable. These weights include the antenna system necessary for radiating the radio energy. The full significance of these statements is not realized unless it be added that the very best commercial apparatus now obtainable weighs from one to two pounds per mile of range, and occupies a space of from one to two cubic feet per twenty-five miles of range, making necessary the removal of the forward controls.

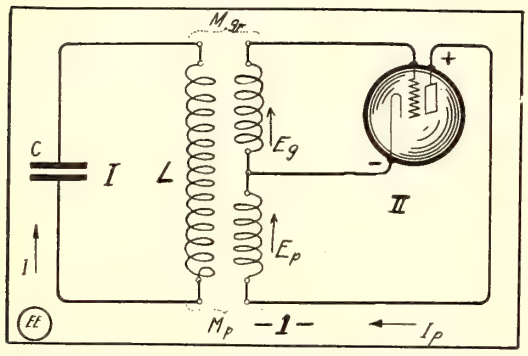
(5) The establishment of radio instruction classes for officers undergoing pilot training has not been neglected. Group instruction in operating, and the functions and care of the various parts of radio apparatus, is given on such days as are unsuitable for actual flying.

(6) Other devices being experimented with are aircraft and submarine detection apparatus and radio direction-finders for aircraft.

September Meeting of Institute Radio Engineers

A VERY interesting and instructive paper was presented by Prof. L. A. Hazeltine, September 5, 1917, at a meeting of the Institute of Radio Engineers held in the Engineering Societies Building, New York City.

The paper, which is the first of a series to be presented this season by the Institute, covers the subject of the Audion from an entirely different side than ever before read before the Institute. Prof. Hazeltine showed by diagrams and stereopticon views the feasibility of measuring the curve of the transposed energy from the grid to the plate and the formulas for calculating this quantity. By so doing he illustrated the method of determining whether an Audion would oscillate or not, and if the curve was too broad, the Audion would probably not act as a receptor, but could be used as an oscillator or amplifier.



In This Diagram I Represents an Oscillatory Circuit Which Is Excited by a Suitable Means and Current Transferred Inductively to Two Split Inductances, Which by Virtue of Their Position Produce Regenerative or Oscillatory Action in the System.

The subject certainly aroused quite an interest in all present, and Prof. Hazeltine was highly commended on his treatment of a heretofore unthought of phase of the Audion. The lantern views showed past and present Audion hookups and also an idea of those to be experimented with in the future. Also a discourse as to the merits and demerits of the various circuits.

The paper was discust by many prominent men, among whom was Dr. Lee de Forest, who spoke a few words outlining the present status of the Audion. Mention was also made of the Audion being used to check various measurements owing to the high per cent. of its efficiency and almost negligible per cent. of errors.

The subject for the October meeting was "Radio Telegraphy in Competition with Wire Telegraphy in Overland Work" by Robert Boyd Black, U.S.N.R.F.

EFFICIENCY IN RADIO TRANSMITTING CIRCUITS.

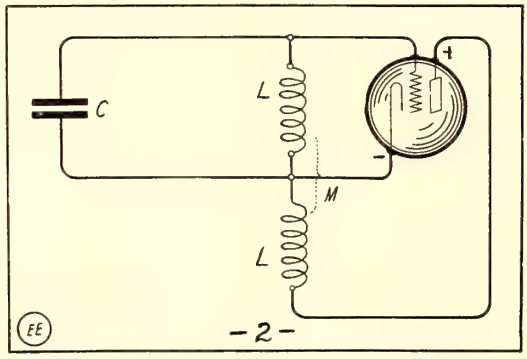
By Bayard Shumate.

THE efficiency of the average amateur radio transmitter is very low and is usually due to carelessness regarding small details, rather than to poor instruments.

In the first place an efficient transformer costs little more than a poor one, so it is advisable to purchase it from a reliable firm. As the maximum input allowed is only 1,000 watts, as little energy as possible should be lost in the transformation. A choke coil should be inserted in the primary circuit, as it is invaluable in close tuning as well as in preventing arcing at the spark gap. A good one was described in a previous issue of this magazine. The core of this coil should be about the same size as the leg of the transformer.

The condenser is probably the source of greatest loss in the amateur station, for most of them seem content with any old kind they happen to think of. A condenser that brushes or that has poor connections loses about half of the energy supplied to it. Thin sheet brass makes excellent coatings for the plates and the cost is not prohibitive. The lugs should be one inch or more wide and carefully soldered to the plate. The series-parallel connection should be employed if possible, as it gives almost entire freedom from puncture and minimizes brush losses. Four banks, each of the capacity required for the transformer, are connected—two in series and two in parallel. As each section handles only one-fourth of the voltage, thin glass may be used. The dielectric strength of a thin dielectric is much greater in comparison to the voltage required to puncture it than that of a thick dielectric. Thus the use of thinner plates allows the use of a fewer number with the same capacity. Glass losses are reduced in this way also. This type of condenser when immersed in a good grade of oil gives excellent satisfaction.

High frequency resistance is much greater for short wave lengths than for long, so the amateur is handicapt by this also.



This Audion Diagram Represents Another Method of Coupling Inductively the Plate and Wing Circuit. In This Case Condenser C, Is Shunted Across the Wing Inductance Permitting Greater Freedom of Tuning Grid Current.

The frequency of an oscillatory current at 200 meters is enormous (something around 1,500,000), therefore all connections must be made with conductor having a large surface. Conductors containing 50 to 100 strands of No. 22 bare wire, twisted together, are commonly used but heavy brass strip is preferable where possible. Those of the primary circuit should be very short and should not exceed 20 inches. The condenser, gap and oscillation transformer can readily be arranged to allow these short leads. The transformer may be set anywhere and the current may be supplied to the two condenser connections thru small wires (No. 18 to 22), which have been coiled into a spiral. These spirals form choke coils, which aid in preventing arcing at the gap and prevent kick-backs. (See "E.E." for January.) If any conductor heats to the slightest degree, it should be replaced by a larger one, for the energy lost in producing this heat means many miles less effective range.

Almost any standard rotary will give good service if it is not run too fast. It is true that a high tone is more audible than a low one, but on a 60 cycle current the condenser cannot be properly charged when a very high tone is used. It is best to use a medium tone so as to combine the audibility of the higher tone with the powerful condenser discharge of the lower.

The oscillation transformer loses energy due to the inductive coupling. It should then be large enough to secure a proper transformation of energy and not too loosely coupled. Three inches is enough for a half kilowatt set and will give a sharp wave if properly handled. A sharp wave depends more upon resonance than upon coupling, tho a sharp wave cannot be secured if the coupling is too close. A good method of tuning is as follows:—

(1) Connect a hot wire ammeter in the aerial circuit, set the coupling at about 4 inches and connect the entire secondary in the circuit.

(2) Adjust the primary clips until the meter shows the greatest radiation.

[*Note: If more than two turns of primary ribbon are necessary the condenser is too small and must be enlarged accordingly.*]

(3) The ammeter is now removed from the circuit as it damps the oscillations. The set is then tested for sharpness with a wave meter. This need not be an expensive instrument. About twenty turns of insulated wire (18 to 20) are wound on a tube 4 or 5 inches in diameter and connected in series with a small battery lamp and variable condenser. This will be sufficient for comparative readings. If the lamp lights over a large number of degrees on the condenser scale, the wave is broad. Then move one of the secondary clips around one turn of ribbon, a little at a time, until the lamp will light over ten or fifteen degrees only. If the wave cannot be tuned sharply by this means, the coupling is too close and must be moved back. If the wave is found to be sharp, the coupling may be tightened until it begins to broaden a bit. If it can be sharpened again at this point it will be to advantage. The point is to get the wave sharp with the coupling as close as possible. A sharp wave is advisable for long distance work because no energy is wasted in the waves aside from the one affecting the receiving station.

The aerial conductors should be stranded if possible and of course as high as possible. They should not be over 110 feet in total length to have a 200 meter wave. The wires should be widely spaced as a few wires widely separated have a larger capacity than many wires close together.

Thus efficiency results from careful attention to small details, for if a single detail is slighted it means the loss of energy —something that the amateur has little enough of to start with.

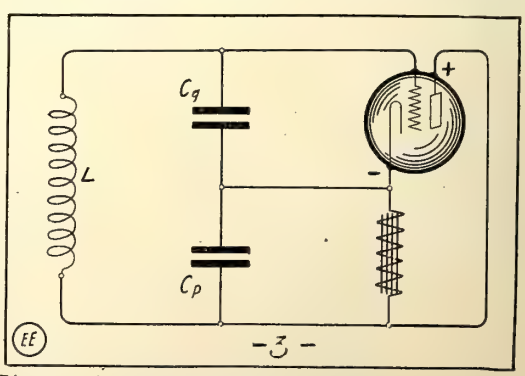


Diagram 3 Shows a Method by Which Plate and Wing Units Are Coupled Electrostatically Thru Condensers Cg and Cp.

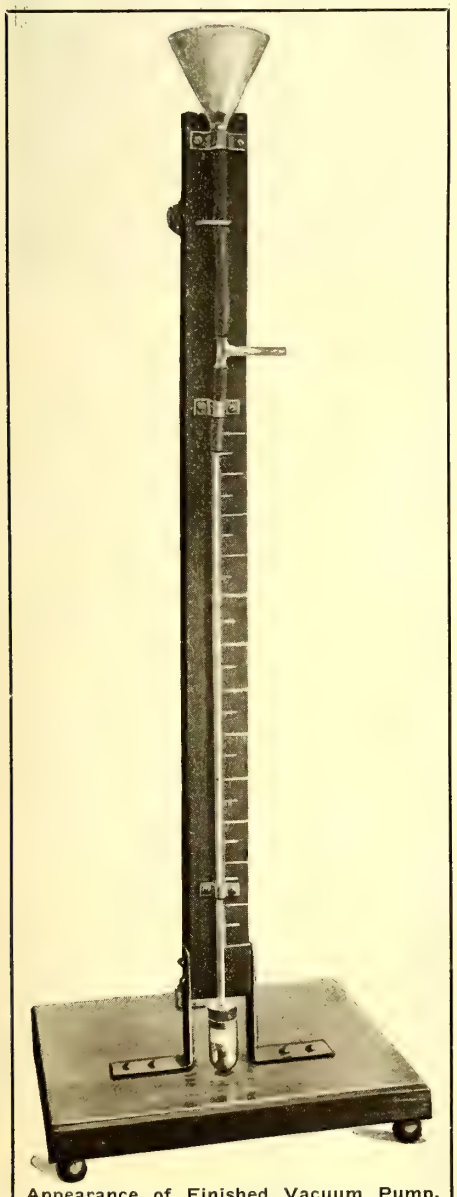
THE CONSTRUCTOR



Construction of a Laboratory Vacuum Pump

By RAYMOND FRANCIS YATES

A GOOD vacuum pump should be included in the equipment of every laboratory, but, owing to the prohibitive price of such machines, the experimenter generally finds it impossible to purchase one. The following



Appearance of Finished Vacuum Pump, Details for Constructing Which Are Given Herewith.

paragraphs describe the construction of a pump that is capable of creating a vacuum as high as 1/1,000,000th of an atmosphere (equivalent to .00003 inch of mercury). The total cost of construction should not exceed $3 including the 22 ounces of mercury necessary to operate it.

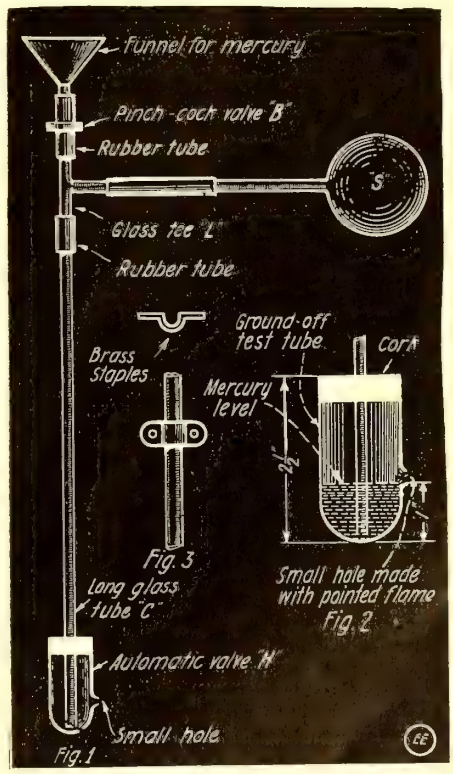
The principle upon which the pump works was first discovered by Torricelli, and Geissler of Bonn, Germany, was the first inventor of an apparatus utilizing the Torricellian principle for creating high vacua in enclosed vessels. Geissler's vacuum pump, however, was very complicated and somewhat costly and Dr. Sprengel later made many improvements on it, not only making it more convenient for the laboratory, but increasing its efficiency and making it much easier to manipulate.

Before starting the actual construction of the pump, it is advisable that the builder become sufficiently acquainted with its theory of operation to proceed in making the various necessary parts in an intelligent manner. The experimenter, Torricelli, discovered that a column of mercury passing thru a tube with a small bore pushed the air in the tube before it and left a vacuum in its wake, providing one end of the tube was closed to prevent the re-entrance of air. Referring to Fig. 1, it will be seen that a small column of mercury passing down the long glass tube "C" will act as a piston and push the air before it into the automatic valve "H", which permits the air to leave but makes it impossible for it to re-enter. The passage of the mercury from the reservoir into the tube is controlled by the valve "B" and the vessel to be evacuated is connected to the glass tee "L".

The automatic valve is shown in detail in Fig. 2. With a little study it will be seen that when the test tube is filled with mercury air may escape from the glass tube thru the small hole but the mercury prevents the air on the outside from re-entering. Every time mercury is dropt thru the long glass tube "C" the air in the vessel "S" becomes more rare until it is reduced to an infinitesimal fraction of its original value. From 20 to 30 minutes operation will produce a very high vacuum in a vessel with a capacity under .5 of a liter. When the air in the vessel "S" reaches a small value, the mercury in the tube "C" mounts to the barometric height of approximately 30 inches.

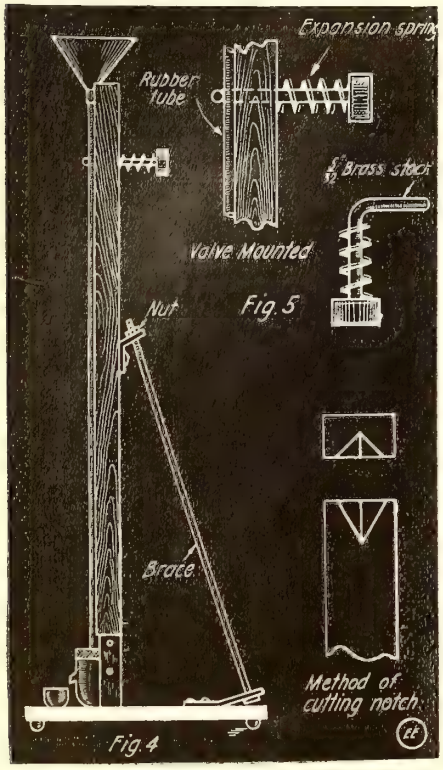
The first material required is the standard on which to mount the long glass tube, and a base. These are cut from quartered oak. The base is 9 x 9 x 1" and the standard is ¾ x 1½ x 36". Both should be cut accurately and sandpapered. A notch is then cut in the top of the standard as shown: this is to accommodate the glass funnel which holds the mercury. After this, the base and the standard may be varnished. Obtain two brass angles and fasten them to the standard as shown. The glass tube should be about 31" long with a bore not exceeding 3/32". The tube is fastened to the standard by means of four small brass staples as shown in Fig. 3. Care should be exercised in screwing the staples to the standard as the glass tube will crack if pinched too tightly. After mounting the tube, the standard should be fastened to the base by means of the brass angles. Owing to the inability of the angles to hold the standard rigidly because of its height, it will be found necessary to provide a brace at the back of the standard. This is shown in Fig. 4. The brass rod should be about 18" long. A glass funnel about 3" in diameter should be purchased and its stem reduced to about ¾ of an inch by grinding it on the corner of an emery wheel and breaking the larger portion off. The funnel is then mounted on the top of the standard by means of a small brass staple. The funnel is so fastened to the top of the standard that it will rest in the notch previously cut. Such procedure is absolutely necessary owing to the great weight of the mercury in the funnel.

The glass tee should have a bore about the same size as that of the large tube. Such tees may be purchased from any chemical supply house for a few cents and the writer would not advise any builder to attempt to make one unless he is thoroly experienced in glass blowing. The tee should be connected to the end of the funnel and the long glass tube by means of heavy rubber tubing just large enough to fit snugly over the top of the glass. Be-



Important Features of Ideal Mercury Vacuum Pump for the Experimenter, Including Details of Automatic Over-flow Valve.

fore the rubber tubing is put on, the glass should be smeared with a thin layer of vaseline. After the rubber tube is put on, black thread is wound tightly around each



Side View of Home-made Mercury Vacuum Pump Which Is Suitable for Exhausting Geissler Tubes, X-ray Bulbs, Lamps, Coherers, and a Host of Other Things Dear to Every Experimenter's Heart.

joint and another application of vaseline is smeared over the thread and joint. This procedure produces a joint that is very near to being absolutely air-tight and such joints are positively necessary to the successful operation of the pump.

The little valve at "B" was developed by the writer and is simplicity in itself. It is shown in detail in Fig. 5. By pressing the knob, the pressure of the arm on the tubing is overcome and mercury is permitted to flow (for a fraction of a second) from the funnel into the tube. Releasing the pressure causes the spring to bring the arm back to its original position where it pinches the rubber together and prevents the flow of mercury. When the pump is not in use, the arm should be turned so it will not come to rest upon the rubber tube as permanent pressure will injure the tubing.

To indicate the degree of vacuum attained at any stage of the operation, it will be necessary to make a suitable scale on the standard at the side of the long glass tube. The lines are drawn ½" apart and after marking them with a soft pencil the lines should be painted over with white "show-card" ink applied with a very small brush. Such a scale stands out prominently and adds to the appearance of the instrument considerably.

When the pump is operated, the vessel to be evacuated should *not* be connected to the tee by means of a long rubber tube as the tube will be pressed together by the atmospheric pressure on the exterior (14.7 lbs. to the square inch) and the further passage of air from the vessel will be interfered with if not altogether prevented. This difficulty can be overcome by using glass tubing with small pieces of rubber at the joints to produce flexibility. All joints should be prepared according to the preceding directions.

When the pump is operating properly, the mercury will fall thru the long glass tube in separate little columns and each column acts as a piston pushing air before it. The valve at the top of the standard should be manipulated intermittently until the mercury in the tube rises to about 30 inches. This will indicate a vacuum sufficiently high for ordinary purposes.

A small receptacle is placed under the hole in the test tube to receive the mercury as it overflows. When the receptacle is full, the mercury is poured back into the funnel. *Do not permit all the mercury in the funnel to run out as this will destroy the vacuum.*

REGARDING TESLA AND OUDIN COILS.

By Carl H. Rauschenberg
Experimental Engineer

I present herewith two photos illustrating my cone-shaped high-frequency coil in operation. The photo Fig. 1 shows the enormous brush discharge from a wire attached to the upper terminal and also the discharge from top of coil. The photo Fig. 2 shows the spark discharge from a ball terminal placed on top of the coil to a grounded conductor.

This coil is very similar to one described in the "E. E." a short time ago (see May, 1917, issue). It was excited by a ¾ K. W. Thordarson Type-T transformer and an oil immersed condenser of about .008 M. F. using small 8-stud rotary gap running at 5,000 R. P. M.

The building of the coil was not so difficult, the method of building the secondary cylinder being somewhat different from usual practise. I went to a tinshop and told them to make me a cone of heavy galvanized-iron 15" dia. at bottom, 7" at top and 20" high; *seamed on the inside.* This gave a perfectly smooth outside surface. I set this form on a table and cut large pieces of ordinary building paper of a shape to fit around it. I just merely built up the paper using ordinary glue until I had a thickness of about ⅛". The paper can be cut so that it will fit the cylinder perfectly. The best method is to watch the tinner cut out the iron for the cone, take the dimensions he uses and cut your paper the same way. If the first piece of paper is cut the same size as the tinner cuts the metal it will be found to overlap slightly when fitted around the coil. This is as it should be

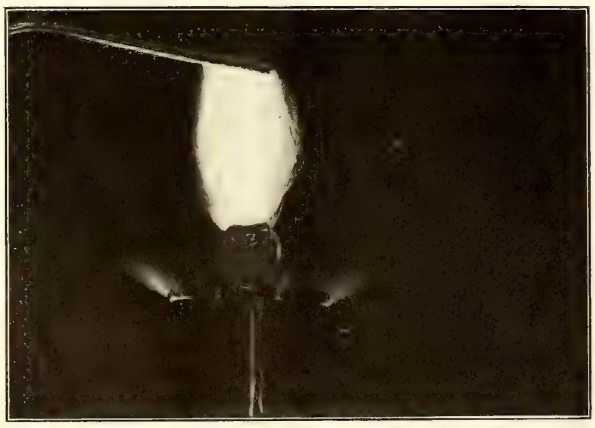


Fig. 2. Showing the Powerful High Frequency Spark Discharge From a Ball Terminal on Oudin Coil to a Grounded Conductor.

and glue should only be put on the lap so that the paper is not glued to the form which must be removed later. After the first sheet is in place cut another sheet to the same dimensions and trim the edges till they just meet, fitting the paper before applying glue. Spread the sheet of paper on the floor, give it a thin coat of hot glue and quickly apply it to the form. Continue



Fig. 1. Illustrating the Vigorous High Frequency Discharge From Free Electrode, As Well As Top, of Oudin Coil of Good Design.

in this way until the desired thickness is attained. About 10 to 12 sheets will be sufficient. The joints should be staggered at various intervals around the cylinder of course. Leave the paper on the form for 48 hours or until perfectly dry and hard. Remove and give two coats of shellac inside and outside.

The winding was done in the usual way using a string to space the turns and the finished winding given 5 coats of shellac to insulate it and hold it in place. The size of wire is not so important, mine being wound with 27 D.C.C. wire. Enameled wire should not be used.

Primary consists of 4 turns of copper ribbon, ¾" wide wound into a spiral with a thickness of ordinary corrugated pasteboard (cut from a bread carton secured at a local grocery), between the turns. Primary leads are connected to binding posts leading to ends of primary ribbon; thus the entire 4 turns are always in circuit, tuning being accomplished with the secondary of a wireless oscillation transformer which is placed in series with condenser, spark gap and primary of Oudin coil; the wiring diagram shown in "E. E." several months ago being used.

I find the spark length from the Oudin type of coil to be not so long as that from the Tesla type with a given amount of power, but much heavier and capable of experiments not possible with Tesla type.

Some wonderful results can be had from the ordinary wireless sending set and in my opinion no amateur will regret the time and money spent in the building of a coil for use on his sending set.

Due to the advent of the war, we are particularly desirous of obtaining snappy manuscripts describing original and practical "Electrical Experiments."

A SHOCKING ELECTRIC ALARM FOR COMMUTERS.

We all have made and used at one time or another some form of that torturing device known as *The Early Riser's Alarm.* At first the regular electric bell was sufficient to rouse us out of bed in time to catch the early train, but it soon lost its wakening powers with the result that a hundred yard dash was necessary to get even the late train. We then installed an electric horn made from a tin can and a bell. That worked fine for a time and then it failed to give us that sudden shock that should accompany our awakening to get us out of bed *immediately.* We had gotten used to the racket and could not increase it any without bringing down the wrath of the neighbors.

The writer tried them all, even considered the use of a small cannon or a device to pull one leg from under the bed but dropt them all in favor of the scheme described here.

The clock used possest no original features but its simplicity may be of interest. Examining Fig. 1, it will be seen that a block of wood was mounted just below the winding key for the alarm. A strip of ⅛ inch brass was fastened to the block in such a way as to prevent the key making more than a quarter turn when the alarm went off. Wires were connected to the insulated strip and to the framework of the clock. It was then a simple matter to set the alarm and it was likewise necessary to arise to turn it off in the morning. A switch may of course be included but it is unnecessary; you will get up anyway.

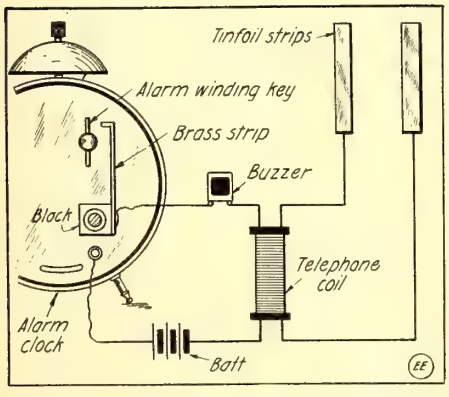
The other parts consist of several dry cells, a buzzer, a small induction coil (a ¼ inch spark coil or a telephone induction coil will do) and two strips of tinfoil 3 or 4 inches wide and 2 feet long.

These are wired according to the diagram in cut; the buzzer being unnecessary when the usual spark coil is employed. The tinfoil strips are laid under the sheet on the bed and separated a distance of about three feet.

Now let us see what happens when "Big Ben" closes the switch. The buzzer will interrupt the circuit, causing high voltage currents in the secondary circuit that find a path thru the innocent sleeper's body by jumping thru the thin sheet that separates him from the tinfoil electrodes. It is borne forcibly on him that his presence is not desired any longer. A departure under such circumstances is accepted as the usual thing by most persons, who will then start the day with zest and vigor.

Try this, "Bugs," it won't hurt you.

Contributed by THOS. W. BENSON.



Are You a Commuter? An Ingenious Experimenter Has Perfected a Sure-Fire Electric Ejector for All Such. Simply Connect the Circuit-Closer to Your Clock; Hook Up a Buzzer, and Telephone Induction Coil as Shown and Also Two Tinfoil Strips, Laid Under the Sheet. When 5 A. M. Arrives, You Will Awaken—Never Fear.

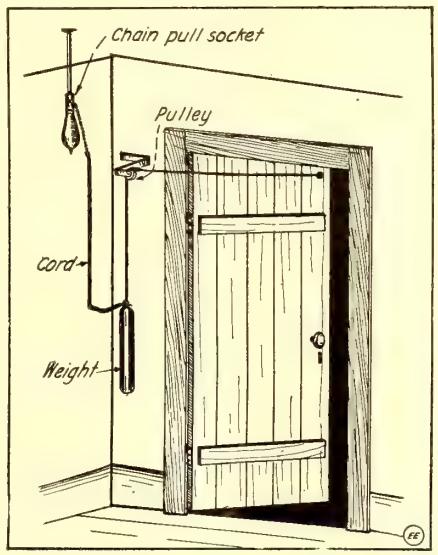
LIGHT CONTROLLED BY OPENING AND CLOSING DOOR.

Not long ago I had occasion to install an electric light in a cellar closet used for storing vegetables. It was important to keep the door of this closet open as little as possible, that the temperature might be kept as low as possible, and for this purpose the door was closed by a weight and rope arrangement. Moreover, servants were frequently obliged to enter or leave the closet with both hands full. It was therefore necessary to install a light which would be automatic in action, and would not require the door to be kept open while the light was burning, as is the case with several of the automatic door switches now on the market.

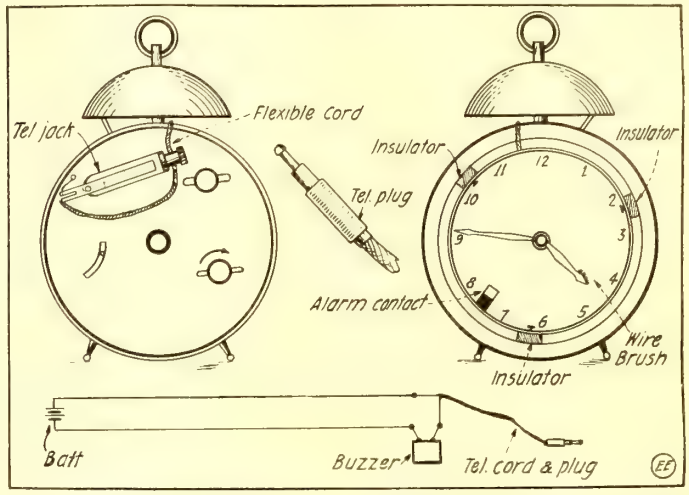
All these difficulties were met at once in a very simple manner. A common pull socket was installed, and the chain of the socket was connected by a cord with the weight used to close the door, in such a way that when the weight was as near the floor as it could go, and when therefore, the door was closed all the way, the cord was pulled taut, and the chain with it. The result of this was, that when the door was opened, the weight was raised, the cord loosened, and the spring of the socket drew the ratchet back, engaging the switch; when the weight pulled the door to again, the cord was again tautened, the switch operated, and the lamp lighted.

The results of this arrangement were these: The switch was entirely automatic, being operated by the opening and closing of the door. When one enters the closet, the light is lighted, when one leaves, it is extinguished. The light is not turned on until the door is closed, so there is no inducement to leave it propt open, to save trouble in opening with the hands full, but also to fill the closet with warm air. The whole apparatus consists of an ordinary chain-pull socket and a piece of cord, thus obviating the mortises necessary in the ordinary door-switch, and making a very much simpler and cheaper installation.

Contributed by THOMAS T. HOOPES.



It Is Often Desired to Have a Door Control a Lamp, Such as in Cellars, Garrets, Etc. By Attaching a String and Counterweight to a Chain-Pull Socket, the Problem Is Solved.



By Employing a Telephone Jack Switch as Shown, It Is Possible to Disconnect the Electric Alarm Attachment from the Clock Instantly. A Very Desirable Feature.

USING TELEPHONE JACK TO CONNECT ALARM CLOCK.

Having seen a number of electric alarm clocks of many fearful as well as ingenious designs in the "E.E.", including the one in the January number, I show above for approval one that I have had in use for over a year with excellent results. Most of those previously publisht make contact when the alarm spring unwinds. In the clock I have, the winding spindle does not turn when the spring unwinds. The arrangement I have differs from those previously described, as it does not depend on the alarm spring. The clock is separate from the rest of the circuit and may be used elsewhere when the alarm is not needed. When the alarm is wanted, simply hang the clock upon a hook and insert the plug in the telephone jack mounted on the back of the clock. Place the alarm contact on the dial at the hour desired. The battery may be placed in the attic or cellar, the wire fished thru the partitions, and brought out at the binding posts. Mount the buzzer and telephone cord as per drawing; connect one lug of the jack to the frame of the clock, the other to a ring made from a shade holder in the front and insulated from the clock by three small fiber blocks. When the hour hand comes in contact with the alarm contact, the buzzer operates.

Contributed by HOWARD D. DYE.

RENEWING DRY CELLS.

I have been experimenting with dry batteries for over a year, to find a renewing solution and I have kept a worn out dry dry battery alive with the following solution, for over six months:

Hydrochloric acid, 12 ounces.

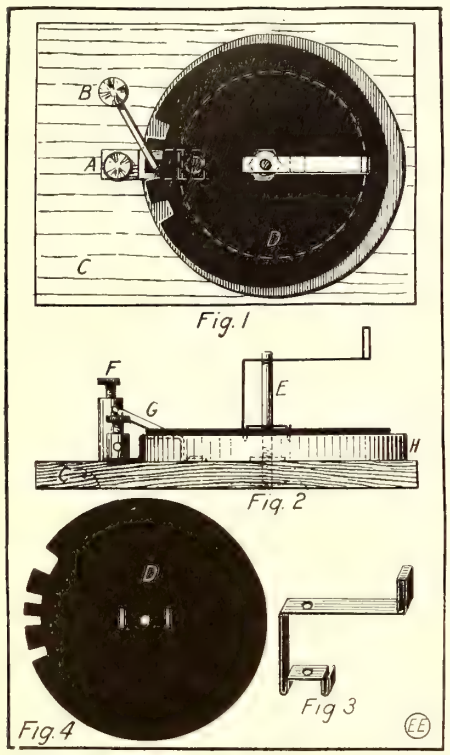
Add scrap zinc till acid stops boiling; use earthen jar.

The sealing wax is to be removed from top of dry of battery, the loose carbon surrounding the carbon proper is to be loosened (an ice pick will do this) and the acid solution poured in till the loose carbon is thoroly wet, but not muddy. The battery is then resealed, and is ready for immediate use.

Contributed by JOHN BLACKHURST.

A HOME-MADE CODE-LEARNER.

Figure 1 shows the base and the dimensions are left to the builder. The wooden ring should be about ¼" thick and ½" wide. A is a brass or copper strip sunk even with the surface of the ring; it is fastened inside with a screw and outside with a binding post for connection. B is a binding post with two holes, one for a connection, and the top one for a strip



Home-made Code Transmitter Constructed from Cardboard Disc, a Hand Crank to Turn it with and a Contact Spring Which Closes the Sounder or Buzzer Circuit.

of brass or copper pressing on A to make contact. C is the base to which the wooden ring D is glued. Fig. 2 is a side view of the machine. "E" is a brass rod in the center of the ring, over which the disk (Fig. 4) and the crank (Fig. 3) slip. Fig. 3 shows the crank, which is about ¼" wide with holes bored in so as to slip over E. Fig. 4 is the disk which is made of thin cardboard with the dots and dashes cut out as shown. Connections are taken off at the two binding posts and connected to a battery and buzzer.

Contributed by
FRANKLIN McTAVISH.

REMOVAL OF INK STAINS.

The tartaric acid and citric acid ink remover combination leaves a yellow stain. It affects only fresh stains appreciably, and even then does not remove them well at all.

The only method that I have found satisfactory for fresh stains on paper, is the following two solution remover, the concentration of which may be varied in individual cases. Two parts of concentrated borax solution are dissolved in ten parts of water and one part of citric acid added, this forms the first solution. The second solution consists of three parts of calcium chlorid, ten parts water, two parts of concentrated borax solution. The calcium chlorid should be dissolved in the water, the mixture set aside for a few days and only the clear supernatant liquid used.

The first solution is generously applied, the excess removed, and the second applied. The spot should finally be washed with water.

Contributed by J. FIERSTEIN.

AN EXTREMELY SENSITIVE MICROPHONE.

The writer recently conducted some experiments in an attempt to construct a simple and compact microphone that would be extremely sensitive. The result of his work along this line is shown in the illustration.

A microphone transmitter was obtained and arranged to be mounted on the back of a shallow box just a little larger. The transmitter was of a recent type having a metal diafram with an insulated carbon button attached to the center. A carbon diafram transmitter cannot be used very satisfactorily.

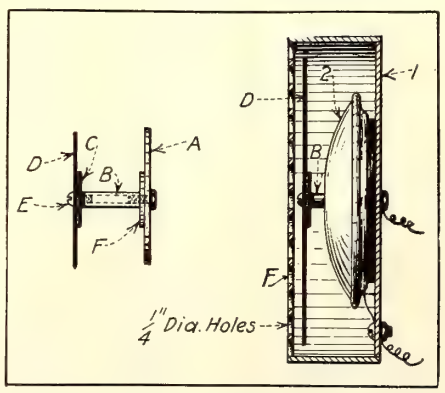
The nut was removed from the center of the diafram and a piece of brass rod one inch long and ¼ inch in diameter was drilled lengthwise and tapt with a No. 8-32 thread. A washer ½ inch in diameter was soldered to both ends of this rod as shown in the detail drawing at B, C, and F.

After substituting a mica diafram for the metal one the parts were reassembled with the short threaded brass rod instead of the nut in the center of the diafram.

A 4-inch disk of mica was then cut and by means of a small 8-32 screw and a washer fastened to the brass rod. The whole device was then placed in the box and connections made to the transmitter in the usual manner.

The front of the box was pierced with a large number of holes ¼ inch in diameter.

When properly made and assembled this device is very sensitive and will pick up the faintest sound. A method for testing the sensitiveness of such microphones that was found of value by the writer is to connect them in series with a receiver and battery and note the distance they can be held apart and still act on one another. The receiver and transmitter should first be brought close



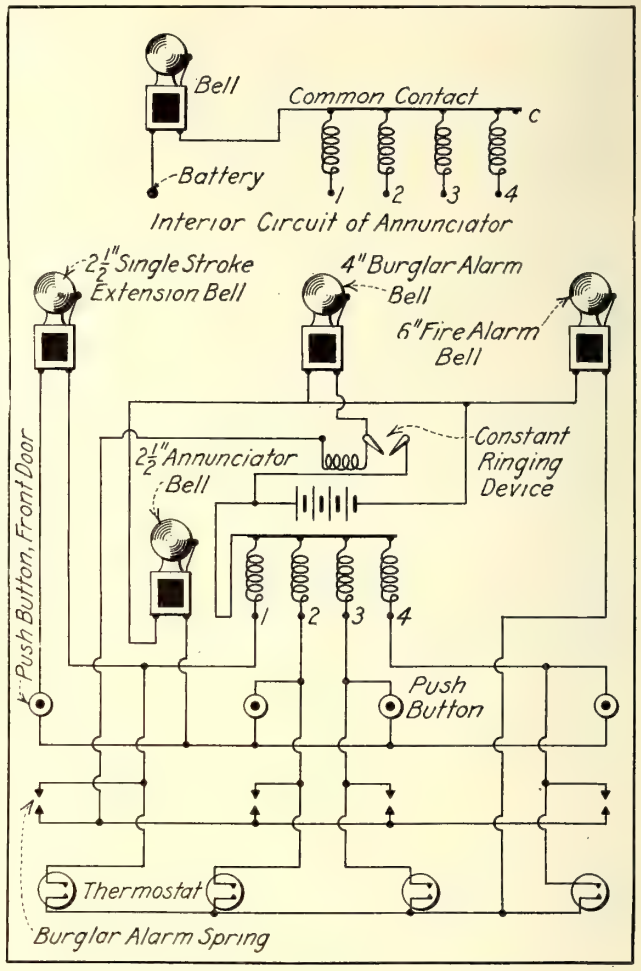
Reconstructed Microphone Possessing Extreme Sensitivity. Suitable for Dictagraph Purposes.

together and when they whistle, separate them slowly, noting the distance between them when the note ceases. This instrument will give an audible note when 2 feet from the receiver with four volts.

Contributed by THOMAS BENSON.

COMBINED CALL BELL, FIRE AND BURGLAR ALARM SYSTEM.

The scheme given herewith is to connect an ordinary four-drop annunciator, so that it may be used for a *call bell, burglar*



Hook-up for Combined Call Bell, Fire and Burglar Alarm System with Centralized Battery.

alarm and a *fire alarm* system simultaneously, to give location of call, etc., in all cases, and a constant ring for the burglar and fire alarm, and one extension bell to operate *only* from the front door, the bell on the annunciator operating also; if any other button is prest only the bell on the annunciator operates.

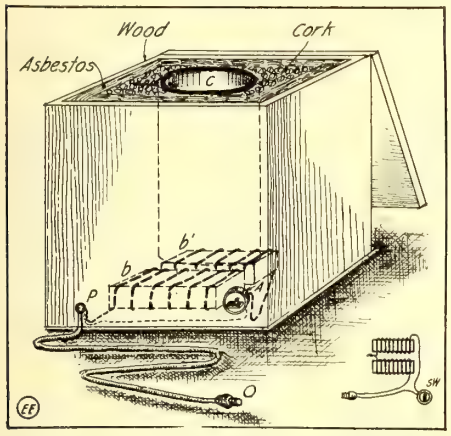
This is accomplisht by disconnecting the bell from the common wire which connects to the *drops*, and connecting the battery direct to this common connection. The opposite terminal of the battery connects to all bells, and the other side of bell acts as a feed wire for its particular system. A ringing device is used to give a constant ring on the burglar alarm systems, while the ordinary paraffin thermostats, which remain closed after paraffin has melted. serve to give a constant ring on fire alarm system. To get satisfactory operation on extension bell from the front door, a single stroke bell must be used; this, however, will operate as a vibrating bell due to the make-and-break of contact at the vibrating bell, which is in series with it. If a strong battery is used or a bell ringing transformer, two vibrating bells may be used on parallel.

Contributed by THOMAS J. HAYDEN.

Due to the advent of the war, we are particularly desirious of obtaining manuscripts describing original and practical "Electrical Experiments." We shall continue to publish Radio articles, but what we need is snappy "Electrical" articles.

HOW TO MAKE AN ELECTRIC FIRELESS COOKER.

A "Fireless Cooker" finds an important place in every home, especially one that



Why Not Build an "Electric Fireless Cooker?" Two Ordinary Bricks Wound with Resistance Wire, Form the Heating Unit to Start the Food Cooking. Don't Let Any of the Cork Get in Contact with the Heater Wire.

is operated by electricity. The one that I am going to describe can be built very cheaply, for the material used in its construction is found in almost every home.

The cabinet is made of wood 16x16x18 (quarter-sawed oak ½ in. thick is the best). The inside is lined with about ¼ inch asbestos sheeting. Two ordinary house bricks are each wrapt with several feet of No. 26 Nichrome resistance wire. These two bricks are then covered with asbestos and put in the bottom of the cabinet. From one end of Nichrome wire on brick (b^1), a copper wire is connected by twisting (not soldered). This wire is connected to one terminal of switch (A). The other terminal of the switch is connected to one of the flexible wires. The other wire (P) is connected to the other end of the resistance wire. Another sheet of asbestos is placed over the brick. On top of this a large tin bucket is placed, after being covered by asbestos sheeting on the outside. (A lard bucket is very good.) The space between the bucket and the cabinet is now to be filled with ground cork, such as grapes are packed in. This is clearly understood by looking at sketch. Next put a cover over this so that the only thing you will be able to see is the inside of the bucket. A thick lid is now made for the cabinet with a catch at the front to keep it tightly closed. When you want to cook something, place it in a pot that will fit in the bucket. Turn the current on by switch (A). This will make the bricks hot. These bricks will give off heat for a great while, thus saving current and money.

Contributed by CHARLES FENSKY.

EXHAUSTING BULBS BY MEANS OF LIQUID AIR.

Those who are intending to take up research work as their career, will find immense value in the study of vacuum tubes as used in electrical science, especially in the radio art.

The great difficulty encountered with such devices is the production of sufficiently high vacua in the vessels and the necessity of expensive apparatus for this purpose, which naturally prohibits the average individual from investigating the above-named contrivances.

Liquid air has played an important rôle in the past for the production of extremely high vacua in bulbs and it has been found that it can be used with great ease for this purpose. The following directions will prove of value to the amateur scientist who desires to delve into the great mysteries offered by the investigation of vacuum tube phenomena.

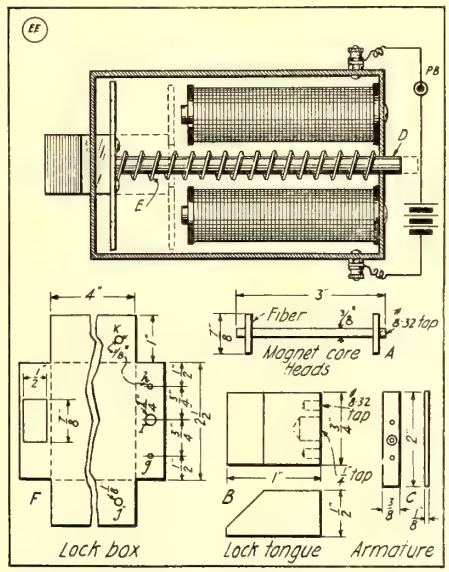
The vessel to be exhausted is filled with a gas which may be more easily condensed than air; as carbonic acid gas. The vessel is provided with an extension tip which can be sealed off very readily. The open end of the extension is then immersed in liquid air, when the carbonic acid is withdrawn from the vessel and deposited in the extension; this is then sealed off, leaving a high vacuum in the vessel.

Precaution should be exercised when pouring the liquid air, as a drop of this liquid when in contact with the human skin will produce a severe burn which is difficult to heal. It is advisable to siphon the liquid from the container into the vessel which is to be exhausted. Carbonic acid gas is inflammable and care should be taken to keep any lighted matches away from the container when such experiments are conducted.

Contributed by SAMUEL COHEN.

HOME-MADE ELECTRIC LOCK.

A cheap and efficient electric lock can be made easily if the following plans are followed. The drawing speaks for itself, but a few words may be necessary. The lock box F, is made from a piece of sheet iron, 6" long by 4½" wide, cut as shown in the figure. It is then bent to form a box. A square hole is cut in the center of one end and 2 ⅛" holes, ½" from each



An Electric Lock Presents Many Advantages Over the Ordinary Mechanical Type. The Control Button May Be Placed in a Secret Location.

side. The two electro-magnets are made as follows:—two pieces of iron rod ⅜" in diameter and 3" long are tapt on one end for No. 8-32 machine screws. A fiber washer ⅞" in diameter is put on each end and the bobbin wound full with No. 18 cotton covered magnet wire. A piece of brass 1" long, ¾" wide and ½" thick is filed to the shape shown in Fig. B, and in one end a ¼" hole is tapt in the center, and 2 holes on either side are tapt for No. 8-32 screws. The armature as shown in Fig. C, is made from a piece of iron ⅛" thick and 2" long by ⅜" wide. Three holes are drilled in it to correspond with the piece of brass in Fig. B. A piece of brass rod ¼" in diameter and 4½" long is threaded for ¼" on one end. A length of brass spring wire is then wound around the rod. The lock is now ready to be assembled. First put the magnets in place with 8-32" screws, and connect the two inside wires together and the two outside wires to the two binding posts on the sides. Then assemble the other parts as shown in Fig. G. Connect it in series with a push button and batteries, and when the circuit is closed the electro-magnets will attract the iron armature C, thereby releasing the lock.

Contributed by L. E. SUMMERTON.

READING VOLTS AND AMPERES WITH THE SAME METER.

A volt and an ammeter are usually mounted on the experimenter's switchboard. Too often those meters have made a considerable dent in the amateur electrician's pocketbook and absorbed money that would be used for purchasing other necessities. What then is required is a method for reading both volts and amperes on the same scale without changing the meter itself in any way.

A common voltmeter will read amperes on the same scale if shunted by a resistance of one ohm. It is only necessary to wire the instrument to the circuit as shown in the illustration, Fig. 1. Throwing the switch up gives ampere readings and down gives the voltage.

That this is true can be proved by Ohm's law. Given a resistance of one ohm it is clear that a current of one ampere will flow under a pressure of one volt. Therefore when the voltmeter indicates a drop of one volt across the one ohm resistance it is plain that one ampere is flowing thru the resistance. Should the meter show a drop of ten volts across the coil, then according to Ohm's law, ten amperes will be flowing. The voltage drop then shows directly the amperes in the circuit.

By changing the resistance of the coil it is possible to vary the range of the instrument. For instance should a coil of one/half ohm be shunted across the meter the reading will be one/half the actual current flow, thus when the meter reads 10 the actual amperes are 20. In other words

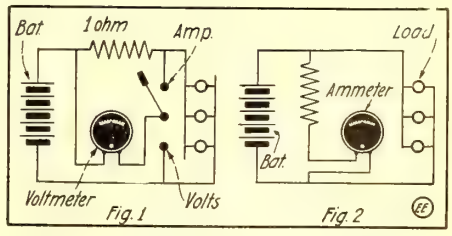
$$C = \frac{E}{R}.$$

Conversely it is possible to read the voltage with an ammeter by connecting as in Fig. 2. In this case the resistance is connected in series with the meter. The principle being again based on Ohm's law which states that the voltage is equal to the resistance multiplied by the current; or $E = R \times C$.

Say for instance that the coil has a resistance of 10 ohms and the meter reads 5 amperes. By multipling these together we get 50 showing that the voltage applied is 50 volts.

It should be remembered that the resistance used should be heavy enough to carry the current without undue heating. Furthermore it is advisable to use a resistance wire that has practically no temperature coefficient such as "Thurlo" wire, thus doing away with the errors that would be present due to changes of resistance when the wire is heated by the current.

Contributed by THOS. W. BENSON.



It Isn't the Instruments You Have; It's the Way You Use Them. By the Application of Ohm's Law, It Is Possible to Read Volts with an Ammeter or Amperes with a Voltmeter.

A D. C. Step-Down Rheostat, Toaster and Stove

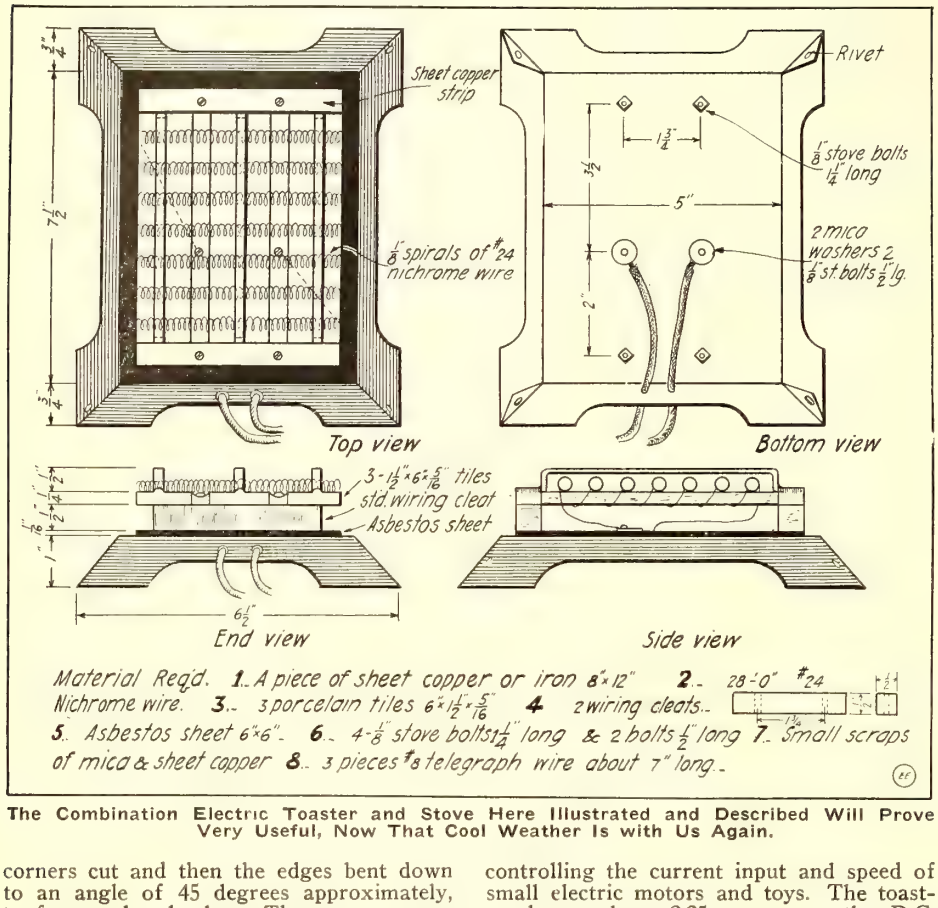
By W. R. WAY

First we have to cut a piece of copper or tin to the rectangular shape, size 10" x 7½". One inch was then marked off from the edges all the way around, the corners cut and then the edges bent down to an angle of 45 degrees approximately, to form a bevel edge. The corners were fastened by means of small tacks or rivets clinched on one side. Cuts were taken out of the bevel edges to improve the appearance and decrease the weight of the base. Having done this six ¼" holes were drilled in the top of the base at their correct distances apart as shown in the sketch. All sharp edges were either bent over or filed smooth. The base may now be considered as finished.

A sheet of 6 x 6" asbestos board 1/16" thick was then laid on the base, and the cleats placed over this and in line with their respective holes in the base top. A ½" wide strip of copper, 12" long, was laid on top of each tile (slate or asbestos board will serve) and holes drilled to suit holes in cleat. The porcelain tiles were placed in position, the strip of copper placed over them on each cord, and 2⅛" stove bolts 1¼" long, were used to bring the two strips together and bind the cleats and tiles to the base securely.

The heating element consists of 28 feet of No. 24 Nichrome wire. This was wound on a ⅛" steel rod in spirals of 6" length and a single wire 6" long left between each spiral. Approximately seven spirals could be made out of this length of wire. When the wire has been formed, it is wound around the tiles, the coils being placed on top and the single wires underneath the tiles so as not to lose heat downwards and heat the base unduly. The ends of the wire were connected to two terminals, having mica washers, and thence thru a cord and plug to the 110-volt lighting circuit. The toaster was then complete.

Besides being an excellent toaster, the device makes a good electric stove or heater, or it may be used as either a rheostat, potentiometer, or resistance for controlling the current input and speed of small electric motors and toys. The toaster draws about 2.25 amps., on the D.C. lighting circuit, and I successfully operated a 1/16 H.P. 27-volt D.C. series motor in series with the toaster. It is made of materials (except perhaps the wire) which nearly any experimenter could easily find lying around the house, and is very easily constructed.



The Combination Electric Toaster and Stove Here Illustrated and Described Will Prove Very Useful, Now That Cool Weather Is with Us Again.

INDIA INK REMOVER.

I think a notice in your magazine to the effect that India ink can be completely cleaned from tracing cloth, would be of interest to your readers. It is claimed that it leaves no trace of the ink and does not injure the cloth. This article is sold and manufactured under the trade name "RASINDIA" and is guaranteed.

Cont. by W. L. FETHERSTON.

HOW A DEAF MUTE ANSWERS HIS DOOR BELL.

Did it ever occur to you how a person who is totally deaf, and living in a house all by himself with his wife, who is also deaf, could answer his door bell?

Probably there have been many schemes devised so that a deaf man might know when his door bell rung. Many of these unfortunates depend on their faithful dogs.

The author has a very fine dog, who can be relied upon all the time, but Nature did not intend that he should remain indoors all the time. Whenever the dog is outdoors for his daily exercise, the door bell proposition presents a difficult problem.

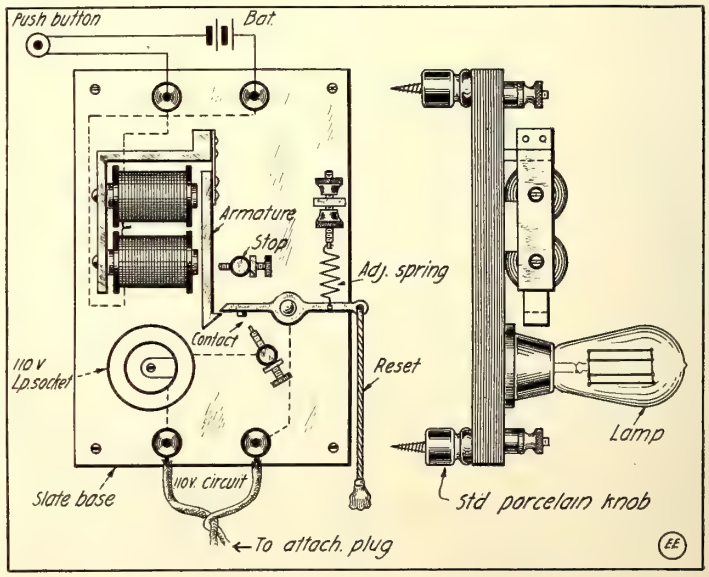
The deaf man, having a keen bent for electrical novelties, designed an electrical system by which the push button would turn on a 40-watt Mazda lamp in the house which would light up a room; this lighting up of the lamp is quickly noticed by the deaf couple's sensitive eyes, the lighted lamp being a signal indicating that some one is at the door. This lamp will burn continuously till the call is answered.

The details and wiring diagram of the device are given herewith. The details of the signal system are as follows: When the push button is closed, the battery circuit is closed, energizing a pair of electromagnets which attract a special form of armature. This armature has a trigger on its end, and on its travel toward the poles of the magnets releases a spring lever. This lever falls toward a stop which serves as a contact, closing a secondary circuit which operates a 40-watt, 110-volt Mazda lamp. The spring lever remains closed; then when the battery circuit is opened again, the armature trigger moves away from the magnets. By pulling down gently the reset chain cord secured to the extreme end of the pivoted contact lever, it is brought upward, passing the latch of the trigger and now rests on the top part of the trigger. In resetting this way, the lamp is turned off automatically, and the next time the push button is worked the whole operation goes on all over again. This device has been in use since last February, and is serving its purpose very admirably.

The regular door bell is disconnected, as there is no need for it in this house. The dog is able to give his customary warning by the slightest noise of the magnetic pull and click of the contact lever.

This man is working on an electrical device at present to wake him up in the mornings, since alarm clock gongs are useless to him.

Contributed by the deaf man himself—
K. B. AYERS.



A Deaf Man Invented This "Flash-Lamp" Door Alarm. Pushing the Button Causes the Bell Magnets to Trip the 110 Volt Lamp Switch. It Is Reset by Hand After Each Alarm.

Chemical Action of Storage Batteries

By ALBERT W. WILSDON

(Concluded)

IF the current is kept constant and the value of V is measured at short intervals, the charge and discharge curves obtained are of the form shown in Fig. 3. The value of V rises rapidly in the first few minutes of the charge from 2.0 to 2.1 volts, and during the rest of the charge continues to rise slowly, until at the end it suddenly rises to 2.5 to 2.7 volts. During this period of rapid rise in the value of V, the cells begin to evolve gas, after which the value of V changes only slightly. On allowing the battery to stand on open circuit for several hours, the electromotive-force E falls to the value corresponding to the density of the

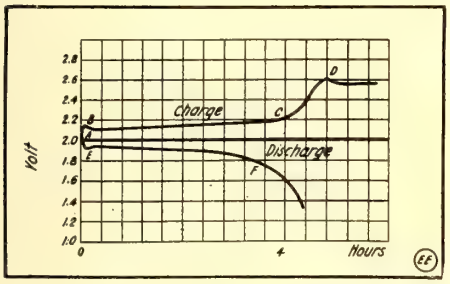


Fig. 3.—Curves Showing Change in Lead Storage Cell Potential on Charge and Discharge.

acid. If the battery is then allowed to discharge with the same constant value of the current as used in charging, the value of V^1 at first falls rapidly to 1.9 volts and then gradually to 1.85 volts, after which it decreases more rapidly to zero. The curves given in Fig. 3 were obtained with about 20 per cent acid and a current density of about 0.005 ampere per square centimeter of electrode surface. With a greater current density the distance between the charge and discharge curves would increase. The general character of the curves for different makes of batteries is the same, tho for those having a thin layer of active material the curves are more marked, and for those having a thick layer, they are more rounded.

From the fact that the charging potential V is several tenths of a volt higher than the discharging potential V^1, as is shown in Fig. 3, it is evident that there is a *loss* of from 20 to 30 per cent. in the energy stored. It might seem at first sight that it results from the loss of energy due to the resistance of the cell itself, to the IR value in equations 20 and 21, but the value of the resistance of the cell is too small to account for such a large loss. On open circuit the resistance of the smallest cells used is only several hundredths of an ohm, and no large increase in its value takes place when a current is passing. The cause of this loss in energy is the polarization of the electrodes caused by the change in concentration of the acid in the pores of the plates. On charging, acid is formed in the pores of the plates where it becomes more concentrated than in the rest of the battery on account of the fact that diffusion does not take place with sufficient rapidity to equalize it. Since the electromotive force of the battery increases with the concentration of the acid surrounding the plates, a higher imprest electromotive force will therefore be necessary in charging. On discharge, the acid is used up in the plates and becomes more dilute than in the rest of the battery, and the voltage falls correspondingly. The charge and discharge curves of the lead battery may now be taken up in detail.

The Charging Curve

On closing the charging current, sulfuric acid is immediately set free at both electrodes and the electromotive-force therefore rises rapidly, as shown by the portion of the curve AB. The rate of diffusion increases with the difference in concentration of the acid on the plates and in the rest of the battery, and when concentration difference has become so great that the rate of diffusion and of formation are equal, this rapid increase ceases. The maximum point at B is probably due to the destruction of the thin continuous layer of sulfate which forms on the electrodes during rest, thus reducing the resistance of the cell. The slow regular rise to C is due to the gradual increase in the density of the acid and also to the deeper penetration of the current lines into the active mass and the corresponding greater difficulty in equalizing the acid concentration by diffusion. The final rise CD takes place when all of the lead sulfate on the surface of the plates has been used up, and consequently the sulfate does not dissolve rapidly enough to replace that electrolyzed out. Very soon the lead solution becomes so dilute that the work necessary to deposit lead is equal to that required to produce hydrogen on the cathode and oxygen on the anode. If allowed to stand on open-circuit, sulfate diffuses from within the plate and brings back the electromotive-force to the normal amount. The maximum point at D is due to the mixing of the concentrated acid in the electrodes with that outside by the gas bubbles.

The Discharge Curve

In discharge the acid is used up in immediate proximity to the electrodes, and this continues until the concentration difference between the acid on immediate proximity to the electrodes and in the rest of the battery has become so great that diffusion just supplies the quantity used up. During this time the value of V^1 falls rapidly along AE. The minimum point at E is possibly caused by the formation of a supersaturated lead sulfate solution. The solubility of lead sulfate in a 20 per cent solution of sulfuric acid decreases with decreasing concentration, so that at the beginning of the discharge, when little solid sulfate is present, a supersaturation of short duration is probable, and the electromotive-force of the battery decreases with increasing concentration of the lead ions. The subsequent gradual fall in the value of V^1 represented by EF is due to the gradual decrease in the density of the acid in the entire accumulator, but more especially to the greater difficulty in the acid diffusing deeper into the plate as the current penetrates deeper. Finally the rate at which the acid diffuses cannot supply the acid used up by the action of the current, and the value of V^1 falls off rapidly.

According to this explanation, the loss in energy on charge and discharge is due entirely to the concentration changes that take place in the electrolyte within the active mass. The smaller these concentration changes are, the more nearly will the accumulator approach *complete reversibility*. This is illustrated in Fig. 4. These curves were obtained with an accumulator of 200 ampere-hours capacity. It is seen that for a current of 0.1 ampere, corresponding to a current density of 0.0017 ampere per square decimeter, the charging and discharging potential differ by only 0.006 volt, or 0.3 per cent of the electromotive force of the cell, and that by reducing the current this loss may be still further reduced.

This loss is not distributed equally between the two plates. The porosity of the lead plate made from the same sulfate paste as the peroxid is about 1.4 times as great as the peroxid; the potential of the peroxid plate falls off about 1.6 times more than the lead plate for a given change in the concentration of the acid, and finally the concentration change on the peroxid plate is greater than on the lead, because not only is sulfuric acid used up on discharge, but water is also formed. All of those facts tend to make the loss on the peroxid plate greater than on the lead plate. When the positive and negative plates are made of similar frames and paste, and have approx-

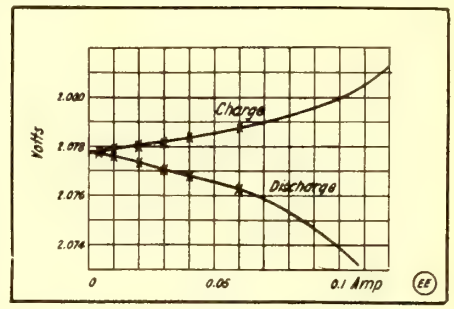


Fig. 4.—Change in Pole Potential of Lead Storage Battery on Charge and Discharge, as a Function of the Current.

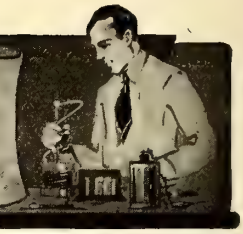
imately the same capacity it has been found that 60 to 70 per cent of the loss takes place on the peroxid plate.

The capacity of an accumulator in actual practise means the number of ampere-hours that can be taken from it if discharged at about nine-tenths of its original electromotive-force, the point where the rapid falling off in the electromotive-force takes place. The capacity therefore is determined by the rate of discharge, for the smaller the current the more time the acid has to penetrate by diffusion deeper into the plate, when all of the active material on the surface has been used up. It is also quite evident that the conductivity of the acid will affect the capacity, for the higher the conductivity the deeper will the current lines be able to penetrate into the plate. Since there is a density of sulfuric acid at which there is a *maximum conductivity*, it would be expected that the capacity of a lead storage battery would have a maximum value for this density, and this has been shown experimentally to be the case.

The current efficiency of a lead storage battery, or the ratio of the number of ampere-hours obtainable on *discharge* to the number put into the battery on *charge*, is from 94 to 96 per cent. The small loss of 4 to 6 per cent is due to self-discharge and to the small amount of gassing that cannot be avoided. The energy efficiency, on the other hand, which is the ratio of energy obtainable in the external circuit on the discharge to the energy put into the battery on charge, is only from 75 to 85 per cent. The cause of this comparatively low value, as explained above, is the difference between the charge and discharge potential. The loss in voltage due to the internal resistance is only about 3 per cent with the usual acid concentration and current density. The loss due to polarization is a minimum when the conductivity of the acid in the battery is a maximum, for in that case the lines of current spread over a larger surface by penetrating deeper into the plate.

(*Continued on page* 493)

HOW TO MAKE IT



This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

A SMALL INDESTRUCTIBLE RHEOSTAT.

The general construction of the majority of small rheostats does not permit of extremely rough usage, and in some cases is not adapted to the requirements imposed upon this class of instrument. In a word, those with wooden bases are apt to be destroyed by fire, and the ones mounted on porcelain are easily broken.

An instrument constructed after the principle of the one illustrated herewith will be found nearly indestructible. A large iron pulley of the type shown, or a similar form, provides a circular groove, at the perifery of the wheel which is well suited to hold the slightly stretched spiral spring. This spring is of fine steel wire and is insulated from the wheel by a narrow strip of asbestos. The ends of the wire are tied together with asbestos cord, one end being grounded to the wheel; to permit direct electrical base connection.

Any suitable type of handle can be fitted to the wheel to obtain the necessary rotary adjustment. Contacts and connections can be made as desired.

Contributed by R. U. CLARK, 3RD.



An Unusual But Simple Form of Battery Rheostat. It Comprises a Resistance Coil Supported on a Rotatable Grooved Pulley, Against Which a Spring Brush Bears.

ANENT THE "CAPILLARY" GRAVITY CELL.

I read with great interest Mr. Reed's article on "Bats" in the August ELECTRICAL EXPERIMENTER. As a result, I made one of his "capillary" cells. For the capillary cloth I used a piece of old Turkish towel. It worked excellently. But as Mr. Reed says, the internal resistance of the cell is very high.

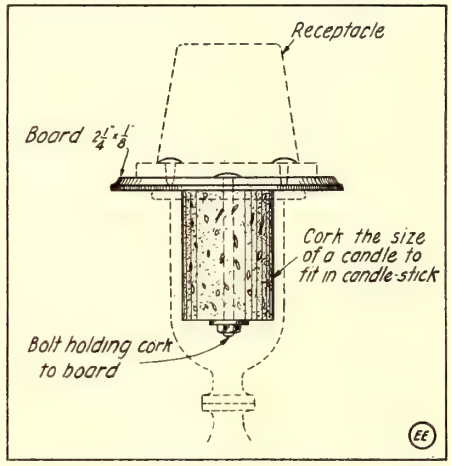
I tested the current of my cell by the loudness of the sound it produced in a telephone receiver. I had four dry cells which I have used for a long time. The capillary cell made a sound not quite as loud as one of these cells. But then I took some common salt, and put some in the solution in the inside cup, in the water outside, and on the capillary cloth. I used enough to saturate the solution. Then I tested my cell, and found that it would produce a sound in the telephone receiver as loud as the four dry cells together connected in series.

Contributed by WM. A. TRIPP.

SECOND PRIZE, $2.00

ELECTRIFYING THE CANDLE-STICK.

Herewith is a drawing of a circular wood base to which a standard lamp socket is



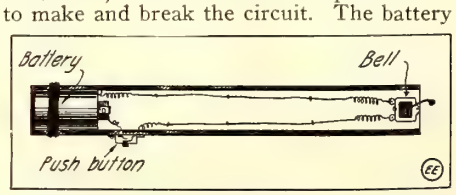
Here's a Simple Way in Which to Electrify Those Handsome Brass or Glass Candle-sticks Which are Seldom Used With Messy Wax Candles.

screwed. The wood base has a cork screwed on to it which fits down in the place intended for a candle in the candle-stick. This little device enables one to make a neat electric candle-stick lamp out of a few odds and ends.

Contributed by JOHN S. STEWART.

A WINDOW TICKER FOR HALLOWE'EN.

A window ticker for Hallowe'en or Thanksgiving can be made with a wooden pole about thirty-six inches long or more and an inch and a half wide. A bell with the gong removed, is screwed on one end and is connected with a flashlight battery on the other end, with a switch or a push-button to make and break the circuit. The battery



Instead of Taking Chances With the Old Spool Window Ticker on Hallowe'en, Use This Simple Electric One on a Long Pole.

is the kind that fits in a pistol flashlight. To use it hold the tapper of the bell near the window and push the button. This kind of ticker is much better than the one operated by a spool with notches in it.

Contributed by THEODORE A. SMITH.

To solder iron use a flux of muriatic acid which has been "cut" with zinc scrap. Don't use this on electric work.

THIRD PRIZE, $1.00

A TOY ELECTRIC STOVE FOR THE KIDDIES.

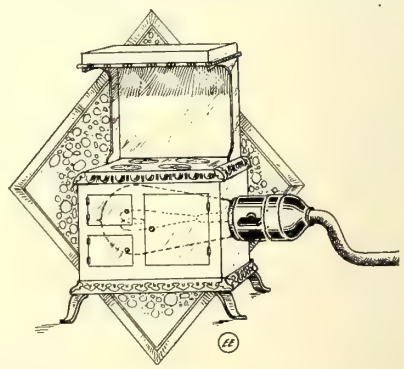
The day of electrical toys that actually work has arrived, as is evidenced by the many practical devices on the market intended to amuse the youngsters.

To fix a toy stove so that it really heats, is not a great problem for those who have access to lighting current. A common 16-C.P. carbon filament lamp mounted in a toy stove will add greatly to its interest retaining qualities.

This can be accomplished very easily. A hole is cut in one side of the stove large enough to pass a key socket. It is soldered in place so the key can be turned. An incandescent lamp with a red bulb is now screwed into the socket and the stove reassembled. It is advisable to make sure the socket is in good condition and not "grounded."

The heat given off by the lamp will not be very great, but the fact that it does heat and the red glow coming from the various parts will bring pleasure to the little "Housekeeper."

Contributed by THOS. W. BENSON.



To Please the Kids Why Not Turn Their Useless Toy Stove Into an Electric one? An Electric Lamp Does the Trick.

REMOVING ACID STAINS.

If first aid is given to acid-stained cloth, one may often remove the stain without taking the trouble to neutralize the acid; the removing agent is merely chloroform. If, however, the cloth has been plainly injured or destroyed by the acid, strong ammonia should first be used to neutralize.

In the case of hydrochloric or sulfuric acid, concentrated ammonia alone will be sufficient. But beware of cheap dyes! Ammonia will turn a pair of black-striped, beach trousers into black trousers. In such a case, chloroform will also remove the running dye.

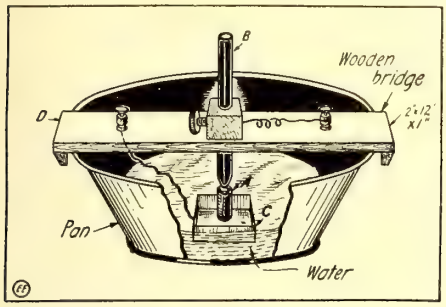
Contributed by J. FIERSTEIN.

Don't forget to send a photograph of your "rinktum" with your description. It makes the article more valuable in every way.

A NOVEL "WATER MICROPHONE."

I give herewith a diagram and description of a very sensitive microphone which is very simple in construction, the entire apparatus being made from a tin pan and an old dry cell carbon.

A lengthy description is unnecessary as its construction can be easily understood by referring to the accompanying diagram,



A Novel Experimental Microphone Made With a Pan of Water and Two Carbon Rod Contacts, One of Which Floats on the Water As Seen.

in which B is the stationary carbon contact, held in position by wooden supports D, and A the loose carbon contact which is slightly dished as shown and supported by wooden float C. The position of the contacts, which is determined by the water level, can be accurately adjusted with a fountain pen dropper.

I have found this instrument to give excellent results using two dry cells. If placed on a table a pin may be dropt near it and heard very distinctly in the 'phones.

Contributed by C. RALPH.

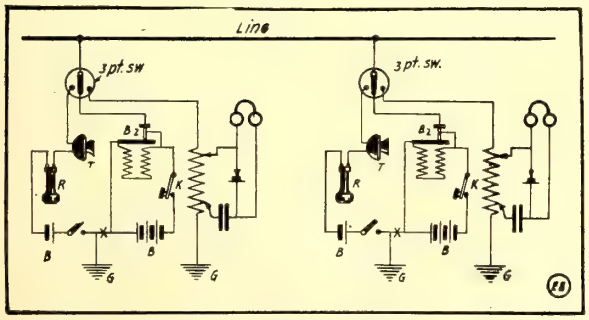
USING A TELEGRAPH LINE FOR TELEPHONE AND WIRELESS.

Very good results have been obtained with circuits indicated in the accompanying drawing.

To talk by telephone close 3 pt. switch on proper point; ordinarily this prevents batteries from running down when not in use. R is the receiver, T the microphone, Sw. the 3-point switch, B the battery cells, G the ground, K the telegraph key and B_2 the buzzer, preferably of the hy-tone type.

This hook-up was used on a line about half a mile long with six stations connected in and it gave the best of results. The buzzer is tuned to give a loud buzz in the station 'phones which can be heard at a good distance from the set. To telegraph over several miles of wire in this way the buzzer currents can be intensified by inserting inductances at X—X; these may be ordinary gas lighting coils costing about $1.50.

Contributed by CHARLES PHILLIPS.



A Clever Scheme Permitting Telephone, Telegraph or Radio Messages to be Transmitted and Received Over a Telegraph or Lighting Circuit.

HOW TO MARK YOUR NAME ON TOOLS.

There are many tools used by mechanics that are so delicate in construction, that it would ruin them if they were marked with the names or initials of the owner put on in the usual way by means of a steel stamp; as many are sprung or thrown out of adjustment, which renders them useless for accurate work. By the chemical method, names or initials may be placed upon tools, etc., without any risk of their being damaged. The corrodent employed does not injure the hands, nor does it wear off the metal; while the solution is cheap and easily applied. The formula is as follows:

Distilled water	4 ounces.
Copper Sulfate	1 ounce.
Salt	1 "
Zinc Sulfate	½ "
Alum Sulfate	¼ "

Mix all the chemicals in the water and shake vigorously until they are dissolved. The mixture is then ready to use. Now take the articles to be marked; clean the rust off of the metal with fine sand paper or emery cloth on the spot where the lettering is to be placed. Smear the spot with good soap; then write down the name with a scriber or other sharp instrument, and cover the marking with the fluid—or better still; fill up the tracing with it.

Leave the object alone until the name has turned copper-colored. Moisten the soap with water and rub it off. The solution need only be left on the writing five minutes. The mixture is to be used only on iron or steel goods. To those who would like to have their names put on tools in a neater manner than is possible by the use of a scriber; the use of rubber type, which can be bought in a 10-cent store, is recommended.

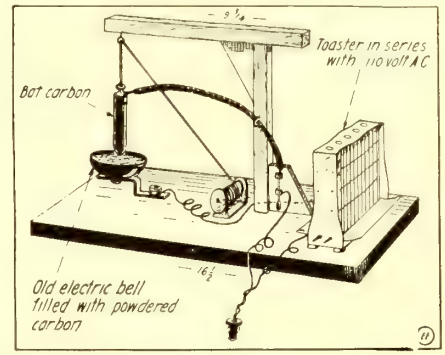
In using these, proceed as follows: Set the type in the holder in the reverse direction to what it will appear when printed; or in other words, reading from right to left. Purchase a small can of asphaltum varnish from a hardware store. Also tack a piece of cotton cloth to a level piece of wood. Spread a small amount of the varnish by means of a flat stick, on the cloth; press the type on the varnish, then press it lightly on the metal and let dry. Make a small rectangular piece of wood about ⅛ of an inch thick, the length and width depending upon the size of the tool and name; the object being to have as wide margins as possible around the name.

Bevel the sides of the rectangular piece of wood with a knife or file—a steep angle making it withdraw easily from the soap. Put a tack in the middle of the piece of wood to serve as a handle. Lay the rectangular piece of wood over the name, making sure that the margins are equally spaced; then put soap or putty around the sides of the wood so that none of the solution will escape. Withdraw the wood, and fill the place with the corrodent. After five minutes, pour the latter off; clear away the soap as previously described and you will have the name in black letters on a copper-colored background. The type should be cleaned after using, turpentine removing the varnish easily. In inking the type with asphaltum, care must be taken not to get too much on, as it will clog the letters. If the type should have too much ink on it, the surplus can be gotten rid of by pressing it on a piece of paper. It would be better for the beginner to try the process on a piece of iron or steel before putting his name on the tool; thus he will become familiar in handling the type and do a good job. These directions for doing the work sound formidable; but it will be found in practise, that it is a very easy matter to place names on tools.

Contributed by W. S. STANDIFORD.

EXPERIMENTAL ELECTRICAL FURNACE.

The drawing in this article shows a small electric furnace which I have constructed in my shop recently. It has given excellent results and I think it will interest numerous other amateur electricians.



Here is a Handy Small-Sized Electric Furnace Which Will Weld Almost Anything.

The furnace is very simple in construction; the drawing will explain everything.

To operate it one has but to lower the carbon into the pot of carbon dust and then gradually raise it again. A white flame plays back and forth from the carbon to the dust, and by inserting a piece of metal in the cup it is quickly fused. The carbon dust may be obtained by filing or grinding a battery carbon.

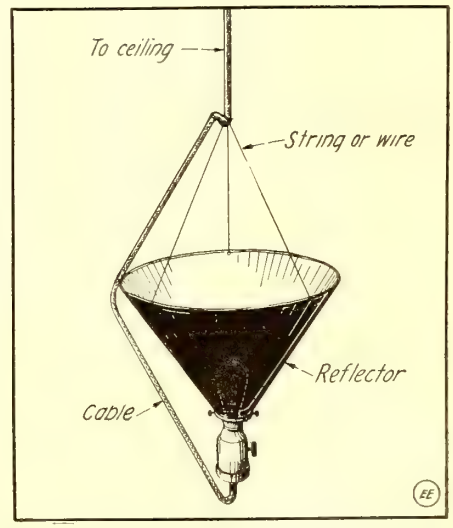
This can also be used as an arc light.

Contributed by STANLEY PENBERTHY.

A GOOD INDIRECT LIGHT MADE IN TEN MINUTES.

Experimenters who have access to electric light in their homes, may enjoy an indirect light by means of an ordinary tin reflector and socket.

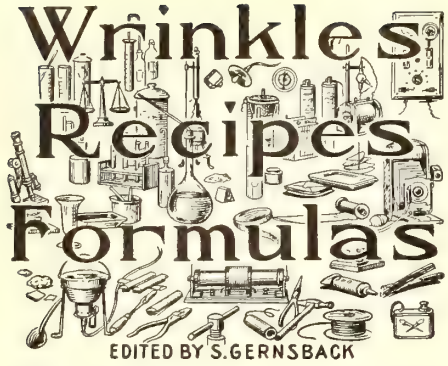
Three ⅛" holes should be drilled at angles of 120 degrees apart, around the rim of the reflector. Three one foot lengths of twine or wire should be cut; knot them at one end, and attach the other ends to the holes. Loop the cable and



Do You Want an Indirect Lighting Fixture? Here's a Simple Way to Make One for a Few Cents.

attach the free end of the cord to it, so it will stay upside-down. The inside surface of the reflector should be painted white, using white enamel if possible.

Contributed by CHARLES MASON.



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

MISCELLANEOUS FORMULAS FOR THE AMATEUR CRAFTSMAN.

No. 1.—Black stain for wood: The intense black color that cabinetmakers produce is obtained by moistening the wood with dilute sulfuric acid and afterwards gently heating. The following mixture answers well. Sulfuric acid, one ounce, water, 8 ounces. When cold add sugar in the proportion of 1 ounce to ten fluid ounces.

No. 2.—Violet Ink: Primula Violet, 1⅓ ounce. Distilled boiled water, 3 quarts. This can be converted into copying ink by adding 4 ounces glycerin.

Primula violet is known as Hoffmans violet. The finest shade is No. 6. Other shades can be made from other colors. Add about 5% alcohol and 1 to 4% glycerin to keep.

No. 3.—Bronzing Copper: Castor oil, 20 parts; Alcohol, 80 parts; Soft soap, 40 parts; water. 40 parts. After copper has been scoured, cover with the above mixture until the desired color is obtained. Then dry in hot sawdust and coat with dilute varnish.

No. 4.—Blue Ink for use on glass: A blue fluid for writing on glass which is not attacked by water is made as follows: Bleached Shellac, 10 parts; Venice Turpentine, 5 parts; Oil of turpentine, 15 parts; Powdered Indigo, 5 parts. Mix the shellac, oil of turpentine, and place in water bath under gentle heat until solution takes place. Then add the indigo.

No. 5.—Sticky Fly Paper: Resin, 1 lb.; Molasses, 3½ ounces. Boil until thick enough.

No. 6.—Stove Polish: Black Lead, 5 parts; Bone Black, 5 parts; Iron Sulfate, 10 parts. Mix thoroly and make into a paste with water.

No. 7.—Hektograph: Gelatin, 1 part; Glycerin, 4 parts; Water, 2 parts.

No. 1.—Ink for same: Methyl Violet, 1 part; Water, 7 parts; Alcohol, 1 part.

No. 2.—Rosaline, 2 parts; Water, 10 parts; Alcohol, 1 part.

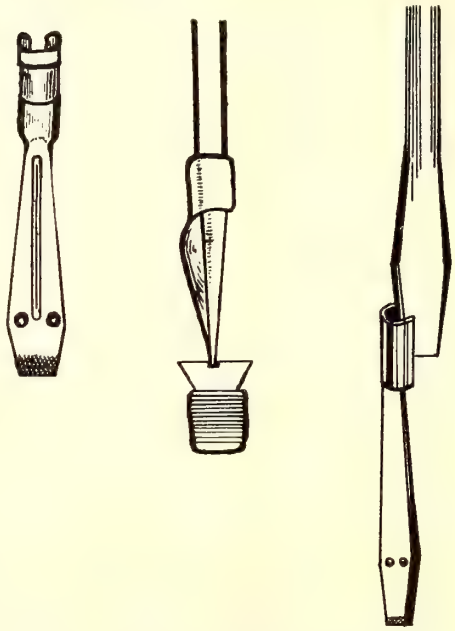
No. 8.—Solder for aluminum: Consists of zinc, tin, aluminum phosphorus. The first two containing the bulk of the alloy. This solder can be used either with the blow pipe or the iron. If the former is used a little silver can be added to it without making it melt and giving it a better color. The surfaces to be soldered are first scraped clean then tinned with the solder itself, no flux being needed. Silver, 2%; Aluminum Phosphorus, 9%; Tin, 34%; Zinc, 50%.

No. 9.—Liquid Glue: Chloral Hydrat, 250 grams; Gelatin, 400 grams; Water, 1,000 grams. The solution is ready in 48 hours.

Contributed by HOWARD A. CROWL.

HOLDING ON TO THE SCREW.

A clever little device has recently been put on the market which should save the motorist's or electrician's vocabulary of swear words from being overworked. The device is made of specially tempered crucible steel and may be slipt on any screw driver. Once in place it serves to hold a screw firmly on the end of the screw driver till it is well started into its required position.



One of the Latest Devices for Mechanics Is an Attachment for Holding On to Small Screws in Inaccessible Places.

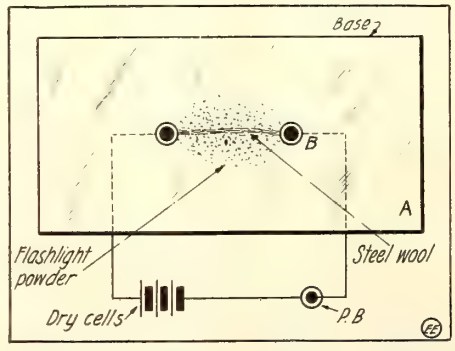
Such a device should prove particularly helpful in fastening parts of machinery which are hard to get at and which require the use of small sizes of screws.—Contributed by ALLEN P. CHILD.

HOW TO SET OFF FLASHLIGHT POWDER.

Very often one wishes to set off flashlight powder when taking an indoor picture, etc. A simple way to set off the powder is shown in the diagram.

A is a small base of slate 2 inches by 3 inches. B two binding posts taken from an old battery. Screw the posts on the base about one inch apart. Procure some fine steel wool from a paint store. Pull out a strand and stretch it between the binding posts. A few dry cells and a push-button are connected as in the diagram.

When a flashlight picture is to be taken pour some powder on the wire and push



When Current From the Battery Is Past Thru the Single Strand of Steel Wool, It Becomes Incandescent; Igniting the Flashlight Powder.

the button. The wire will become red hot and will ignite the powder. A reflector is put behind the base to increase the light.

Contributed by HYMAN R. WALLIN.

THERMOMETER SCALES.

Of the three scales in general use, the Centigrade scale [also called Celsius] is the most rational one and the one used in all scientific research and international literature; it is also used exclusively in most of the European countries. The zero point is the melting point of ice, and the 100° point is the boiling point of water. The Fahrenheit scale is used in the United States and England; on this scale the melting point of ice is exactly 32°, and the boiling point of water is 212°. The Reaumur scale is in limited use in Germany; it has the same zero point as the Centigrade scale, but the boiling point of water on this scale is exactly 80°.

TABLE SHOWING THE COMPARISON OF THE READINGS OF THERMOMETERS.

C = Centigrade, or Celsius. R = Reaumur. F = Fahrenheit.

C	R	F	C	R	F
— 30	— 24.0	— 22.0	23	18.4	73.4
— 25	— 20.0	— 13.0	24	19.2	75.2
— 20	— 16.0	— 4.0	25	20.0	77.0
— 15	— 12.0	+ 5.0	26	20.8	78.8
— 10	— 8.0	14.0	27	21.6	80.6
— 5	— 4.0	23.0	28	22.4	82.4
— 4	— 3.2	24.8	29	23.6	84.2
— 3	— 2.4	26.6	30	24.0	86.0
— 2	— 1.6	28.4	31	24.8	87.8
— 1	— 0.8	30.2	32	25.6	89.6
Freezing	point	of water	33	26.4	91.4
0	0.0	32.0	34	27.2	93.2
1	0.8	33.8	35	28.0	95.0
2	1.6	35.6	36	28.8	98.8
3	2.4	37.4	37	29.6	98.6
4	3.2	39.2	38	30.4	100.4
5	4.0	41.0	39	31.2	102.2
6	4.8	42.8	40	32.0	104.0
7	5.6	44.6	41	32.8	105.8
8	6.4	46.4	42	33.6	107.6
9	7.2	48.2	43	34.4	109.4
10	8.0	50.0	44	35.2	111.2
11	8.8	51.8	45	36.0	113.0
12	9.6	53.6	50	40.0	122.0
13	10.4	55.4	55	44.0	131.0
14	11.2	57.2	60	48.0	140.0
15	12.0	59.0	65	52.0	149.0
16	12.8	60.8	70	56.0	158.0
17	13.6	62.6	75	60.0	167.0
18	14.4	64.4	80	64.0	176.0
19	15.2	66.2	85	68.0	185.0
20	16.0	68.0	90	72.0	194.0
21	16.8	69.8	95	76.0	203.0
22	17.6	71.6	100	80.0	212.0
			Boiling point of water.		

To convert *Centigrade* into Fahrenheit:

Degrees Centigrade multiplied by 9, and divided by 5, then add 32.

Example — 80° C. × 9 ÷ 5 = 144 + 32 = 176° F.

To convert *Fahrenheit* into Centigrade:

Subtract 32 from the number of degrees Fahrenheit, then multiply by 5, and divide by 9.

Example — 100° F. — 32 = 68 × 5 ÷ 9 = 37.8° C.

To convert *Reaumur* into Fahrenheit:

Degrees Reaumur multiplied by 9, divide by 4, and add 32.

Example — 16° R. × 9 ÷ 4 = 36 + 32 = 68° F.

To convert *Fahrenheit* into Reaumur:

32 subtracted from degrees Fahrenheit, multiply by 4, and then divide by 9.

Example — 95° F. — 32 = 63 ÷ 9 × 4 = 28° R.

The above table and formula for converting the different degrees to another will be found very useful, especially when, for instance, you have facilities to work with a Centigrade themometer, and the Fahrenheit degree is mentioned.

Contributed by
ALBERT W. WILSDON.

FILLING THE FOUNTAIN PEN WITHOUT DROPPER.

Oftentimes a person finds an occasion to fill a fountain pen, but they have no dropper handy. So here is a little trick to try on your fountain pen. Take a pin or match, and draw a channel out to the edge of the mouth of the ink bottle, with the ink. The ink will follow this channel, and run into the fountain pen, without spilling a drop.

Contributed by HOBSON ARNOLD.

Experimental Chemistry

By ALBERT W. WILSDON

Eighteenth Lesson

Sodium Hydroxid (NaOH) and Potassium Hydroxid (KOH)

HISTORY.

THE word "Alkali" meant originally "Ash," a particular sort containing Sodium Carbonat, and used in glass-making. Two classes of alkalies were early distinguished—the mild alkalies, which are now called alkalin carbonats, as Sodium Carbonat, and the caustic alkalis, as NaOH (sodium Hydroxid). Two divisions of these latter are now made, *i. e.*, the volatile alkali, ammonium hydroxid (NH_4OH), which upon the addition of heat entirely vaporizes, and the fixt alkalis, which leave a solid residue on the evaporation of their solutions. Sodium and potassium hydroxid are two examples of these. With strong heat these vaporize but do not break up, and, until Davy's experiments on them with the aid of the electric current, they were regarded as elements.



Fig. 89. Interesting Experiment with Sodium and Water. The Lighted Splint or Combustion Test Is Tried After the Sodium Has Been Dropt in the Water.

In 1736 Duhamel distinguished Sodium hydroxid from potassium hydroxid, previous to which there was no distinction between them, or the salts of sodium and potassium. The latter then became known as "potashes."

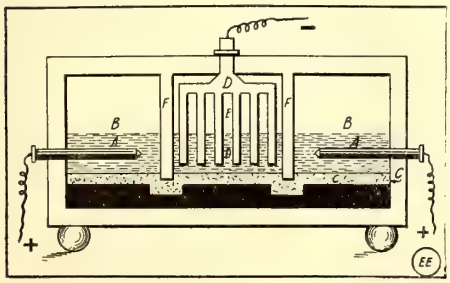


Fig. 88. Diagrammatic View of the Castner-Kellner Process for the Electrolytic Production of Caustic Soda and Caustic Potash.

In 1807 Davy discovered the metal *potassium*, by the electrolysis of potassium hydroxid. Thus by the decomposition of potassium hydroxid by electrolysis it was proved that they were not elements.

OCCURRENCE:—Owing to their strong affinities, neither potassium nor sodium hydroxid are found in the free state. Sodium or Potassium occur very commonly as silicates in granite and other rocks, and in their chlorids (Sodium Chlorid, NaCl, and potassium chlorid, KCl) and in other salts, but never free. Potash (K_2CO_3) is the principal alkali of the animal body, hence the need of potassium in food plants.

PREPARATION:—1. It is conveniently prepared by the interaction of metallic sodium or potassium with water.

$$Na + H_2O = NaOH$$
$$K + H_2O = KOH$$

2. THE ELECTROLYTIC PRODUCTION OF CAUSTIC SODA AND CAUSTIC POTASH:—This will probably be of most interest to readers of this journal, as one of the methods of preparation.

There have been numerous methods and processes invented for the manufacture of the caustic alkalis by electrolysis. Probably the best known method is the *Castner-Kellner process*. This consists of a tank (Fig. 88) which is divided into three compartments as shown; the two outside (BB) contain the sodium or potassium brine, and the carbon anodes (+ +); while the centre one (E) contains the iron cathode (D). Thru this inside compartment (E) a continuous supply of water flows, which takes up the caustic soda (or potash) produced and is conducted off into collecting tanks. The partitions (FF) are open below, just reaching to the surface of a layer of mercury (CC) which covers the entire bottom of the tank. The metal (Sodium or potassium) liberated amalgamates at once with the mercury (C), which by the tilting of the whole apparatus up and down, by means of a cam passes into the middle compartment (E), where it acts as the anode during the passage of the current to the iron cathode (D); the metallic sodium (Na) or Potassium (K) of the amalgam is thereby liberated, which reacts with the water present, forming sodium (or potassium) hydroxid, and hydrogen gas which is formed at the negative electrode (—). From the compartments (BB) chlorin passes as a gas to the upper parts, which is then drawn off and utilized for making bleaching powder, hydrochloric acid, etc. The lye obtained from the cathode chamber (E) contains about 20 per cent of caustic soda or caustic potash, which, after evaporation, yields a product of about 99.5 per cent pure.

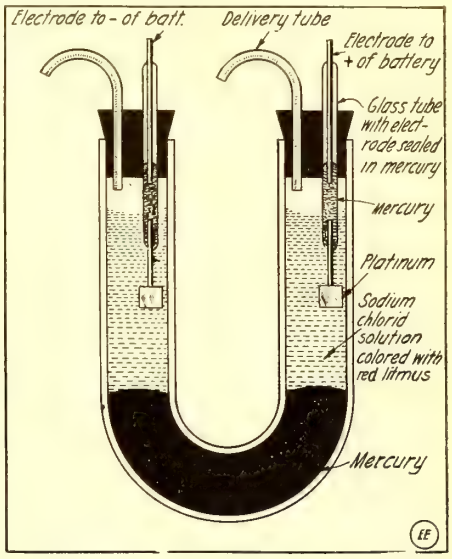


Fig. 92. Home-made Laboratory Apparatus for the Electrolytic Preparation of Sodium Hydroxid. It is Used in Conjunction with a Battery.

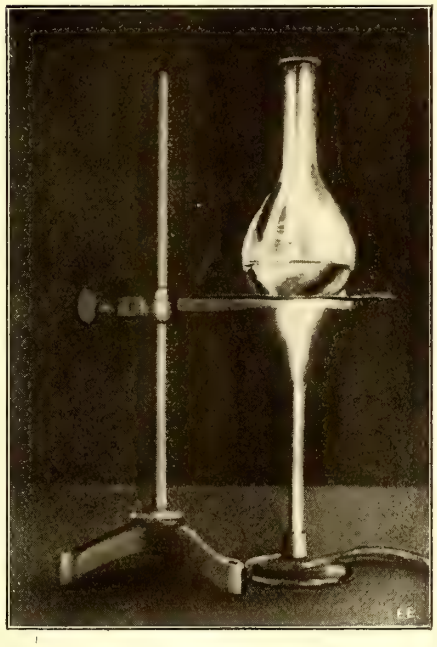


Fig. 91. Experiment No. 101, In Which Sodium Hydroxid Is Produced by Heating a Solution of Water, Slaked Lime and Sodium Carbonat.

3. On the commercial scale sodium hydroxid is produced by a modification of the *LeBlanc process* for preparing sodium car-

(*Continued on page* 494)



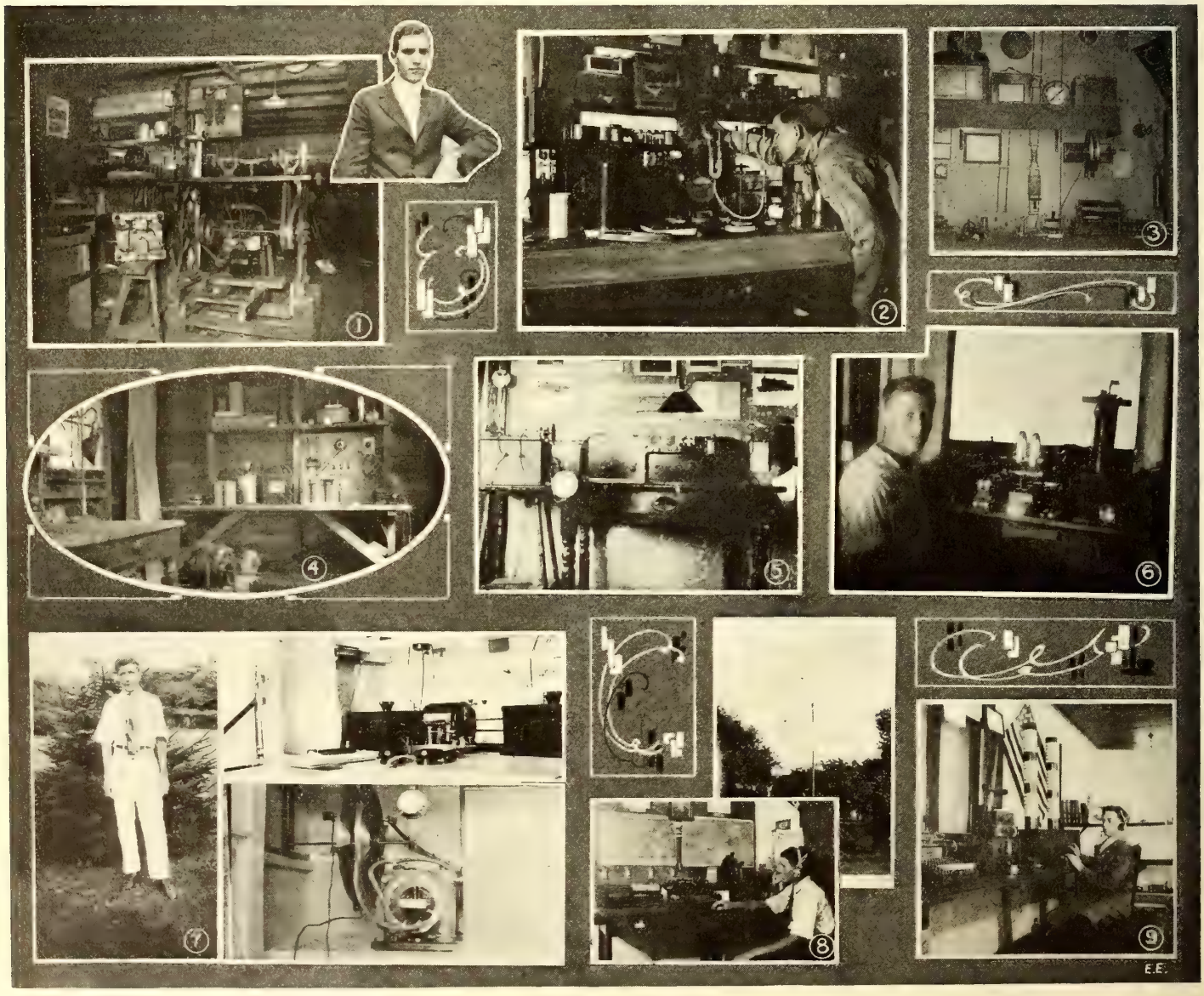
Fig. 90. Another Sodium and Water Experiment—After the Action Stops the Air Orifice of a Bunsen Burner Is Held Over the Bottle, Giving a Yellow Color to the Flame.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

At Last Some "Electrical Laboratory" Photos!!!

At last the "Radio-bugs" seem to be waking up. Observe the four Electrical laboratory photos we have with us this month. Now, why is it that we can't receive more photos from "ELECTRICAL LABORATORY" owners, when there are about a million of you scattered thruout the United States at this very moment! As you will remember we made all of you a special offer in the September number, *viz.,* we offered to give not only the $3.00 monthly prize for the best "Electrical Lab." photo, but 5 (five!!!) additional prizes of one year's subscription to this journal, and a copy of the "EXPERIMENTAL ELECTRICITY COURSE" for the best five photos submitted, after awarding the first prize. And all the answers we receive are FOUR photos. After awarding first prize of $3.00 the remaining three have been awarded a year's subscription and a copy of the famous *Experimental Electricity Course.* As we have just said, it is strictly up to you whether you wish to take a chance on winning the $3.00 cash prize, and also if you wish to throw away the chance of receiving "The ELECTRICAL EXPERIMENTER" magazine for one year **free of all cost,** besides the copy of the *Experimental Electricity Course,* which is worth $1.00 alone to my electrical student. Address the Editor "With The Amateur's Prize Contest."



A GROUP OF REPRESENTATIVE AMERICAN AMATEUR LABORATORIES

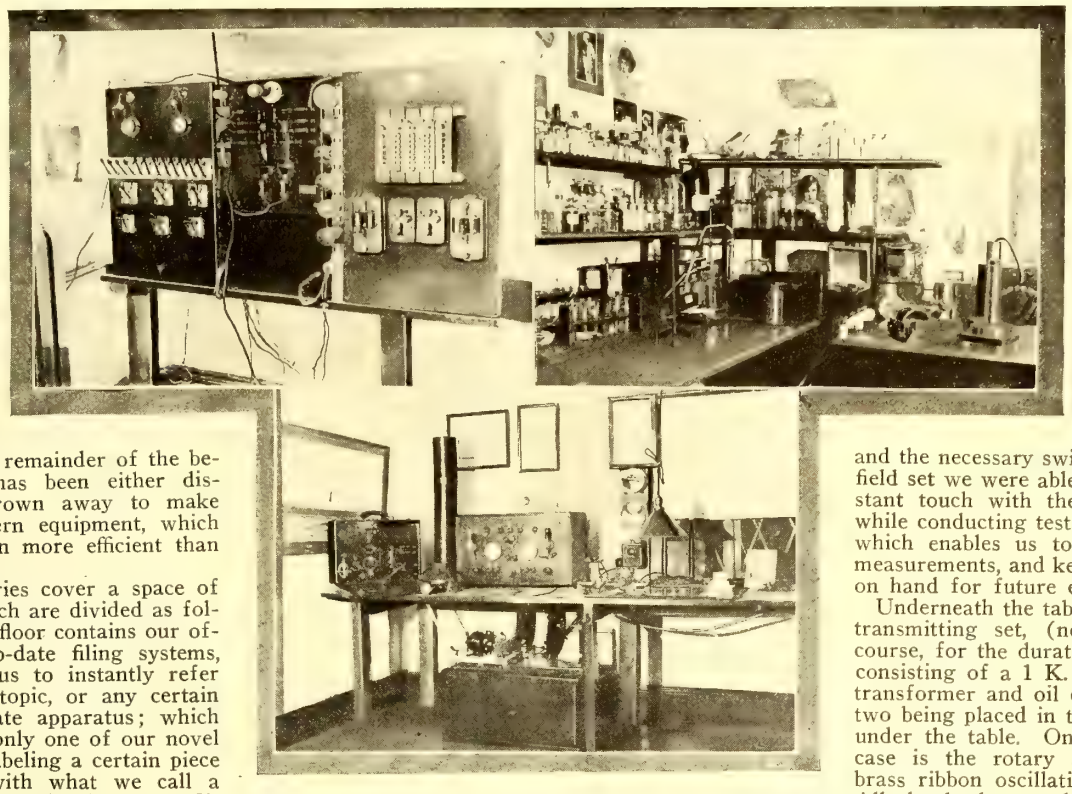
Electrical Laboratories of, 1—Joseph F. Birchler, St. Louis, Mo. ($3.00 Prize); 2—Thos. W. Benson and Mr. Uphoff, Philadelphia, Pa.; 3—Earl Scottie Ensign, Toledo, O.; 4—James L. Clifford, Evansville, Ind. (Nos. 2 to 4, inclusive, each awarded one year's subscription to the "E. E." and a copy of the "Experimental Electricity Course); Radio Stations of 5—Osmond Ryer, Pasadena, Calif.; 6—Clarence de Witt Rogers, Jr., Larchmont Manor, N. Y.; 7—W. Leathe, Larchmont, N. Y.; 8—Raymond Yoder, Newton, Kansas; 9—James Girand, 6EO, Phoenix, Ariz.

An Exceptional Experimental Laboratory

By GEORGE HOLMES and ALBERT W. WILSDON

THE Editors' very appealing and pathetic "S O S" for electrical and kindred laboratory photographs, was picked up on our short wave regenerative set, and due to the strong regenerative action, we take great pleasure in introducing our laboratories to ELECTRICAL EXPERIMENTER readers together with photos and data.

In obscurity for several years, our endeavors have been constantly branching out, ever since the early stages of the radio babyhood. Our complete laboratory, scientific instruments, periodicals, and various equipment is the outcome of nigh on to ten years accumulation. By this we do not mean that we have preserved all of the apparatus which was made and acquired during this period, but specimens of the early stages of electrical, chemical and radio apparatus have been carefully preserved, and the remainder of the beloved "junk" has been either dismantled or thrown away to make room for modern equipment, which has been proven more efficient than the older types.



Figs. 1 (Upper Left), 2 (Upper Right) and 3 (Bottom View), Illustrating the Excellent Electrical and Chemical Research Laboratory Owned by Two Live-Wire Experimenters. Such a Laboratory Is Something to Be Proud of.

The laboratories cover a space of four rooms which are divided as follows: The first floor contains our office, with up-to-date filing systems, which enables us to instantly refer to any special topic, or any certain piece of intricate apparatus; which by the way, is only one of our novel features. By labeling a certain piece of apparatus with what we call a "key," and putting the data on a filing card, then by reference thereto, valuable time and trouble are saved by this system. Our books, consisting of hundreds of scientific books, periodicals, magazines, patent papers, scrap books containing clippings of interest, and bearing on all scientific subjects, were taken from papers as far back as ten years. The library, with the aid of our filing system, is of great convenience when conducting experiments. Many pleasant winter evenings have been spent in this room, chatting and discussing future and past experiments and research problems.

Above the office is the "Radio" room, Research and Testing room, Photographic dark room, and Chemical Laboratory.

The layout of our Radio room may be of interest to readers who are contemplating overhauling, or reconstructing their sets. On the right hand side of the room are the switchboards, constructed of slate, all the wiring being past thru approved conduit. Fig. (1), shows these switch-boards and a group of relays. Either D. C. or A. C. current, varying from one to two hundred and fifty volts are instantly available, which of course is of great advantage in many experiments. A certain laxity on some of the work prevails owing to the numerous cables which have to be strung temporarily, such as for testing arcs, etc. Fig. (3) shows a partial view of the Radio Apparatus, which is all home-made.

Our radio apparatus is of course now cut off from actual service, in accordance with the proclamation of the President, and a careful scrutiny of the rotary gap and oscillation transformer under the table, discloses the wire sealing it up, upon which we have placed a tag bearing the inscription "Sealed in accordance with President Wilson's Proclamation. Here lies the remains of Pal Wireless, who died a struggling, and sudden death. May his spirit be reincarnated in all the glory of the original." Seems a funny sort of thing to be tagging on a wireless set—don't it? But when we go over the pleasant memories of the incoming signals from Nauen, Sayville, and other high powered stations we feel a lump in our throat, but of course we pass it over (not the lump, but the ban), saying "What has happened, had to happen, and it must be for the best." We sincerely hope that it is for the best, and have in fact, mapt out "some set," incorporating several new features, such as Morecroft inductances. We trust that the reader will pardon us for this lengthy post mortem statement, but we feel certain that like thoughts are creeping into his own mind on glancing over our belated loss.

Well, to get down to brass tacks, the general layout will probably be of interest. Facing the south against the window shown on the extreme right of the Radio "Lot" photo, are the operators' desks, upon which a large square glass plate is placed and under which a map of the important radio stations is located, which we have improved upon by placing the call letters after them; thus enabling us to determine the distance of the station. Under the glass is also placed various station calls and miscellaneous information of importance to the operator. Next to our right hand are the push buttons for the rotary gap, and the radio transmitting key together with keys for the outside telegraph lines, thus permitting us to get in communication at once with the various stations on our lines via telegraph. To the left of the operators' position may be seen the aerial switch, hot wire radiation meter, one step Audion amplifier, damped and un-damped wave receptors, crystal detector, receiving set, also a large loading inductance. The receiving circuits are all connected with Litzendraht and soldered. Three pairs of 'phones are available.

On the extreme left of the photo may be seen a portable sending and receiving set. The portable transmitting set consists of a one inch spark coil with the necessary accessories. The receiving set contains a loose coupler of our own design, variables, loading inductance, and the necessary switches. With this field set we were able to keep in constant touch with the parent station while conducting tests, a great factor which enables us to make accurate measurements, and keep accurate data on hand for future experiments.

Underneath the table is the regular transmitting set, (now "sealed" of course, for the duration of the war) consisting of a 1 K. W. Thordarson transformer and oil condenser, these two being placed in the large cabinet under the table. On the top of the case is the rotary spark gap, and brass ribbon oscillation transformer. All the leads are short and are of flexible copper cable with heavy rubber insulation. The ends being soldered into lugs.

The aerial used consisted of a large 100 ft. iron pipe mast, having short and long wave-length aerials, together with the necessary ground switches. (The aerial is not up at the present writing!) The aerials consisted of 500 feet of phosphor bronze wire for the reception of long and undamped waves, and the second of a 4 wire 80 feet long, adapted to transmitting and receiving on a short wave regenerative set.

On the other side of this room are placed two drafting tables, upon which new apparatus are designed and drafted.

The room directly opposite the radio-room is the laboratory, around the walls of which are placed shelves to hold the various instruments and supplies. A large table in the centre of the room holds the numerous testing devices; such as Wheatstone bridges, wave-meters, decremeters, hot wire meter, volt meters and ammeters.

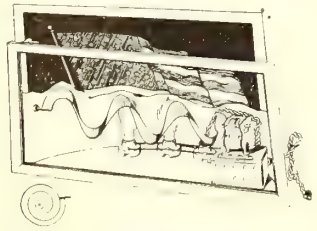
In one corner of the room are located the chemical and testing tables, which permits tests to be made while the experiment is in progress, and in this way we have the advantage of several readings with which we can compute the results. The chemical laboratory is completely equipt, containing all the common reagents and

(*Continued on page* 500)

LATEST PATENTS

Illuminated Display Apparatus.
(No. 1,238,739; issued to Frederick C. Bowdidge and Preston C. McMullen.)

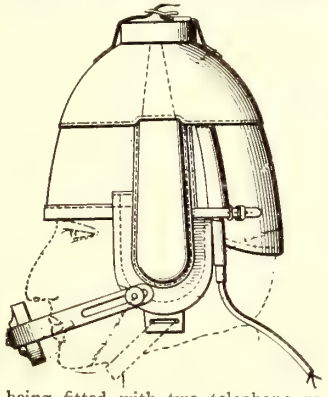
This patent describes a very simple and yet effective device for creating the effect of a waving flag or other moving object. A glass screen in



the front of cabinet shown, has for instance a waving flag painted on the face of it. Back of this screen there are placed several lamps for illumination and in front of this a slowly revolving metal spiral connected to a small electric motor. For best results the space around the flag should be made opaque. The spiral is cut out from a flat piece of metal and afterward expanded to the shape shown in the cabinet.

Telephone Helmet for Aviators
(No. 1,235,851; issued to Jesse Lee Spence.)

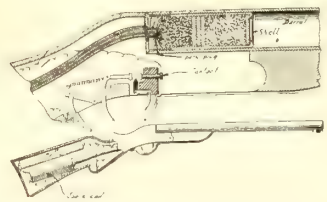
The patentee here provides an improved form of telephone helmet for aviators, the helmet proper being composed of leather or other suitable material. Instead of the helmet



being fitted with two telephone receivers pressing against the ears, use is made of a single telephone receiver mounted at the top of the helmet. This communicates with two sound channels which extend downward on either side of the helmet to the ears. The microphone is adjustably supported on a removable bracket, pivoted on either side of the helmet in the manner shown.

Electrical Gun
(No. 1,239,344; issued to Levi M. Bowman and William A. Smith.)

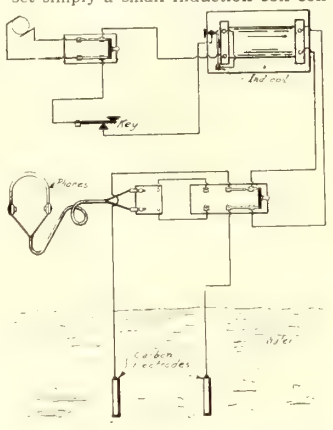
This represents an electrically fired gun which appears to possess several meritorious features. Acci-



dental discharge is prevented, for one thing, and after having once been sighted, the pulling of the trigger to fire the gun will not pull the gun off from the object sighted at. Further, this electrical gun structure includes a special primer or firing cap which carries a sparking point, so that the shell is discharged by the formation of a disruptive spark in the primer. The stock of the gun contains a battery which is connected to a spark coil in the usual manner. The spark coil primary circuit is controlled by the trigger contact.

Underwater Radio Scheme
(No. 1,233,211; issued to Frank P. Fisher and Hugh Dehart.)

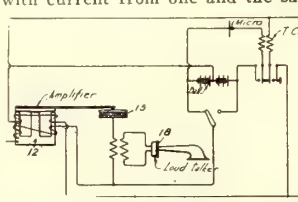
Under-water telegraphy can be carried on by this arrangement over considerable distances it is claimed. The apparatus involved is very simple, comprising for the transmitting set simply a small induction coil con-



nected with a source of power and a signaling key. The secondary leads from the coil are connected to a double pole, double throw switch as shown, so that the receiving set (pair of 'phones) can be switched in when desired. The blades of the switch are connected to two carbon electrodes submerged in the water, a suitable distance apart. It has been found that about 20 feet apart is the proper distance to set the electrodes for an apparatus having a range of 500 to 1,000 feet. It is mentioned that communication can be established with submarines.

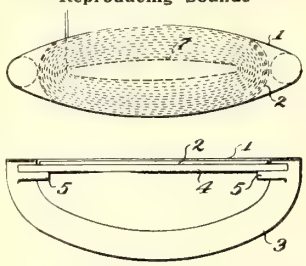
Telephone Amplifier
(No. 1,232,514; issued to Henry C. Egerton.)

This invention relates to amplifier systems for increasing the intensity of telephone currents. It permits several stations similarly equipt and on a common circuit to be supplied with current from one and the same



service. The loud-talking receiver and horn are actuated thru a transmitter element 15, which is in turn controlled by the amplifier motor 12, which is of special construction. It is rendered particularly sensitive to telephonic currents by means of two distinct windings, conected in such relation one with the other, that opposite magnetic polarities are present within each core; therefore a given impulse of current thru the operating windings acts to increase the magnetic pull at one end of the armature, while decreasing the magnetic pull at the other end of the armature, all in a well-known manner. Suitable bearings at the middle pole-piece of the amplifier electro-magnet, permit the armature of this magnet to move reciprocally in a rocking manner in unison with reversals or changes in amplitude of the telephone curent, thereby varying the pressure on the active material of the transmitter element 15.

Telephone for Transmitting and Reproducing Sounds



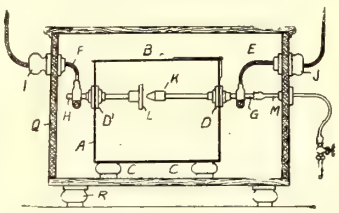
(No. 1,238,439; issued to Rudow Rummler.)

This invention relates to telephones, wherein a diafram and a coil of wire are so arranged that the coil may exert a direct inductive action on the diafram, more or less independently of the permanent magnet, and provides means for magnetically suspending the diafram in a magnetic circuit.

In the construction shown, an electrical diafram 1, of magnetic material, such as soft iron, is placed above the flat, spiral elliptical coil of insulated wire 2, this coil being connected in the usual manner. The permanent magnet is seen at 3.

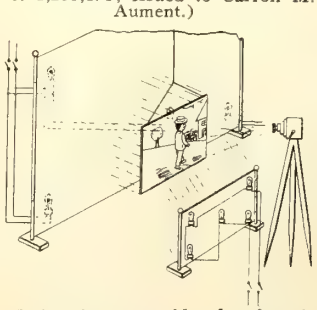
Rectifying Spark Gap for Radio
(No. 1,235,935; issued to Archibald Shaw.)

This design of high tension, high frequency spark gap is one of the



best yet brought out. It employs a fine stream of gas, such as air, under high pressure which is forced out thru the center of the smaller or point electrode of the gap. This stream of air is forced against a relatively large flat disc, and when the primary and secondary circuits to which such a gap are in resonance, no arcing will occur, but the discharge will take the form of a bluish-white incandescent blaze of tapered form, extending across the gap; furthermore a pulsatory discharge having a very high frequency passes in one direction only. It has been found best to employ an air pressure of 110 lb. per sq. in.

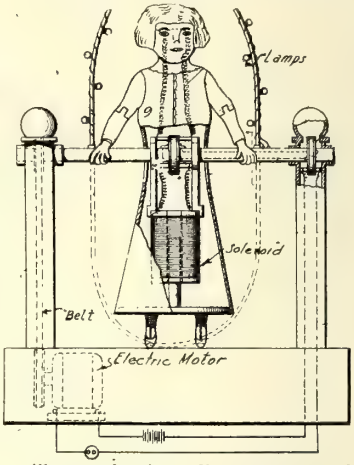
Making Cartoon Movies
No. 1,235,871; issued to Carroll M. Aument.)



This scheme provides for the taking of cartoon motion pictures in a new and improved manner. It represents an advance over other methods in that a permanent background is used instead of a number of them, and the scene is moreover painted or sketched on a properly prepared glass plate. The artist can thus prepare a scene or figures on either side of the glass, and suitable illumination is provided to enable him to do so. Special illuminating screens are employed as shown.

Electric Dancing Doll
(No. 1,238,786; issued by Joseph Kershaw.)

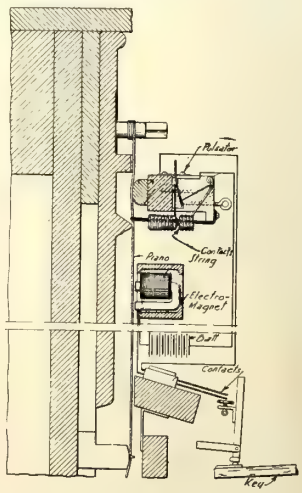
This is a particularly ambitious electrical toy in the form of a miniature metal doll which is supported on a crosswise shaft in the manner



illustrated. A small motor mounted in the base of the toy connects with the revoluble shaft by means of a belt; the motor circuit being periodically made and broken at the proper instants, by the contact disc and brushes carried on one end of the shaft. When the skip rope reaches the downward position, the toy figure is pulled upwards by means of the solenoid concealed in the skirt.

Electrical Piano
(No. 1,233,306; issued to George Breed.)

This is one of the cleverest electrical piano ideas we have seen. The



music strings are supported in the usual manner as indicated. At a point along each string is placed an electro-magnet which starts the string vibrating when its circuit is closed by the key contact shown. Included in this circuit is a special tuned interrupter or pulsator near the top of the string.

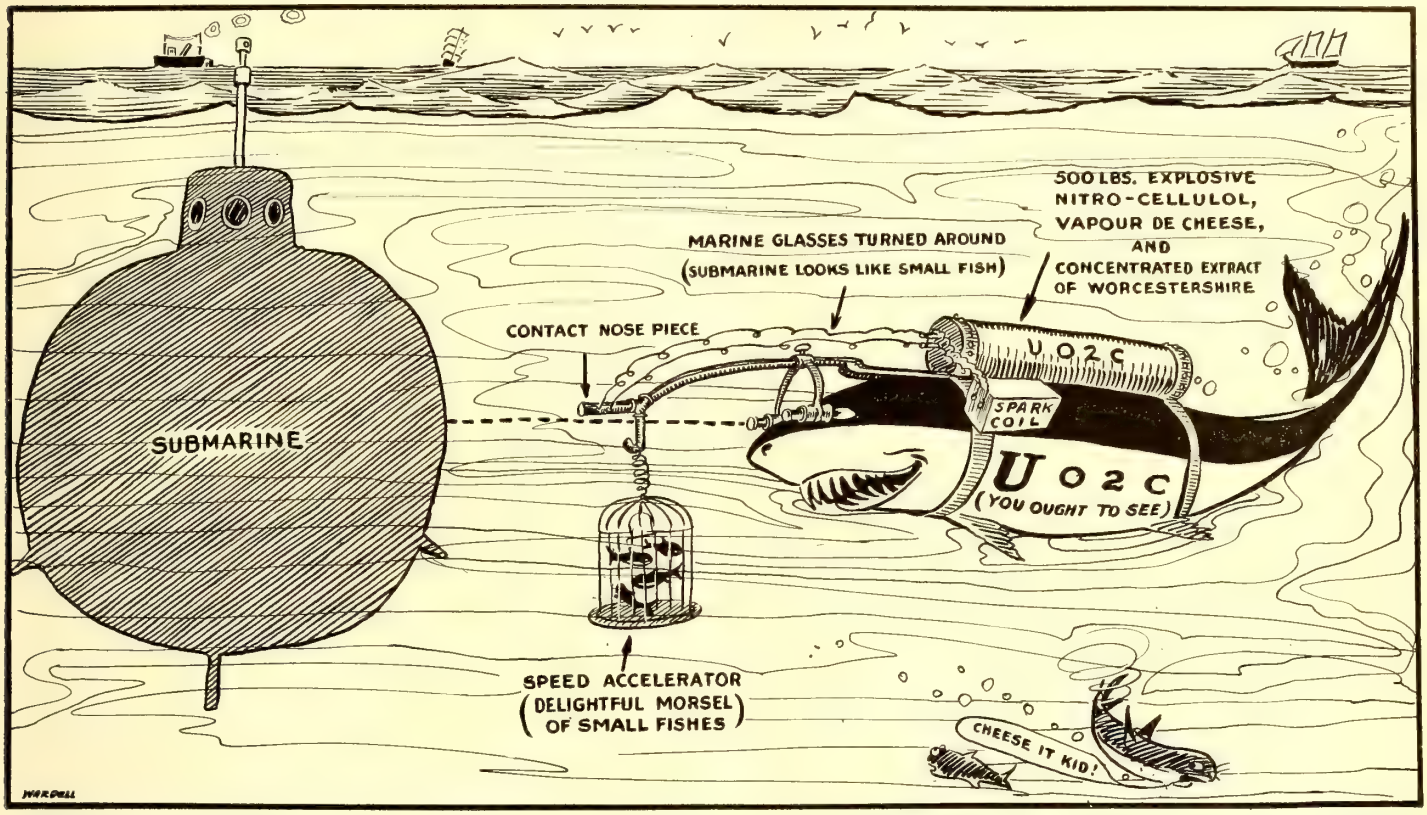
COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c EACH.

Phoney Patents

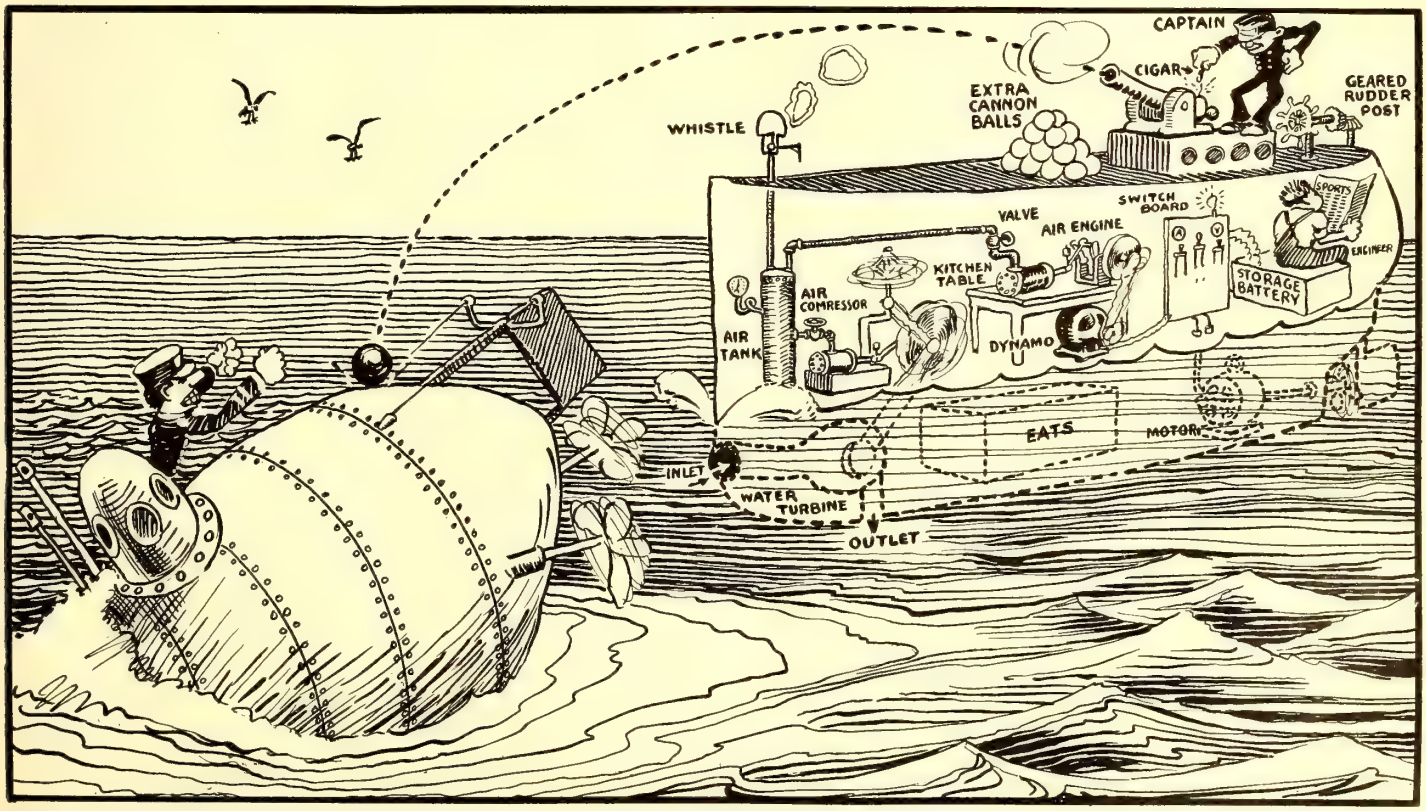
Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for the entire universe.

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Prize Winner. SUBMARINE KILLER. Shark Carries High Explosives in Tank Strapt to His Back. Extension Beam Carries Fish-Bait in Front of His Nose. This Makes Him Speedy Trying to Catch Fish. Inverted Marine Glasses Make Submarine Appear Like Small Fish. He Rushes for it—Contact Nose Piece Operates Spark Coil, Which Blows Up the Tank, Sub., Shark and All. Inventor, John P. Buckley, Washington, D. C.



SELF-PROPELLED BOAT. Water Enters Ship's Bow Thru Inlet, Leaving it by Outlet, Incidentally Driving Water Turbine. The Latter Drives Air Compressor, Which Runs Air Engine and This Drives the Dynamo. The Latter Charges Storage Battery Which Runs Motor. Motor Operates Ship's Propeller, Thus Ship Will Never Run Out of Power. Inventor, Thomas Stewart, Jersey City, N. J.



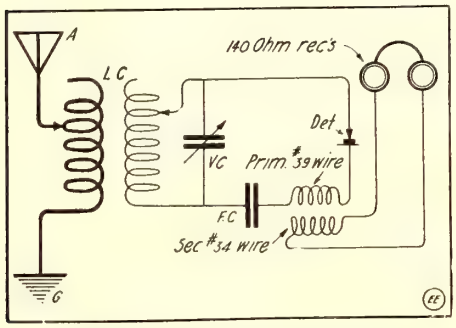
This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. **Only three questions can be submitted to be answered.**
2. **Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.**
3. **Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.**
4. **If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.**

RADIO TELEPHONE RECEIVER TRANSFORMER.

(853.) William Reeve, East Boston, Mass., desires data for building a radio telephone receiver transformer.

A. 1. Relative to data on radio telephone



How Telephone Receiver Transformer Is Connected in Radio Detector Circuit.

receiver transformer we advise as follows:

The annealed iron wire core should be made of small size stock. It may measure ¼ of an inch in diameter by 3 inches long. The primary coil to be connected to the detector circuit consists of ⅛ pound of No. 39 B & S single silk covered magnet wire. The secondary coil to be connected to the 140-ohm receivers comprises 1/16 pound of No. 34 B & S single silk covered magnet wire.

ALTERNATING CURRENT QUERIES.

(854.) Albert H. Beiler, New York, asks:

Q. 1. Will you please inform me whether a polarity changing current has the same effect as an alternating current? By polarity changing current I mean a current that changes at regular intervals; not gradually increasing or decreasing from positive to negative following a sine curve; but one that would be produced by a pole changer or a reversing switch actuated at regular intervals. Would such a current if reversed rapidly enough, operate a transformer or induction coil, and would it have the same effect on a magnet as a true A. C. which produces a field that repels a copper or aluminum ring? It is this latter point I am particularly interested in.

A. 1. A polarity changed current has not the same effect upon electrical apparatus as that of an alternating current. However, such a current can be employed to operate a transformer but not an induction motor. We doubt very much whether a rapidly reversed current would give the same results with the repulsion of aluminum or copper as those obtained with the use of a true sine wave A. C. There is no doubt however, that some results of a trifling nature can be obtained by a rapidly reversed current.

Q. 2. According to the capacity effect in an alternating current, the capacity reactance is exprest as follows: $X = \frac{1}{2 \pi f c}$; X therefore varies as $\frac{1}{c}$. Now since the capacity effect tends to throw the voltage out of phase, it may be likened to resistance, in that the greater the capacity, the less the effective voltage.

That means the more capacity in a line the greater the resistance, yet how does this reconcile itself with the above formula where R varies as $\frac{1}{c}$? Again, if my reasoning has been wrong and the above formula correct, why the objection to a great capacity, since it would lessen the resistance in the conductor.

A. 2. The capacity reactance varies inversely as the capacity and frequency of the circuit; thus by increasing the capacity the value of the fraction becomes smaller, thus the capacity reactance is decreased which means that the resistance in the circuit is decreased when the capacity is increased, and this is actually true. Since increasing the capacity means an increase in the storage of electricity, then a greater quantity of electricity will be discharged per given time with an increase of capacity. The current leads in phase when there is capacity reactance as you mention in your question and which is true.

Q. 3. When an inductance is connected to an A. C. Circuit, a C.E.M.F. is generated which is out of phase with the charging current. Why is it said to be ahead of the current by 90°, since the current has to flow thru the inductance *first* before producing the C.E.M.F. in which case the *current* is ahead? Why does the inductance throw the *line* voltage out of phase with the *line* current? It seems that the *C.E.M.F.* only is out of phase with it, so how does it affect the line E.M.F. This same question by the way may be put as regards capacity where the *C.E.M.F.* charge is out of phase with the charging current, but throws the current out of phase with the line voltage.

A. 3. You are well aware of the fact that whenever an inductance is placed in an A. C. circuit that the current will lag in phase, but not 90 degrees, providing that there is sufficient inductance to produce this effect. It should further be borne in mind that every centimeter of line conductor over which the current travels in the conductor generates a counter-electromotive-force which is directly in opposite phase with that of the imprest E. M. F. The relation which exists between capacity and inductive reactance being that the latter is directly proportional to the inductance, while the capacity reactance is inversely proportional to the capacity. Thus an increase in inductance is a decrease in current, while it is vice versa with capacity reactance.

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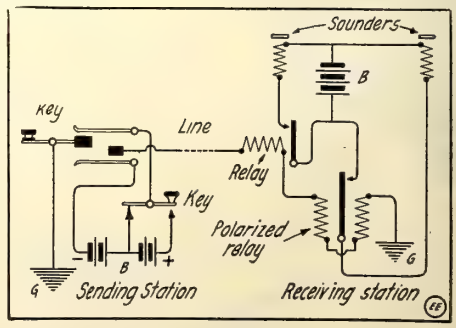
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Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, *233 Fulton Street, New York City.*

QUADRUPLEX TELEGRAPHY.

(855.) Peter Jolsen, Wilmington, N. C., inquires for:



Connections for Original Edison "Quadruplex" Telegraph System.

Q. 1. A wiring diagram of the original Edison quadruplex telegraph?

A. 1. The diagram below gives the connections.

Q. 2. In operating a simplex telegraph and if it is desired to know what distance can be covered with a given equipment what usual procedure should I follow in regards to formulas, etc.?

A. 2. There is a general formula which will give the maximum operating distance with a given equipment; this formula is as follows:

$$l = \frac{NR_r}{2R} + \sqrt{\left(\frac{NR_r}{2R}\right)^2 + \frac{2I_2R_1}{R(I_1 - I_2)}}$$

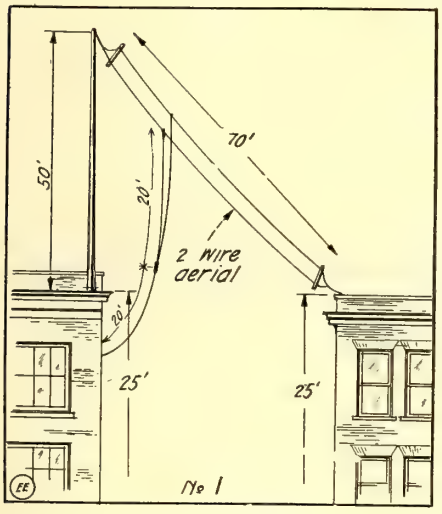
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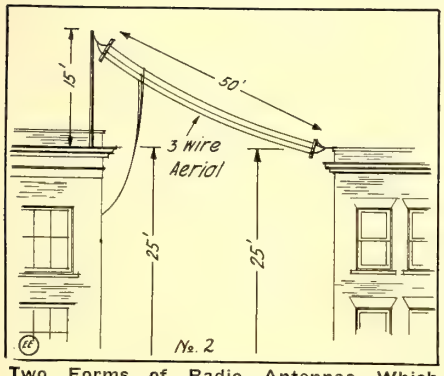
l = Maximum transmission distance in miles.
N = Number of relays in circuit.
R_r = Resistance of each relay in ohms.
R = Resistance of line per mile.
I_2 = Current in amperes which will just cause trip of relay armature.
R_1 = Insulation resistance per mile in ohms.
I_1 = Current in amperes necessary to actuate relay.

INDUCTANCE CALCULATION.

(856.) T. Cass, Toronto, Ont., writes:

Q. 1. Please note these drawings of two different aerials. Could you find space in





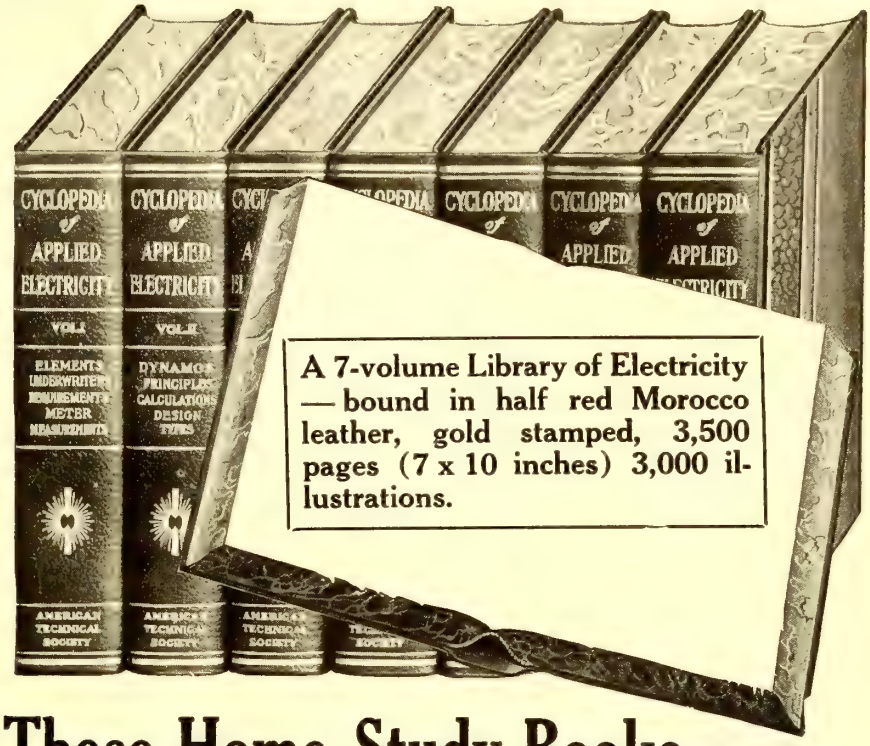
Two Forms of Radio Antennae Which Querist Shows. He Wishes to Know Which is the Best of the Two.

vour next publication of the "E. E." to inform me which will give the best results in Wireless Telegraphy? Each aerial contains two hundred feet of copper wire, as you will see by the measurements.

A. 1. Both types of aerial which you submit are satisfactory. However, the first aerial, No. 1, will be more suitable for receiving purposes, while the second one, No. 2, is more efficient for transmitting.

Q. 2. How do you calculate the inductance of a coil in centimeters?

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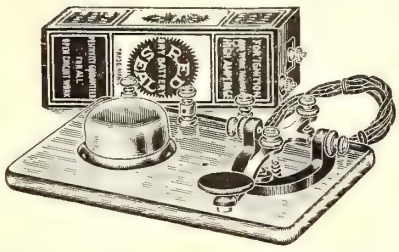
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For Learning Telegraph Codes

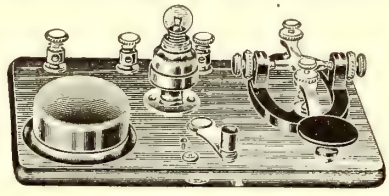


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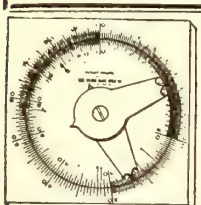
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A. 2. We should refer you to a series of articles published in the March, April and September 1917 issues of this journal which cover the subject of the calculation and measurement of inductance very completely. These copies can be obtained at 15 cents per copy from our "Circulation Department."

EARTH VERSUS AERIAL CURRENTS.

(857.) A. Kramer, Philadelphia, Pa., asks:

Q. 1. Where do *earth currents* originate?

A. 1. Earth currents originate from many sources, two of which are the chemical reaction between certain metals and acids or alkalies which are present in the ground. Another phenomenon which results in earth currents, is the variation of the magnetic field of the earth, which causes electric currents to be generated in metals present in the earth. Altho this phenomenon does not occur in every part of the earth, yet there are several places where this action was noted.

Q. 2. Could earth currents be properly termed aerial currents?

A. 2. No. Both of these currents are entirely different from each other. The latter type of current is generated by the action of water and dust particles floating in the upper air strata.

COMPOSITION FORMULA.

(858.) Joaquin Agusty, San Juan, Porto Rico, wants to know:

Q. 1. I have a stove made of the common coil resistances, built by The National Electric Co., of Chicago, and the base is made of a composition or paste, very hard, which never broke with the hottest tests and is a very good insulator. It has a reddish brown color and looks as if made of asbestos and cement. It appears as if it had been melted in a mould before dry to make it any form desired. I want to know the composition of such paste.

A. 1. We are unable to give you the exact composition of the substance in question. However, several of these materials have been made with a porcelain compound intermixed with another material which withstands sufficient heat.

Q. 2. What is the composition for the making of phonograph records, such as the Edison type. Could the Edison cylindrical records be employed as tubes for spark coils, and flat disc type record as bases for electrical apparatus?

A. 2. Phonograph records are made from a composition of wax, tar and a rubber compound. The exact percentage of these ingredients is kept secret. Another secret compound is composed of shellac and finely powdered mica, compressed hydraulically into the desired form, heat being applied during the compression process. Phonograph discs are unsuitable for building electrical apparatus as they are very brittle and are poor electrical insulators.

Q. 3. How many pounds of No. 24 D.S.C. magnet wire will be necessary for the primary of a loose coupler of 10,000 meters wave length? How many pounds of No. 32 D.S.C. magnet wire will be necessary for the secondary?

A. 3. Two and a half pounds of No. 24 D.S.C. wire will be required for the primary and 1½ lbs. of No. 32 for the secondary.

POWER PLANT QUERY.

(859.) Allen W. Strete, Ohio, writes:

Q. 1. Am unfortunate enough to be without commercial current as I live in the country. Advise me as to what would be the cheapest form of current to use for experimental purposes, batteries or a small engine and a dynamo?

A. 1. We would advise you to employ a small gasoline engine to drive a direct current dynamo, so as to charge a storage battery from which you can derive the proper electrical energy for experimental work. The dynamo should be wound to have a potential of 10 volts and 20 amperes.

Q. 2. What kind of batteries are the cheapest in the long run, dry cells, gravity or storage?

A. 2. Storage batteries are most serviceable, all things considered.

TWO INCH SPARK COIL FOR RESONATOR.

(860.) R. O. Sutherland, South Bend, Ind., asks:

Q. 1. Will a good 2 inch wireless coil with mechanical interrupter operate the small Resonator shown in Fig. 1 of Dr. Strong's last article "Electricity and Life"?

A. 1. It will operate the resonator, but not at its full strength.

Q. 2. If not, will it operate the small Tesla coil shown in his previous article in the May issue?

A. 2. Yes, it will easily operate the small Tesla coil to its full strength.

Q. 3. Is a rotary spark gap necessary to produce best results when a high speed vibrator interrupter is used?

A. 3. It is not exactly necessary but far better results will be obtained by its use, as the oscillatory circuit of the condenser and primary of the resonator is made to oscillate at a greater period, which increases the oscillatory value in the secondary of the resonator.



THE EMISSION OF ELECTRICITY FROM HOT BODIES. By Prof. O. W. Richardson, F.R.S. Cloth bound; 6 by 9 inches; 304 pages, 35 illustrations. Price, $2.75. Published by Longmans, Green & Co., New York City, N. Y.

The student of electro-physics who desires to learn all about the basic how and why of the emission of electricity from the hot bodies will do well indeed to study this authoritative work by Prof. Richardson, who has done considerable work in this field. The opening chapters treat on the theory of ions, the specific charge of the ions, apparatus used in experimental determinations of the charge, the electron theory, the kinetic theory, the quantum theory, the contact difference of potential, etc., etc.

The author then proceeds to discuss the temperature variation of electronic emission, the effect of gases on the emission of electrons, the kinetic energy of the emitted electrons (with various graphs, formulae and tables), the emission of positive ions by hot metals, the specific charge and electric atomic weight of the ions, the effect of gases on positive ions, the emission of ions by heated salts, ionization and chemical action, et cetera. It is a masterly and thoro treatment of the subject.

CHEMISTRY IN THE SERVICE OF MAN. By Dr. Alexander Findlay. Cloth covers; size 5¾x8¾ inches; 255 pages; illustrated. Price, $1.60 net. Publisht by Longmans, Green & Company, London and New York.

Not since the late Robert Kennedy Duncan's book on "The New Knowledge" and "Modern Chemistry" has anything appeared in this same vein covering the advances and present status of Chemistry until the interesting volume by Dr. Findlay, compiled from his lectures for the United Free Church College and given us in this book. It will be of particular interest to readers who make no particular claim to chemical knowledge.

Written from a British viewpoint, it gives us a mental yard stick by which we can gage the great progress that both English and American chemists have made, particularly in the last few years.

Special attention is called to the chapter on Velocity of Reactions and Catalysis as having two viewpoints for consideration which will surely govern future chemistry on the comparison that man in his laboratory resorts to high temperatures, powerful and corrosive reagents, crude, cumbersome and noisy apparatus, while nature building the most complex compounds makes them noiselessly, smoothly, and usually at the ordinary temperatures.

On the importance of the "Infinitesimal to the Finite," Dr. Findlay states in this relation that in Astronomy one deals with magnitudes so vast as to be beyond the grasp of our minds; in the domain of catalysis the magnitudes in some cases are so small that it becomes equally impossible to form a true conception of them.

A subject of particular interest will be found under the heading of "Cellulose and Cellulose Products."

There are interesting chapters covering the electro-chemic products, such as the manufacture of chlorin, caustic soda, aluminium, grafite, etc., as also chapters on Colloids and Synthetic Chemistry.

LABORATORY MANUAL OF INORGANIC CHEMISTRY FOR COLLEGES. By Dr. Lyman C. Newell of Johns Hopkins. Cloth covers; size 5x7½ inches; 240 pages; illustrated. Price, $0.64 net. Publisht by D. C. Heath & Company, New York.

This manual is to be used to accompany any standard text-book in Chemistry and particularly the author's work entitled "A Course in Inorganic Chemistry for Colleges." It can be commended as being well edited, and the illustrations of apparatus, etc., have been carefully considered.

The subject matters themselves are quite complete, but the attitude of the author, taken particularly in the questions asked, are not conducive to the best kind of thinking.

However, this appears to be a very valuable little text-book for the laboratory, as its form is such that it is unnecessary for the student to do any re-reading, while it is sufficiently full to cover all preliminary work necessary. The field that it covers is quite large, but not so great as to make it appear a brief of larger treatises of the same type.

THE NATURE OF MATTER AND ELECTRICITY. By Comstock and Troland. Cloth covers; size 5½ x 8 inches; 203 pages, illustrated. Generously supplied with tables and references. Price, $2.00 net. Publisht by D. Van Nostrand Company, New York City. 1917.

This book purposes to be an outline of modern views on the nature of matter and electricity. In reality it is an attempt to popularize these modern ideas, with the usual result that it is neither scientific or popular. It is too bad that a man like Serviss could not be called in to really popularize such important subjects which no doubt are of considerable interest to the scientific laity. Particularly the analogies are not very good, and unless an analogy helps to very clearly illustrate the point, it is very often better to stick to the idea itself.

The book can be recommended for one thing, that the references from which the different chapters have been taken have not been omitted and these would be of considerable help to the student or to the scientist who would want a convenient source of reference on the several subjects touched on in this volume.

X-RAYS. By G. W. C. Kaye, M.A., D.Sc. Cloth covers; size 5½ x 8½ inches; 285 pages, illustrated. Price, $3.00. Publisht by Longmans, Green & Co., of New York and London.

Dr. Kaye's second edition of X-Rays is a book to be commended to any one interested in this absorbing subject. Not alone are the X-Rays treated on, but the book covers the phenomena of a Discharge Tube, Cathode Rays, Positive Rays, and some very complete data on the construction of X-Ray Tubes. It is a pleasure to know that the scholar of J. J. Thompson has remembered his saying that "When measurement commences science begins," and the reader will find that nearly every subject handled by Dr. Kaye carries with it data relative to measurement, making for a very clear understanding, even tho the reader may not be interested from that exact viewpoint.

This book is a good example of the possibilities of interweaving personalities with scientific data, and thruout this volume the personal touch is very evident.

It is a book, not only for the scientist and physicist who is interested in this subject, but also for a great number of professional men who are using or are in direct contact with this field.

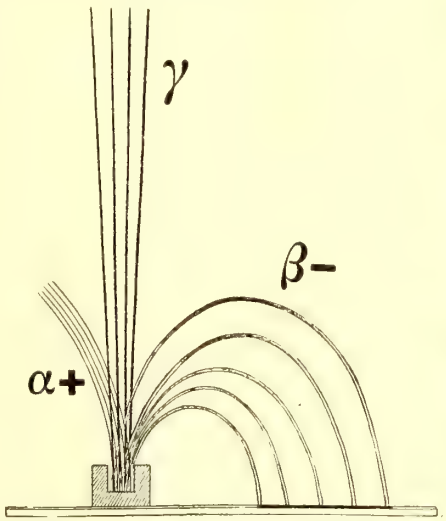
The Appendix is well indexed and contains some very valuable tables and data.

It can be well recommended as the best book in the English language on the subject of X-Rays.

(*Continued from page* 451)

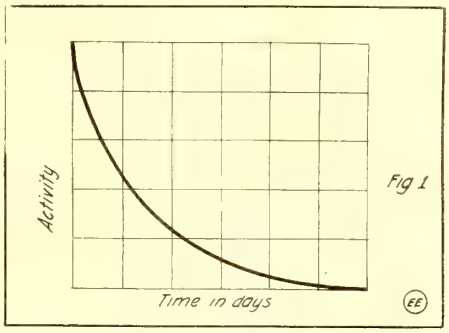
Radium deposit is 26 minutes; for Actinium deposit—34 minutes and for Thorium deposit—10.5 hours.

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Showing the Separation of the Three Entirely Different Types of Radium Emanation Rays in a Strong Magnetic Field.

platinum wire or dish, volatilize before white heat and are redeposited on the cooler bodies in the neighborhood. Rutherford also demonstrated that induced activity could be concentrated on the negative elec-

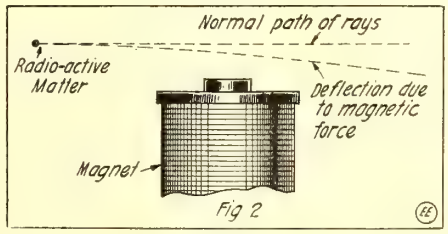


Decay Curve for Radium Emanation.

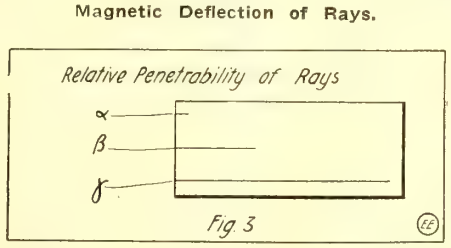
trode in a strong electric field, indicating that the radioactive carriers have a positive charge. The distribution of the active deposit in a gas at low pressures has been investigated by Makower and Russ.

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(To be concluded)



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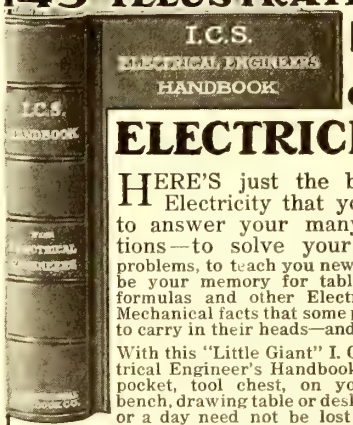
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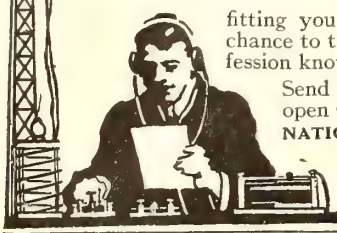
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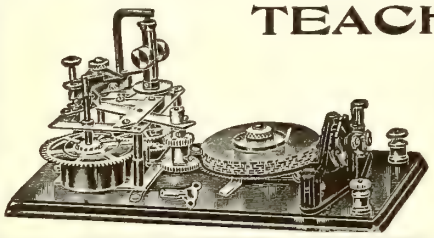
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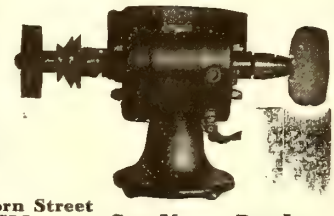
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THE CAUSE AND NATURE OF MAGNETIC CURRENTS.

(*Continued from page* 455)

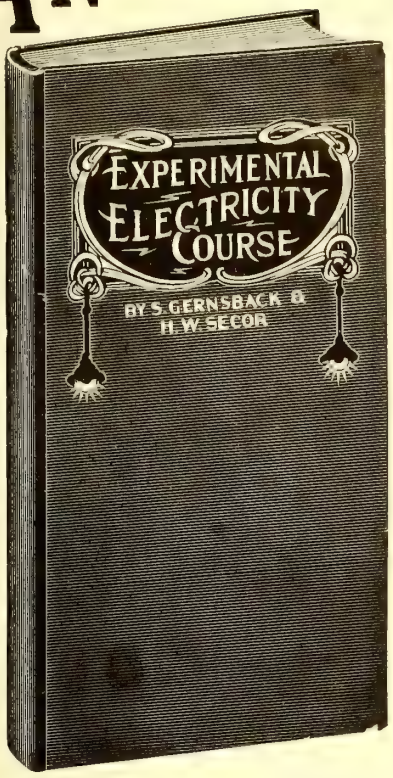
be moving in the same direction and will re-enforce each other.*

The formation of an electromagnet is now easily and simply explained. As has been seen, a wire bearing a current draws the surrounding ether towards it from all sides. If the wire is coiled, the ether is drawn toward the wire of the coil from both inside and outside. The supply of ether outside the coil is practically unlimited, but within the coil the supply is limited. Part of this ether, as seen in the experiment with a wire bearing a current, is repelled from the wire and part is drawn along with the current in the wire and is carried outside. The result is the formation within the coil of a more or less complete ether-vacuum within the coil. Into this ether-vacuum the surrounding ether rushes just as air rushes into an air vacuum. If the currents rushing into the ether-vacuum were not moving from both directions the point of greatest vacuum would naturally be at the center of the inside of the coil; but as these currents are coming from both directions the result is a partial compression, or, more properly less of an ether-vacuum, at the center than at points midway between the poles and the center. Hence the greatest lateral "attraction" or pressure is a point between the center of the coil and the poles. This has been shown by preceding experiments to be exactly the condition existing in a magnet. Currents from the inside of the coil at the central point, on account of a partial excess of ether at this point, passing thru the wire join currents from the outside meeting at the external center of the coil form a neutral or repulsive point which has already been noted in the magnet and proven to exist by the field of iron filings and the photographic plate.

Attraction and repulsion hardly need explaining. If two magnets or coils are placed so that the north pole of one is over the south pole of the other, the currents surrounding each will be moving in the same direction and will be in effect one continuous current. This will produce an ether-vacuum between the two, for both currents are moving toward the poles of their respective magnets tho in the same spiral direction, a continuous spiral, and an ether-vacuum is formed between them, just as an ether-vacuum is formed in the coil, and the two magnets or coils will be drawn together, or rather forced together by the ether rushing towards them from the opposite poles. If one coil is now reversed and the like poles of the magnets are brought together the currents surrounding will be moving spirally in opposite directions, the particles of ether drawn in from the sur-

** Note. The difference between the upper and the lower side of the needle is slight but even this is sufficient to give a preponderance of force on the lower side of the needle. In addition to this it must be borne in mind that the currents surrounding the needle extend to a considerable distance from its surface and thus give a considerably greater preponderance to the forces on the under side. This preponderance of force on the under side of the needle increases the tendency of the currents on the under side of the needle to re-enforce each other and move in the same direction and this is sufficient to produce the result.*

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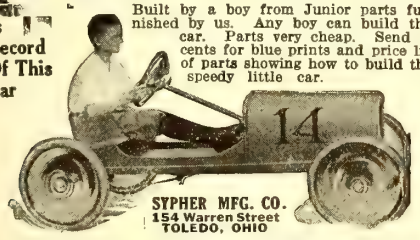
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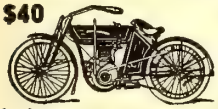
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rounding ether will accumulate and the excess of ether, in rapid motion in opposite directions, seeking to escape and opposing each other by their motion, will drive the magnets apart. If two magnets are placed side by side with opposite poles together, the currents between them will be moving in the same direction, producing a vacuum and the two will be drawn together. If like poles are placed side by side the currents will be moving in opposite directions, a condensation will be formed, and the magnets will b repelled.

Here two experiments heretofore made by others may be explained. These experiments re-enforce what has already been set out. Indeed, these experiments rightly understood are alone sufficient to prove part of that which has been advanced; but they have never been understood and have never been so used.

A flexible, free wire bearing a current coils itself about a straight bar magnet, coiling and uncoiling and recoiling as the current is reversed. Here the currents of ether drawn to the conductor simply force the conductor to coil, uncoil, and recoil in such a manner that the currents moving toward the conductor are moving as nearly as possible in the same direction as the currents moving spirally about the magnet.

If a wire with its lower free and plunged in mercury be suspended over the north pole of a bar magnet and a current of electricity be past downward the wire will revolve clock-wise about the magnet. This is not a contradiction but an additional proof. As seen in Figure 10, the ether currents moving toward and along the wire will be drawn inward by the currents rotating about the poles of the magnet. This will aid in producing a greater ether pressure inside the circle described by the end of the wire, and the wire will be forced outward. Moreover, the currents on the side of the wire on which the spirals are approaching will not reach the wire but a partial ether-vacuum will be formed in advance of the wire while the currents drawn in on the other side of the wire will form a condensation. Thus the wire will move away from the condensation and toward the partial vacuum and the wire will rotate clock-wise—contrary to the motion of the currents about the pole of the magnet and contrary to the motion of the several iron articles shown in the previous experiment.

Having proven the old theories of magnetism to be absolutely false, there is no reason why we should not point out their absurdities. It is desired especially to call attention to and emphasize these absurdities, because the fact that these absurdities were recognized by even the immature students of physics, started this investigation in the first place, and because there are other absurdities which we shall meet later; and if philosophy has promulgated and upheld absurdities in one case, it may well have done so in other instances. It will be well to remember this fact.

As to these absurdities. In the very nature of matter, molecules are spherical. (A little thought along the lines of well known laws of matter will show this. I do not care to take it up here, but I will discuss it with anyone who desires to do so.) Spheres are the most difficult of all shapes to permanently magnetize. It is almost impossible to secure definite and permanent poles in a perfect sphere. Hence, it would be difficult to conceive of molecules as magnetized sufficiently so that they could be arranged pole to pole, as the old theories supposed to be done in producing magnets, and equally difficult to so arrange them as to produce an appreciable attraction.

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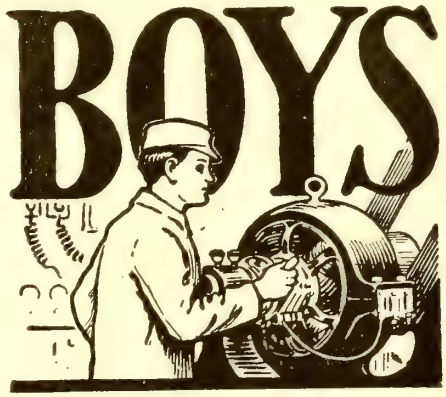




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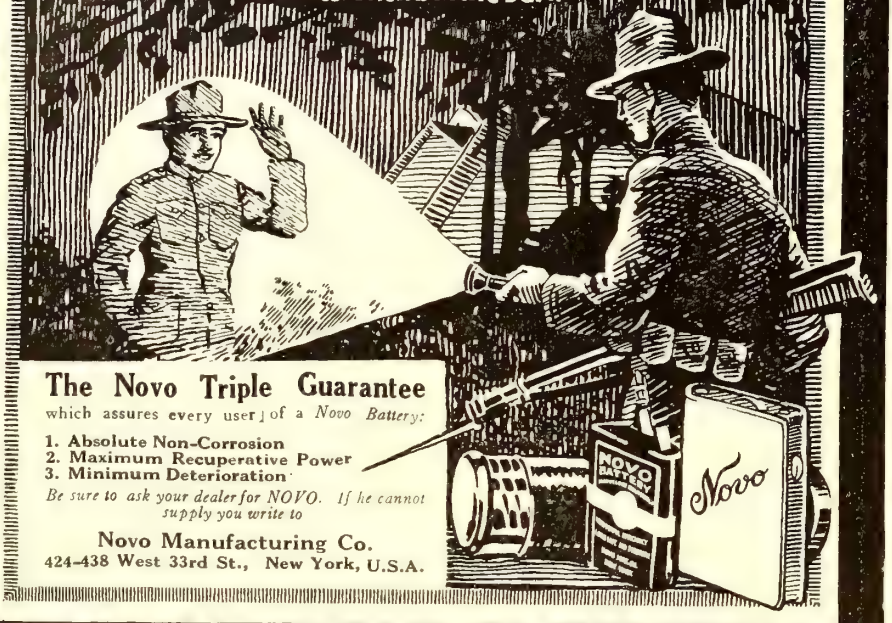
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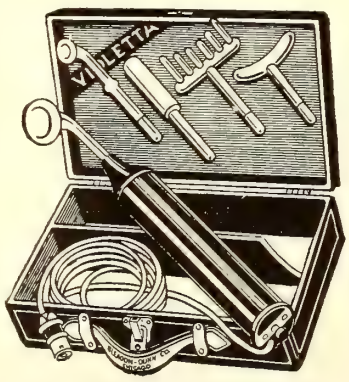


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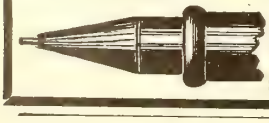
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magnetize iron, therefore, would be to lower its temperature by checking the vibrations of the molecules, while in reality the temperature is raised during the process of producing an electromagnet. If the molecular theory is true, to so change and check the molecules, conceiving it to be possible, would be to disintegrate the substance.

In the theory of the molecular arrangement of magnets it is asserted that magnets are surrounded by "lines of force," "line of tension," "mere lines of direction," "imaginary lines, like lines of latitude and longitude," not themselves in motion but capable of producing motion. This is contrary to the laws of work and the laws of conservation of energy. Motion and work can only be produced by motion. Potential energy must be changed to kinetic energy before motion can be produced or work done.

In all theories on magnetism it is assumed that there are lines of force that move without motion—or is it "emerge" without motion—from the north pole and "pass to" the south pole—and yet without motion—moving from the north to the south pole, yet without motion, being only "lines of tension or direction." Here, too, we have lines of force moving or passing, and yet not moving, in only one direction but exerting equal force in both directions and doing equal work in both directions, for both poles "attract" equally. Was a more confusing and illogical conglomeration ever put out in the name of science? This is contrary to all laws of force. It is worse than the wheels within wheels and cycles within cycles of the old astronomical theories.

In the theories of magnetic induction it is assumed that the induced current is produced by cutting lines of force passing, or existing, between the north pole and the south pole as between the poles of a "U"-magnet, the lines always passing or "existing," from the north pole to the south pole. As a fact, the result is produced by thrusting either pole of a straight magnet into a coil or withdrawing it therefrom. Therefore, if the lines pass, or exist, from the north pole, when the coil is thrust down upon this pole it is moving in the same direction as the lines, when it is withdrawn it is moving against them. Similarly, when the coil is thrust over the south pole it is moving against the lines and when it is withdrawn it is moving with them. That currents are produced in both of these cases is self-contradictory, for in two cases the coil is working against the lines and in two cases with the supposed lines. Therefore, opposite causes are producing the same result. It is not a sufficient answer to say that the direction of the current is changed, for the reason that for half of the time the coil is moving with the supposed lines and half of the time against them, and in all cases work must be done against force to produce a reaction.

In the theory of magnetism, when the molecules are so arranged as to produce a magnet, the north poles of all molecules are in one direction and all south poles of molecules are pointing in the opposite direction.

Each molecule is then exerting force in the same direction, *i. e.*, a molecule at the north pole of the magnet exerts force upon the one next to it in the direction of the south pole of the magnet, and so on to the final molecule at the south pole; and the molecule at the south pole of the magnet in the same line is exerting force on a molecule next to it in the direction of the north pole, and so on to the original molecule at the north pole of the magnet. Meanwhile, the molecule at the north pole is attracting iron and the molecule at the south pole is attracting iron. To a certain

extent, at least, this is the thought, as of old, of a man pulling himself over a wall by his boot straps. It sets at naught the laws of action and reaction. According to this, too, the ideal magnet would be a disk the thickness of two molecules, for here there would be no waste energy. The intermediate molecules are, in the theoretical magnet, merely holding together, or rightly aligned, the molecules at the poles. This is contrary to known facts. Besides, the thin disk composed of two layers of molecules, if such a thing were possible, is the most difficult of all forms to magnetize. Moreover, a chain is no stronger than its separate links. The whole strength of the theoretical magnet, then, is represented by the strength of the molecules on the face of the cross-section of its poles. That is, a thin layer of tiny molecules, so small as to be invisible under the most powerful microscope, are capable by some *mystic* power within themselves, of lifting pounds and tons of weight. This is an explanation that does not in any sense explain.

A solenoid is a magnet. Place an iron core within it and it becomes a stronger electromagnet. According to the molecular arrangement theory, billions of molecules must be changed from their normal position, and the action must be upon billions more molecules than there are in the effective molecules at the poles of the magnet. All of this is waste energy. Yet this enormous waste of energy makes the magnet stronger. This is contrary to the laws of energy.

As stated above, a great amount of energy is exerted in arranging the molecules of an electromagnet. When these molecules are thus arranged they are placed opposite poles together and as they mutually attract each other they will cling together. Yet if the core is soft iron the moment the current in the coil is broken some mysterious force overcomes the force which arranged them pole to pole and the force of the mutual attraction of these billions of molecules, they rearrange themselves contrary to all laws of magnets and the iron ceases to be a magnet. This is the height of absurdity.

Finally, an electromagnet is produced by the passage of an electric current thru a solenoid containing an iron core. Remove this iron core and the solenoid is still a magnet. But here there are no molecules to be arranged pole to pole, for there are no molecules present, and the whole theory of the molecular arrangement of magnets falls to the ground.

FINIS.

ACTION AT A DISTANCE AS EXHIBITED IN SELENIUM CRYSTALS.

(*Continued from page* 459)

transmitted much in the same way that a sound wave is transmitted along a steel rail.

However we do not know that the light can produce a vibration of the molecules. Each molecule of selenium has at least one electron loosely attached to it. This electron probably has a definite location with regard to the center of the molecule, when it is not disturbed. If so there must be a space lattice of electrons in the selenium crystal exactly corresponding to the space lattice of the molecules shown in Fig. 4. Since light is an electromagnetic phenomenon we can well understand how the electrons in the space lattice could be set in vibration and further how these electrons by electrostatic repulsion would set neighboring planes of electrons in vibration. When the electrons are in vibration they are more easily removed from their equilibrium positions in the molecules by a voltage across



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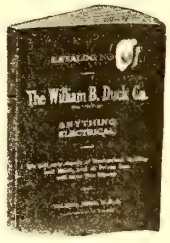
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CLAIM ELECTRICITY PREVENTS INSANITY.

Electricity as a palliative or even a preventive of insanity in its early stages is receiving serious attention in scientific circles, according to reports made before the annual convention of the American Electro Therapeutic Association.

It was said in discussion that experts who are specializing in electro-therapy have achieved remarkable results in the cure of melancholia and insomnia and the restoration of normal mental activities.

Most important results have been attained in the treatment of melancholia and other cerebral "disorders" thru the use of galvanic currents. Results, almost, if not quite as encouraging, have been procured by Philadelphians in the correction of defects of the vision by electricity after eye experts had pronounced cases to be hopeless.

Dr. Alfred T. Livingston, of Jamestown, N. Y., warned the electro-therapy specialists against extreme currents, declaring his best results had been obtained thru applying the electrode to the base of the nerve centers of the brain.

100,000 MORE FOR SIGNAL CORPS.

To fill the Army Signal Corps, the War Department may decide to draft an additional 100,000 men. The signal service has asked for a decision on the method to pursue in filling up gaps, existing in the aviation and telegraph branches, and the general staff is expected to answer in a few days.

The Draft Law permits the filling of units which are now below strength, but it is held that an added 100,000 instead of any of the 687,000 of the original draft would be necessary for the Signal Corps.

Men who join the aviation section will have a chance to train either in American schools or in England, France or Italy.

England, it is learned, has establisht a flying school in Egypt, which is used chiefly by the Canadian corps.

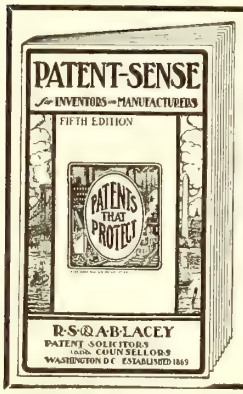
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the crystal. Thus light increases the conductivity of selenium by lowering the stability of the electrons in the crystal structure and these electrons may communicate their state of unrest to neighboring electrons in an almost human fashion. But if this be the explanation, this new property of matter continues to be about as much of a mystery as any other action at a distance.

EXPERIMENTAL PHYSICS.

(*Continued from page* 460)

passes outside of cardboard BC. Seeing the bull's-eye X with one eye and the sight with the other eye, *i. e.,* seeing both the bull's-eye and the sight, he has only to line up his sight to the bull's-eye, pull the trigger, without flinching, and the bull's-eye is hit right in the middle, thus performing the impossible (?). Measuring the angle EX-"e" one can readily determine just how small BC must be, and for those unfamiliar with geometry, the correct size may be found by trial, beginning with a small piece and gradually increasing the size of the cardboard until the largest is found (the larger the cardboard the more marvelous appears the feat). Everyone owning an air rifle, Boy Scout rifle or other fire-arm should perform this trick and learn to mystify his friends by his marvelous skill???

Cut a small piece of clear glass (preferably plate glass) so that two of its sides are parallel (MN and OP in Figure 44). Place the glass on paper and draw line AB up to the side OP not meeting perpendicular. With eye close to the table look across MN until the eye is in line with AB. Draw the line from the eye to MN which appears to coincide with AB if produced. Call it CD. On looking up you will be surprised to find that instead of being in line AB, *i, e.,* EF, it will be some distance away from EF and hence not in the prolongation of AB at all. Remove the glass and draw CB. Our line ABCD, represents the path over which the light in the direction of AB traveled. We notice, therefore, that when the ray of light reached the glass at side OP it bent (was refracted; see Lesson 8) toward the perpendicular XY, while on passing out from the glass at MN it bent away from the perpendicular WZ. The law is stated—*"Light passing from a lighter to a denser medium is retarded in speed and bends toward the perpendicular; light passing from a denser to a lighter medium increases in speed and bends away from the perpendicular."* It is upon this law that the use of all lenses and optical instruments employing lenses depends; hence its importance cannot be overemphasized.

There are two kinds of lenses, *convex* and *concave.* In Fig. 45, lenses number 1, 2, and 3 are convex; 4, 5, and 6 are concave. Convex lenses curve outward, whereas concave lenses curve inward. There are three types of convex (1) double, (2) plano, (3) concavo and three types of concave lenses (4) plano, (5) double, (6) convexo. The action of the double convex and double concave lenses is typical of their respective types and only those two will be considered in what follows. It should be noticed that *all convex lenses are thicker at the middle than any other place, while all concave lenses are thicker at the ends.* Also because of the above stated law of refraction, light bends around the thicker part of the lens. The sun's rays and other rays coming from a great distance are considered to be parallel. In Fig. 46 we see that when parallel light passes thru a convex lens (A) the rays bend toward each other (converge) and meet at a point F. This point is called the *focus* of the lens, and the distance of this point from the center of the lens is called the *focal length.* In the case of the concave lens, Fig. 46 (B), we see that the rays bend away from each other (diverge) and hence appear to come from the point F, on the same side of the lens as the parallel light. This point is also called the *focus* and its distance from the center is called the *focal length.*

EXPERIMENT 54—

Altho the focal length of a lens is one of its most important properties, it is the easiest to determine experimentally. The best method of finding the focal length of a convex lens is to place a sheet of paper on the ground and holding the lens in the hand move the hand slowly up and down until the image of the Sun is sharply seen on the paper. Measure the distance from the lens to the spot (Sun's image) and add to it *half the thickness of the lens.* In the case of a concave lens the procedure is slightly different. The image of the Sun being on the same side as the Sun cannot be caught on a screen, since the screen would not permit the rays to pass thru. (Also the image is not a real one, since the rays do not actually come from F in Fig. 46-B, but only *appear* to come from there). However, holding the lens in front of the right eye a small image of the Sun will be seen thru the lens at the point F, (Fig. 47). Looking at the tip of a pencil held in the left hand, move the hand until with the left eye the pencil tip is seen to be out from the lens the same distance as the image of the Sun is seen to be with the right eye. Have your partner measure the distance from the lens to the pencil tip and add *half of the thickness of the lens* and you have the focal length.

In the case of a camera we have simply to point it at the Sun, get a clear image on the ground glass and measure the distance. When two or more lenses are used in combination, the procedure is the same as for a single lens. In all these experiments a distant tree or window or chimney, or other object may be used instead of the Sun, but the writer prefers to use the Sun since it brings back the days when the focal length was found by him in school using the neck of the boy seated in front of him as the screen. When the boy began to fidget and scratch his neck, the writer knew that the lens was a focal distance away from the neck, but then his interest stopt when the neck began to burn. Now we are interested in actually measuring the focal length. The question arises, "why measure the focal length, what good is it when you have it?" Just this:—*The magnifying power of a lens is equal to* 10 *divided by the focal length.* (Measured in inches.) *The magnifying power of a telescope is equal to the focal length of the objective lens divided by the eyepiece lens.* The magnifying power of the opera or field glass is also the focal length of the objective divided by the focal length of the eyepiece. *The magnifying power of a compound microscope is equal to ten times the length of the tube divided by the product of the focal lengths of the objective and eyepiece.* From these and many other considerations the importance of knowing the focal length of a lens is apparent.

The readers should as exercises measure the focal lengths of lens available and compute the various magnifying powers according to the laws just stated. This subject of light is very fascinating and will be continued in the next lesson which will treat of "Photography." The writer sincerely trusts that interest is aroused in the reader and that the reader will consult the standard text-books for further information on the subject.

(*To be continued*)

PATENT ADVICE

Edited by H. GERNSBACK

In this Department we publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

ELECTRIC BULB.

(176.) Thomas Sheehan of Duluth, Minn., has invented a novel electric bulb; the principle idea being to do away with the glass tip in a certain manner, so that it cannot be broken off easily. In other words it will not project as in the present style lamps. He wishes to know if this idea is patentable.

A. This is indeed a very good idea—as simple as it is good. We do not see any reason, technically speaking, why the bulb could not be made in the manner described by our correspondent, but as a precautionary measure, we would advise our correspondent to get in touch with a patent attorney to make search in the patent office at once.

MUFFLED BELL.

(177.) Paul B. Eaton of Baltimore, Md., has been reading about the *bell softener* which has been discust quite a number of times in these columns, his idea being to use an ordinary clock-maker's cathedral gong: *i.e.*, a wire gong. This is usually made of one piece of spiral steel, and the sound given off by this gong is quite pleasing. He wishes to know if a patent can be obtained on this device.

A. The editor of these columns has been using a device of this kind for some ten years, and there is one in our office which has been there for quite a while. There is nothing new contained in the application of a bell clapper striking the cathedral gong. No patent could be obtained on this.

TELL-TALE WATER GAGE.

(178.) Mr. John Murphy of Halifax, N. S., submits to us information about water gage or tell-tale. The idea being to treat the water gage in such a manner that when the water in the boiler is too low or too high instead of using it or inspecting it, an alarm bell will ring and will continue to ring until the condition is remedied.

Our correspondent wants to know if such a thing is practical and if it can be patented. Also if there exists a demand for this device.

A. While there are several devices of this kind on the market, without knowing what the idea consists of it is quite impossible to tell whether it is patentable or not. Our advice is to get in touch with a patent attorney.

SELENIUM CELL DEVICE.

(179.) Robert Knowles of Toronto, Can., has submitted a rather complicated device whereby a gas jet cannot be lit without introducing a lighted match thru a certain opening, which in turn causes selenium to act on a relay, the latter opening the gas flow.

A. While this idea is very ingenuous, and while we have no doubt that a patent can be obtained upon the device, we do not think the idea is very practical; at best there would be only a very limited market for the device.

AMPLIFIER.

(180.) Clyde Fitch, Pittsfield, Mass., has invented an amplifier which is supposed to work by exciting the field of a small alternator. Several other points of information are given as to how this amplifier could be made to work.

A. It is impossible to state whether a device of this kind will work without trying it out. If our correspondent has faith enough in the idea, we advise having a model built for testing purposes.



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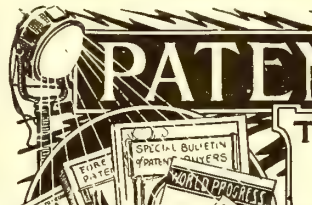
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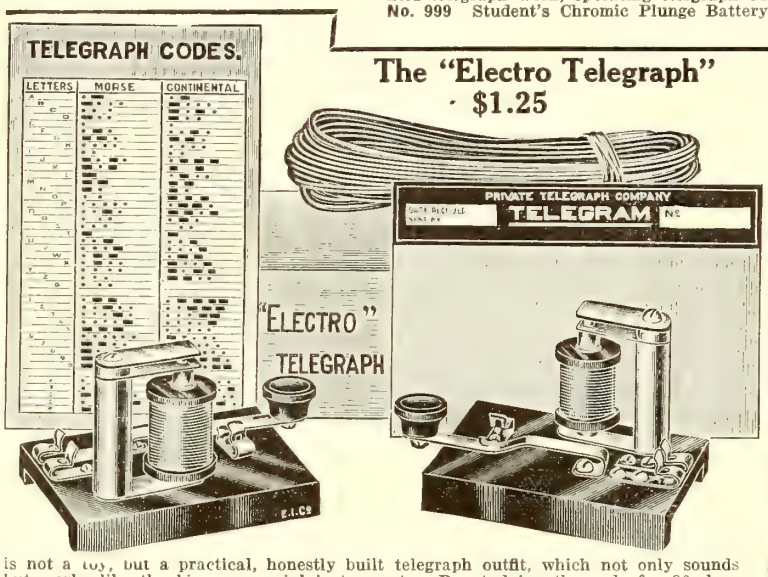
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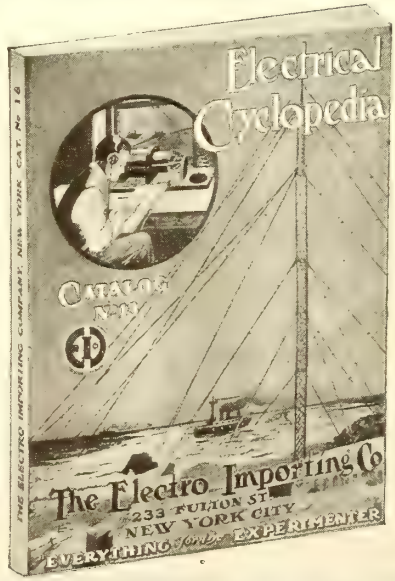
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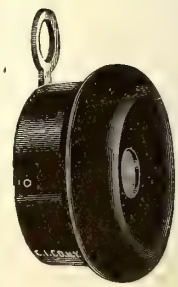
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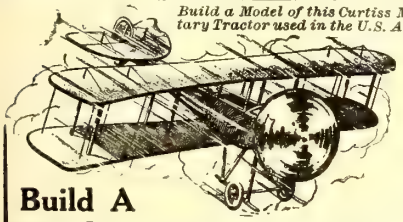
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ELECTRICITY BEING USED TO HASTEN CROPS.

(*Continued on page* 439)

together with the periods of working are important factors in the welfare of the installation. The current expended at Carnarvon is economical in working. The current required at the primary terminals amounts to 450-460 watts per acre per hour (approximately only half a unit); the reason for the discrepancy is entirely atmospheric, the energy required being greater in proportion to the prevailing humidity to make up for the sundry current loss. This occurs on dull heavy days when mist or heavy dew prevails, whereas on prevailing dry periods the efficiency is uniform.

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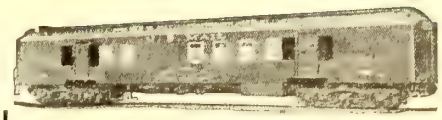
Electroculture has past the back-garden, amateur stage. It is now a serious proposition. But knowledge of its possibilities and limitations is scanty. It falls into place with other possibilities of development in plant industry, which will only reach fruition by the help of well-organized, large-scale research and experiment supported by public funds.

CHEMICAL ACTION OF STORAGE BATTERIES.

(*Continued on page* 473)

If a battery is allowed to stand on open-circuit after charging, the electromotive-force falls in fifteen or twenty minutes to the value corresponding to the density of the acid. This is due to solution around the plates becoming saturated with lead sulfate. On discharge, when the voltage has fallen below the value corresponding to the density of the acid, standing on open circuit brings it back to normal value. In this case the recovery, as it is termed, is due to the diffusion of the sulfuric acid into the pores of the plate where it has become exhausted.

If a charged cell is permitted to stand idle, the density of the acid slowly depreciates, and the quantity of electricity obtainable from it diminishes from day to day. This is known as the *self-discharge* of the battery, and for a cell in good condition amounts to from one to two per cent per day; if impurities are contained in the acid, it sometimes will amount to 50 per



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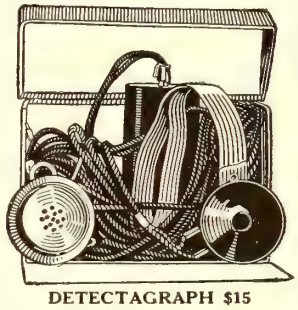
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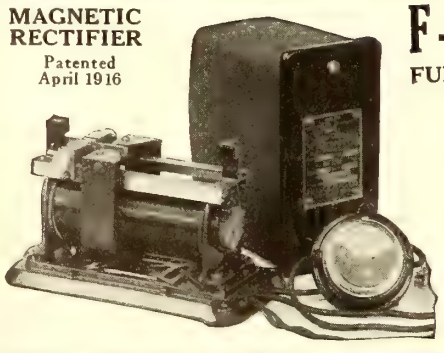
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cent per day. The self-discharge of the lead sponge plate is more liable to occur than that of the peroxid plate, because it is affected by a much larger number of causes. It is fatal for the lead plate if the acid contains any metal which is more electro-negative than lead when in contact with sulfuric acid, for the impurity would become precipitated on the plate and thus produce a short-circuited local element. The lead would thereupon tend to dissolve and deposit hydrogen on the impurity. If the over-voltage of the impurity is not too great, this would in fact take place, and the lead plate would change to sulfate. The potential of the cell: Pb sponge. / Sulfuric acid / Platinized Pt + H_2 is 0.33 volt, hydrogen being the positive pole. A current could be taken from this cell on closing the external circuit; lead sulfate would be formed on the lead pole and hydrogen would be deposited on the positive pole. But if some metal were to be substituted for platinum for which the over-voltage is 0.33 volt or more, evidently hydrogen could not be liberated, and therefore no action would take place. Consequently only the metals standing on the left of the following table would be dangerous for the accumulator; those on the right could exist as impurities in the acid without the least danger, even tho some of these are more electro-negative than lead.

TABLE.

	Over-voltage		Over-voltage
Platinized Platinum	0.005	Palladium	0.46
Gold	0.02	Cadmium	0.48
Iron	0.08	Tin	0.53
Platinum, polished	0.09	Lead	0.64
Silver	0.15	Zinc	0.70
Nickel	0.21	Mercury	0.78
Copper	0.23		

As made apparent from this table, platinum is the *most injurious impurity*. It has been found that one part of platinum in a million of acid will produce a rapid self-discharge of the lead plate. It has been found, however, that metals when present together can produce a rapid self-discharge, *which alone cause scarcely any action.* An explanation of this cannot be given at present.

The self-discharge of the positive plate takes place more slowly than that of the lead sponge plate. Metallic impurities are of no effect on the lead peroxid, for they would not become precipitated upon it. The only kind of spontaneous discharge is due to local action between the peroxid and the lead of the support, which together form a short-circuited element, and this is of importance only for plates with a thin peroxid layer.

Another cause of self-discharge of a battery is the presence of salts of metals that can exist in more than one stage of oxidation. For example, an iron salt would be oxidized to the ferric state on the lead peroxid, and would thereupon diffuse to the lead plate and oxidize it to sulfate, thus gradually discharging both plates.

EXPERIMENTAL CHEMISTRY.

(*Continued from page* 477)

bonat (Na_2CO_3) by the addition of more coal in the black-ash fusion; the reaction being:

$$CaCO_3 + C = CaO + 2CO$$
$$Na_2CO_3 + CaO + H_2O = 2NaOH + CaCO_3$$

PROPERTIES:—Physical:—1. The physical and chemical properties of Sodium and Potassium are quite similar, therefore the properties of both will be given under one heading.

Both are white solids of acrid and nauseating taste.

2. Both are very caustic, dissolving the flesh.

3. They are very deliquescent and soluble.

4. Sodium hydroxid imparts a flame of yellowish color, while potassium hydroxid imparts a purple color.

Chemical:—1. They neutralize acids and form salts.

2. They are both strongly alkalin.

3. They react on many metals.

4. They absorb carbon dioxid and form carbonats.

5. They react with fats and oils to form soaps.

USES:—Small amounts of these hydroxids are used in chemical laboratories, but the most important use is that of soap-making. Fats and oils are mainly stearin (or glyceryl stearat), $C_3H_5(C_{18}H_{35}O_2)_3$; palmitin (or glyceryl palmitat), $C_3H_5(C_{16}H_{31}O_2)_3$; and olein or glyceryl oleat, $C_3H_5(C_{18}H_{33}O_2)_3$; C_3H_5 being the glyceryl radical. Glycerin or (glycerol) is $C_3H_5(OH)_3$.

In *saponification* the hydroxid of sodium or potassium acts on the stearin, palmitin, or olein, and liberates glycerin, forming sodium stearat, etc.

$$\left\{\begin{matrix}\text{Sodium}\\\text{Hydroxid}\end{matrix}\right\} + \text{glyceryl}\left\{\begin{matrix}\text{Stearat}\\\text{Palmitat}\\\text{Oleat}\end{matrix}\right\}$$

$$= \text{sodium}\left\{\begin{matrix}\text{Stearat}\\\text{Palmitat}\\\text{Oleat}\end{matrix}\right\} + \text{glycerol}$$

The stearat, palmitat, and oleat of sodium or potassium are the chemical names for soaps. They are soluble in water: hence a solution of sodium chlorid, in which they are insoluble, is used to precipitat them.

It may be of interest to the reader to give an explanation of the action of soap. Soap dissolves in pure (or soft) water, and the faintly alkalin solution very readily gives emulsions with the skin or the fatty matters in soiled cloth. Thus the fatty matter is removed, and with it is taken out mechanically any dirt in other forms, such as carbon, etc. If soluble salts of calcium or magnesium are present in the water, an insoluble stearat, etc., of these metals is formed and precipitated as a lime or magnesium soap; hence the soap will not dissolve till these salts are removed. The quantity of soap necessary to make a lather is the basis for estimating the hardness of water. The harder the water the more soap required.

Therefore we may safely conclude that the most important use of sodium and potassium hydroxid is in the manufacture of soap which runs into thousands of tons annually.

They are also used in bleacheries, in paper making, in refining oil, etc.

EXPERIMENT No. 98:

Pour 10 or 15 cc. of water into an 8 ounce wide mouth bottle and have a cardboard or paper to cover it. (Do not use a glass plate as a cover), as a slight explosion may occur upon the disappearance of the metal; (Fig. 89). Take a small piece of metallic sodium with a pair of forceps, about the size of a pea, and drop it into the bottle containing the water, covering the latter immediately with a piece of cardboard or paper. Notice how the metal reacts with the water.

While the action is going on, make the combustion test, by removing the cover and quickly thrusting a lighted splint into the bottle. If there is a flame, note the color.

It may be that the operator failed to notice the phenomena which took place when the first piece of sodium was introduced; in that case, repeat the experiment, using a clean bottle, and water.

$$Na + H_2O = NaOH + H$$

Save the liquid, which is sodium hydroxid and evaporate to dryness, and examine it as to color, causticity and solubility.

EXPERIMENT No. 99:

Examine a piece of freshly cut metallic sodium. (Do not handle the metal with your fingers, but use a pair of forceps). Note its color, lustre, and hardness.

Boil about 10 cc. of water in a test tube, and pour it into a clean bottle, and while still hot drop a piece of sodium (a fresh piece) into it and cover the bottle with a piece of cardboard (not glass). Notice the phenomena carefully.

When the action stops, hold the lower opening of a Bunsen burner across the mouth of the bottle, having the cover removed as shown in Fig. 90. Notice the yellow color imparted to the flame, which color is characteristic of sodium and its compounds. This test must be applied as soon as the action of the sodium stops.

EXPERIMENT No. 100:

Prepare potassium hydroxid, following the steps exactly as in the preceeding experiment, except that metallic potassium is employed in place of metallic sodium.

The flame, when the Bunsen burner is placed across the mouth of the bottle, in the case of potassium will give a purple color instead of a yellowish color as obtained with sodium. Notice all phenomena, and compare with that of sodium.

$$K + H_2O = KOH + H$$

EXPERIMENT No. 101:

Sodium Hydroxid made from Slaked Lime and Sodium Carbonat.

Put about 7 grams of finely crystallin sodium carbonat (Na_2CO_3) on a piece of paper, and on another paper 5 grams of slaked lime ($Ca(OH)_2$). Pour the two into a beaker and add about 40 cc. of water. Pour the liquid obtained from the beaker into a Florence flask, leaving the flask unstoppered; (Fig. 91). Place it on a ring stand or tripod on asbestos, and boil for four or five minutes. Before completing the boiling add water enough to replace that which evaporates. Filter, and if the solution is so strong as to break the filter, let the mixture settle, decant it, and use the decanted liquid for testing.

Test the filtrat by its action on solutions of Copper chlorid, ($CuCl_2$), Silver chlorid, ($AgCl_3$), and Ferric (Iron) Chlorid, ($FeCl_3$); by its action on red litmus. Note the color effects in each case.

EXPERIMENT No. 102:

Potassium hydroxid made from slaked lime and Potassium Carbonat.

Prepare by similar method as for sodium hydroxid, except that potassium carbonat (K_2CO_3) is employed in place of sodium carbonat.

Compare all the phenomena observed when potassium is used, with those obtained by the action of Sodium carbonat. The product obtained is:

$$Ca(OH)_2 + Na_2CO_3 = CaCO_3 + 2\,NaOH$$
$$Ca(OH)_2 + K_2CO_3 = CaCO_3 + 2\,KOH.$$

EXPERIMENT No. 103:

Electrolytic Preparation of Sodium Hydroxid.

The apparatus shown in Fig. 92 was described in detail in the October 1916 install-

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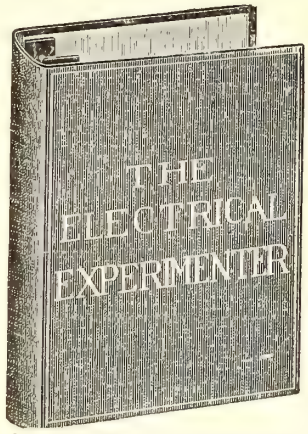
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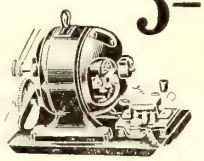
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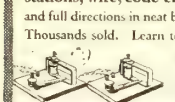
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ment of this series of papers (page 405), and reference is made for a detailed description of this apparatus. Essentially, it consists of a U-tube, fitted with two two-holed rubber stoppers, thru which pass the delivery tubes, and two electrodes, sealed in a piece of glass tubing which contain mercury. The electrodes should be of platinum, as this substance expands and contracts in the same proportion as glass, besides being a better electrode than other substances, it withstands the action of the various solutions much better than copper, nickel, or other electrodes will.

This apparatus may be considered a laboratory modification of the Castner-Kellner method of electrolytic apparatus shown in Fig. 88. The U-tube is filled with mercury so that it extends above the bends of both sides of the tube, which prevents the chlorin liberated from the anode from coming in contact with the sodium hydroxid formed at the cathode. If a little red litmus is added to the salt solution, it will be bleached by the chlorin around the anode, and turned blue by the sodium hydroxid at the cathode. Chlorin is liberated at the anode, and we may assume that sodium is separated for an instant at the cathode, which at once interacts with the water present, liberating hydrogen and forming sodium hydroxid.

The equation of the reaction caused by the electrolysis of the sodium chlorid solution (common table salt) may be represented by the following equation:

$$NaCl + 2H_2O = NaOH + H + Cl$$

AQUA REGIA.

HISTORY:—

This name is given to a mixture of Nitric and Hydrochloric acids which is frequently employed for dissolving gold and platinum, as well as many metallic ores and other substances.

The Alchemists called this mixture *Aqua Regia,* which meant Royal Water or King of Waters, because it possest the power of dissolving Gold, which was considered the king of metals. Aqua Regia was therefore believed to be the strongest solvent known. Any thin liquid they termed *Aqua,* the Latin, meaning water, and affixing some adjective to express the kind of water, as Aqua Pura (Pure Water), Aqua Fortis (Strong Water, which they applied to Nitric acid), etc.

Strictly speaking, Aqua Regia is not an acid, tho it is often so called from its constituents, nitro-hydrochloric acid. It is made by mixing the two acids, Nitric and Hydrochloric,—one volume of the former to three volumes of the latter. A reaction takes place which is variable, depending on the relative amounts and strengths of the two acids. A general reaction is:—

$$3\,HCl + HNO_3 = 2\,H_2O + \underset{\text{Nitrosyl Chlorid}}{NOCl} + Cl_2$$

The solvent power of the Aqua Regia depends upon the fact that, on heating, this mixture of acids evolves Chlorin. In the reaction chlorin is always liberated. When Aqua Regia is employed to dissolve metals, the chlorin liberated, during the reaction forms chlorids, the higher chlorid in case the metal has more than one valence. The action is very vigorous, especially if the liquid is hot. While Gold (Au) and Platinum (Pt) are not affected by hydrochloric acid or Nitric acid, they combine readily with the chlorin to form gold chlorid ($AuCl_3$) and platinum chlorid ($PtCl_4$), which dissolve in the liquid.

As chlorin is one of the strongest of oxidizing agents, either as a gas or in solution, aqua regia will change—ous to—ic salts; as, for example, Mercurous chlorid (HgCl) to Mercuric chlorid ($HgCl_2$), Ferrous chlorid (Iron) chlorid ($FeCl_2$) to Ferric (Iron) Chlorid ($FeCl_3$), etc. It possesses a strong, irritating, characteristic odor, the color varying from orange to red. Owing to the escape of its gases it cannot be kept, but should be made as required for use.

Experiment No. 104.

Hold a test tube in the left hand, nearly on a level with the eye, and pour into it about 6 cc. of hydrochloric acid (HCl), (Fig. 8b in the August, 1916, "Electrical Experimenter"). Add to this about 2 cc. of nitric acid.

Watch the mixture a moment, and if no action can be noticed, bring the tube to a flame for a moment only.

$$3HCl + HNO_3 = 2H_2O + \underset{\text{Nitrosyl Chlorid}}{NOCl} + Cl_2$$

The products are for the most part, chlorin (Cl), Nitrosyl chlorid (NOCl), and Water (H_2O). The mixture is called aqua regia, or nitro-hydrochloric acid, its strength being mainly due to chlorin.

Experiment No. 105.

Put one or two pieces of Zinc into a tube and add a little of the aqua regia. If any gas escapes test its combustibility by applying a lighted splint, also smell the odor, etc.

Put into a dish a few pieces of copper and add a very little aqua regia. After a minute dip a splint into the solution; then hold it in the flame of a Bunsen burner and notice any color effects.

Moisten a glass rod and roll upon one end of it a half sheet of gold leaf. Dip this into a tube containing a small amount of aqua regia, using care not to touch the sides of the tube. Notice the action the instant the gold touches the liquid.

Experiment No. 106.

Ascertain whether gold will dissolve in either hydrochloric or nitric acid, separately, using a clean tube and glass rod, and heating each liquid to the boiling point. (Great care should be exercised in bringing these acids to the boiling point, being careful that the acid does not boil over or spatter on the hands or clothes. If the action becomes too violent immediately remove the tube from the flame.)

If it does not dissolve, pour the contents of each tube together, and notice any action which takes place.

Experiment No. 107.

Ascertain the action of aqua regia on scraps of iron, and note whether the product is the same as when hydrochloric acid acts on iron. Test the result of each action by the use of ammonium hydroxid (NH_4OH), also a splint applied to the mouth of the tube, to determine if a gas is present, etc.

When nitric acid acts as an oxidizing agent, it usually decomposes, as represented in the following equation:

$$2HNO_3 = H_2O + 2NO + 3O$$

If hydrochloric acid is present, the oxygen, as fast as formed, reacts with the acid according to the following equation:

$$6HCl + 3O = 3H_2O + 3Cl_2$$

The nitric oxid formed according to the first equation is not evolved as such, but combines with the chlorin liberated according to the second equation, to form an orange-yellow, gaseous compound known as Nitrosyl chlorid (NOCl).

$$2NO + Cl_2 = 2NOCl$$

By combining these three equations in the regular way and dividing the resulting equation by 2, in order to get its simplest form, one obtains the following:

$$HNO_3 + 3HCl = 2H_2O + \underset{\text{Nitrosyl Chlorid}}{NOCl} + Cl_2$$

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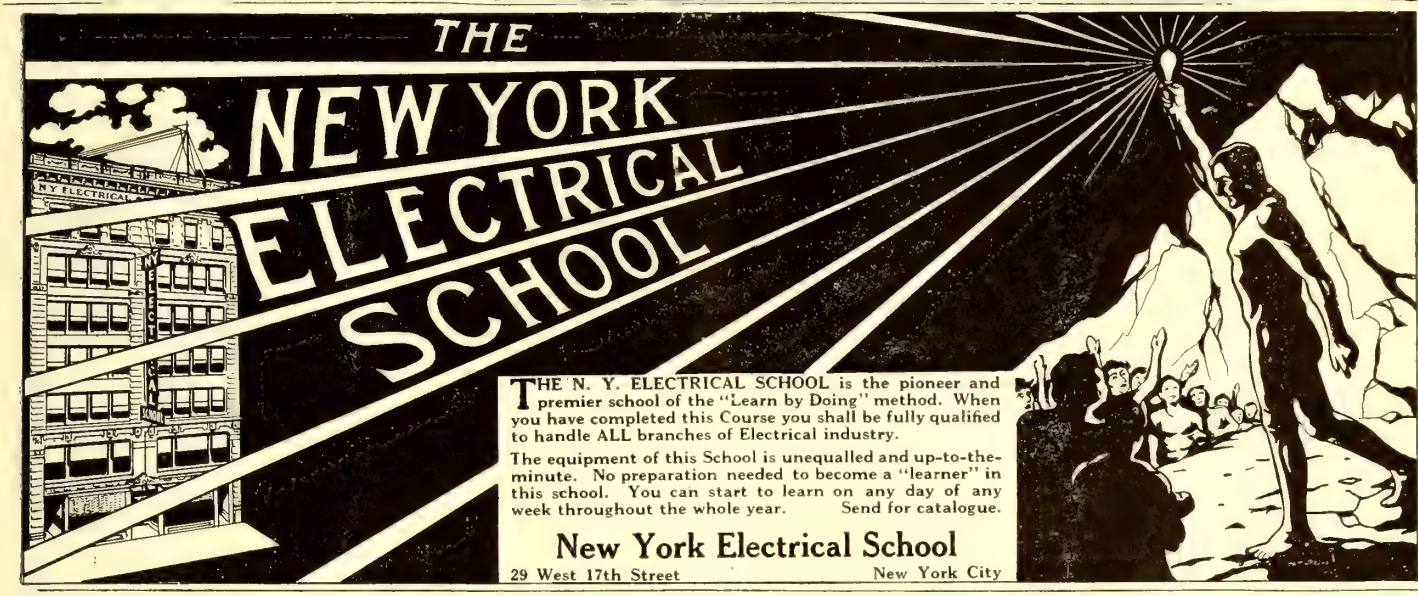
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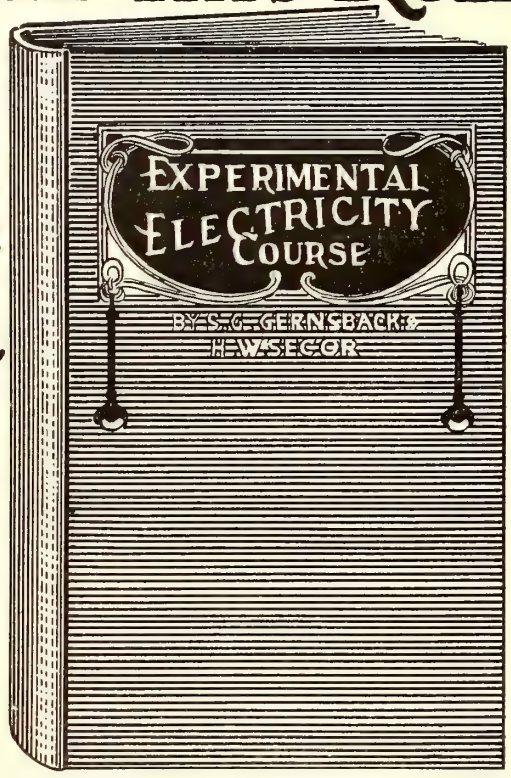
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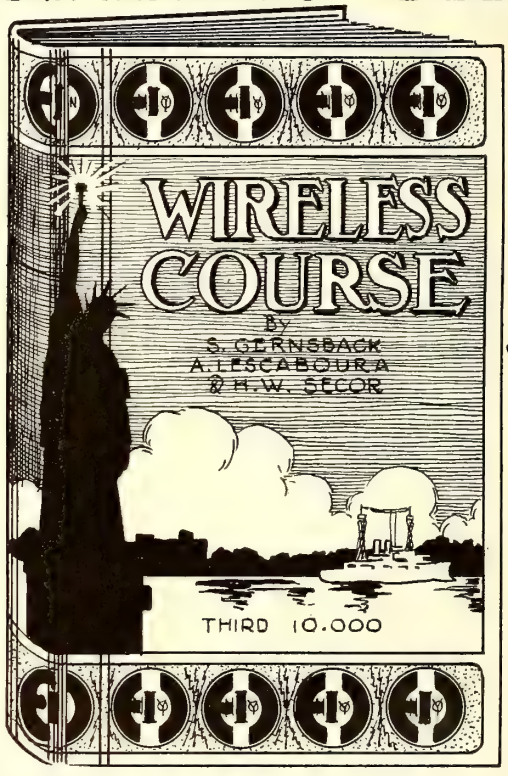
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HISTORIC ELECTRIC APPARATUS.

(*Continued from page* 448)

the year 1810. He did not enclose his incandescent lamp in a vacuum or in a tube however, but contented himself with bringing a strip of platinum 1/30 of an inch thick by 18 inches in length to a high state of brilliance by connecting it to a large number of batteries. Little was done in succeeding years to evolve any form of incandescent electric lamp, and the next we hear of this now universal illuminant is in 1841, when we find the work of de Moleyns. His incandescent lamp utilized a fine platinum wire. About the first incandescent lamp of the exhausted bulb type that we find a record of, is that due to Starr, a Yankee inventor of Cincinnati, Ohio. His first product bears the date of 1845, when he took out a patent for a *carbon filament lamp with an exhausted bulb*. He took out many patents, and evolved a diversified number of incandescent lamps and filaments, but owing to the lack of commercial dynamos, success in those days was of short duration.

Another earnest worker in this field was Henrich Göbel, of New York City, who produced a very promising carbon filament lamp in 1854. Göbel first used wood charcoal for the filament, and later tried carbonized bamboo.

The *Edison incandescent lamp* upon which large sums of money were spent in development for several years, finally emerged from the laboratory in 1879, and from that date progress was real and assured in the development of electric lighting. The illustration in Fig. 7 shows the earliest form of incandescent lamp, and also the Edison lamp as first manufactured. The Edison lamp had an exhausted bulb, and a carbon filament was used composed of carbonized brown paper at first, but shortly afterward this was made of carbonized bamboo. Thousands of different kinds of filament and materials for them were exhaustively tested out in Edison's laboratory, and it is surprising to learn that even in those days there were a number of inventors who proposed *metallic filament* lamps, and actually tried out incandescent lamps, having filaments coated with metallic oxids, etc.

The *arc lamp,* which is very common now-a-days, was invented by Sir Humphrey Davy, who discovered in 1801, that by connecting up a large number of battery cells to a pair of pointed carbon rods, that when these rods were placed in contact and then separated, an electric arc of great brilliance tended to form between the carbons. In 1809, Davy exhibited publicly the first electric arc light, which was excited by *two thousand primary battery cells.* Arc lights languished for a good many years until an Englishman by the name of Wright, in 1844, devised the first successful automatic self-feeding arc lamp. Wright's ingenious automatic arc lamp is shown in Fig. 8, as also Davy's first arc lamp of the hand-feed type.

Wright's arc lamp comprised a series of carbon discs with bevelled edges, arranged in the manner illustrated. Two of these discs were movable; thus making it possible to compensate for the change in the length of the arc as the discs were burnt away, and all of the carbon discs were rotated while the lamp was in operation by means of clock-work mechanism.

The *telephone,* now in use in practically every city and community all over the civilized world, first saw the light of day in Germany (1861) in the apparatus invented by Philip Reis, instructor in natural sciences at Professor Garnier's Institute, a select school for boys at Friedrichsdorf, near Homburg. As Professor Sylvanus P. Thompson has declared—"the apparatus devised by Reis was the employment of a loose or imperfect contact between two parts of a conducting circuit so that the pressure and electrical resistance might be varied by differing stress." By this system (see Fig. 9) Reis was able to transmit musical sounds, especially whistling and other shrill tones, with all variations of pitch and loudness, altho without timbre, probably resembling somewhat the sound of a xylophone (wooden piano)—and less perfectly, also, the sounds of the human voice; the consonants being readily represented, but the vowels less distinctly, if at all.

Referring to this early forerunner of the wonderful telephone which Professor Bell (1876) later perfected so as to be able to transmit articulate speech over any distance by electrical means, we find that Reis used as a transmitter, a small box having two openings, one at the side for the mouthpiece, and the other at the top, closed by a diafram, made from the smaller intestine of a pig. At the center of this membrane was cemented a strip of platinum in loose contact with the point of a platinum wire held in position above it by a light leaf spring. The receiver of the Reis system comprised a steel wire, wrapt around with a coil of insulated wire, thus forming an electro-magnet. This was mounted on a small resonant wooden box resembling a violin, and which served as a sounding board. To this was later added a cover of thin wood, against which the ear could be prest to receive the sounds transferred along the wire electrically from the transmitter.

Wireless telegraphy for practical purposes really dates back to the brilliant scientific researches of Henrich Hertz. Many electrical writers date wireless telegraphy back to the first wireless transmission of messages to 1838 when Professor Joseph Henry, of Princeton University, succeeded in setting up induced currents in the cellar of a building, when a Leyden jar was charged and discharged by means of a static electrical machine placed in the top room of his residence. Next in line to be credited by many writers is Professor S. F. B. Morse, who is stated by one authority ("Wireless Telegraphy," by Sewall, 1904) to have actually sent the *first signal without wires* on December 16th, 1842, when he succeeded in sending a wireless telegram across a canal 80 feet in width, and in November, 1844, Mr. A. D. Gale, under the instruction of Professor Morse, transmitted wireless signals across the Susquehanna River at Havre de Grâce, a distance of nearly one mile.

This wireless scheme, however, was based on the principle of *conduction,* and thus was limited in its application and in the range that could be covered. Considerable experiment was done with *inductive* systems of wireless telegraphy and telephony, in America, from 1882 to 1885 by Professor Dolbear and Thomas A. Edison, the latter investigator having successfully signaled thru space to a moving train from a wire installed on poles beside the railway, in 1885.

The crowning achievement in the realm of radio-telegraphy by *etheric wave* transmission was that of Hertz, in 1886. Across a small spark gap in a ring of wire suspended in a room (there having been no electrical contact with the charging apparatus), Hertz caused tiny sparks to appear as the result of the passage across another and longer spark gap of the oscillatory discharge from a Leyden jar. Finally we come to the work of Guglielmo Marconi,

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We have a number of Fine Hand Generators which we will dispose of at bargain prices. Give up to about 100 volts, alternating current. You can make direct if desired. Strictly high grade. While they last, $3.00 each.

Watson Electric Co.

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FIRES 20 SHOTS IN ONE LOADING. Same size and shape as regular automatic revolver. Shoots B. B. shots obtainable anywhere, same as other rifles and guns. No caps or load necessary, as it works with a spring and shoots with rapidity and accuracy. Nothing to explode. Absolutely harmless and safe. Well made and finished. Sent by mail complete with round of shot for ONLY 25c. postpaid.

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whose successful publisht experiments date from 1896, when he succeeded in transmitting wireless signals by means of *Hertzian waves in the ether* across a space of 100 yards at the British Postoffice in London. Soon afterwards he made a successful trial of sending and receiving wireless signals over a distance of two miles on Salisbury Plain, and from then on, the art of radio signaling advanced by leaps and bounds, and it was but a few years, or to be exact on Thursday, Dec. 12, 1901, at 12.30 P. M., when Marconi received the first wireless signal across the Atlantic Ocean (over 2,000 miles) between Poldhu, England, and Cape Cod, Mass.,—this immortal radio signal having been the letter "S" as represented telegraphically by three dots.

RADIO ROLL OF HONOR.

(*Continued from page* 462)

Utah

Clifton Guiver
Cedric E. Hart

Virginia

Jno. P. Hyde
W. K. Smith, Jr.
Lisle E. Roadhouse
S. C. Haight
Adolph Lefkowitch
J. J. Campbell

Vermont

A. M. Dole

Washington

L. R. Devine
Geo. Stinley
Chas. Callahan
R. Thelberg
E. V. Olson

West Virginia

Chas. P. Guice
Harry Cunningham
Hugh N. Montgomery
F. B. Dadisman

Wisconsin

E. Smith
Norman Kuzweg
Robert Brannfeld
Neil Werner
Wm. C. White
Weldon Eisenbrand
Harry Gerky
Wm. O. Block
Lester Westfahl
Robert Donaldson

Wyoming

Gaylord S. Clark
T. C. Harker

AN EXCEPTIONAL EXPERIMENTAL LABORATORY.

(*Continued from page* 479)

various rare elements and compounds, microscopes, electric furnaces, electric ovens, thermostats for controlling the temperature of the room in cold weather, etc. In short we have facilities for conducting all chemical, electro-chemical, metallurgical and general testing and research work.

By the aid of a Photo-micro-graphic attachment of our own design and with an ordinary plate camera, excellent photos of the various chemical phenomena are obtained. As our dark room is right beside the testing tables we can at once develop and finish any photographs and see if the result is satisfactory. This is an extreme advantage, in that, if the results are poor we can retake the picture at once, thereby eliminating all chances of failures in our photographic tabulation of results.

The dark-room is located in one of the small rooms, which has no windows, right beside our chemical and testing tables. A shelf is set up on one side of this room, upon which only photographic operations, such as developing, fixing, printing, etc., are done. On the other side of this room is a large shelf upon which we have permanently constructed our enlarging and copying camera. At the other end of the room are the trays, wash boxes, fixing boxes, and printing frames. The fourth wall contains the necessary chemical reagents and preparations.

RADIO ROLL OF HONOR

Application for Membership in the Radio League of America

I, THE UNDERSIGNED, a Radio Amateur, am the owner of a Wireless Station described in full in this application. My station has been in use since....., and I herewith desire to apply for membership in the RADIO LEAGUE OF AMERICA. I will abide by all the rules of the LEAGUE, and I particularly pledge my services as a Radio operator, or for Signal Corps duty to the United States Government when called upon.

I understand that this blank with my signature will be sent to the United States Government officials at Washington, who will make a record of my name.

Witnesses to signature:

.....

.....

Name.....

City.....

State.....

Date.....191

Description of My Station and Apparatus

Sending .....

.....

Receiving .....

.....

.....

.....

I can send approximately.....words per minute.

I can receive approximately.....words per minute.

My age is.....years.

.....

.....

.....

.....

(11-17)

THE WORLD AFTER THE WAR.
By a Teuton Scientist.

What will the world be like after the war? A German scientist's imaginative after-war picture is the feature of the latest number of the German review, *Zukunft.* The author, Professor Moritz Lesser, is a member of the faculty of engineering of the University of Bonn. The professor pictures, in fanciful style, a world at peace, in friendly and international relationship making use of the technical discoveries which have been made during the war for the development of commercial enterprise. The article in part is as follows:

"Three months after the end of the war, the directors of the leading banks and corporations of Germany held a meeting to the number of 3,000 in the Reichstag, with the home secretary for chairman, and founded a company 'For the Development and Use of Inventions Discovered During the War.' The object of the company was to employ in peace the technical progress which had been accomplished under the stress of war, and the capital subscribed was 40 times as great as required.

"One object of the company was to build submarines for pleasure trips and to search for treasures lost during the war.

"It was found possible to build a submarine which sank to a depth of more than a mile, and from this sprang the international company for raising the ships sunk during the war. The work was an immense success, and large sums of money were made from this salvage work. There was also huge profit in taking passengers in these ships for trips of exploration and sightseeing along the bottom of the sea. Ships were found which had gone down centuries ago, and one expedition recovered the treasure of a whole continent which was sunk in a Spanish Armada. Moreover, rich veins of coal and iron and other minerals were discovered in the sea.

"Meanwhile wireless telegraphy was perfected until it was possible to send a current around the entire world. It was also possible to supply airships with the current. A company was founded for a passenger and parcel service without gasoline which began serving all important parts of the world.

"At the same time the Peace Conference at The Hague, which represented all civilized nations, decided on the complete disarmament of all the world, without any restrictions. By this time every great Power had established a fleet of unmanned aeroplanes loaded with thousands of bombs, which were to release by wireless current at the first mobilization of the enemy over all his important towns. In this way every hostile town and base would be reduced to ruin in a few hours. This meant that there could no longer be any war."

Other imaginary inventions described by the writer include an American "spectral film," which brought the pictures of distant events as they happened to the theatre and private house. Another invention dispensed with the use of coal and gas by preserving the heat and light of the sun. Traffic problems in the world's great cities were solved by setting pavements and streets in motion. The article concludes:

"Finally, as inventions reduced the trouble of living more and more, the people began to lose the use of their limbs, since everything was done for them, a world conference was assembled, which forbade anyone inventing anything more." *Sic temper gloria mundi.*

LOCATING UNDERGROUND ORES BY ELECTRICITY.

(*Continued from page* 441)

about the center of the primary coil, the magnetic field will be weakened, but the contour lines are not distorted from their normal circular form. However, with a sufficient number of sets of contours, the presence of the conducting orebody is positively determined.

If the conductor be close to the surface, or nearly in the plane of the primary coil, the galvanometer shows a minimum reading when the same amount of magnetic flux is inclosed by both exploring coils, but this minimum reading is not zero, since some current will flow between the exploring coils, probably due to a difference in phase caused by the angle between the lines of force in the two magnetic fields.

The presence of water courses, puddles on the surface or solutions in the ground does not affect this method, since liquids are not appreciably conductive of the low-voltage oscillating current that is induced. Contour lines about any given center can be practically duplicated at any time, regardless of the weather conditions or variations in ground water.

Theoretically, the presence of a conductor within a distance from the plane of the primary coil, of two-thirds the diameter of the primary coil, will measurably affect the magnetic flux in the plane of the coil. This has been proved practically, so that if the primary coil is 200 ft. in diameter, a conductor within 130 ft. of the surface or, if the primary coil is 400 ft. in diameter, a conductor within 260 ft. of the surface, will cause distortion of the contour lines.

The field development of this method was carried out in the Joplin district, Missouri. Of the ores found in this district—namely, zinc blende, galena and pyrite—the zinc blende is not a conductor and cannot be determined, but the galena and pyrite may be determined satisfactorily. Both galena and pyrite are conductors, and as this electrical method does not distinguish the quality of the conductor, drilling is necessary after determining the orebody electrically for identifying the mineral by drill cuttings. This disadvantage is somewhat offset by the fact that all three minerals are often closely associated, so that the electrical determination of an orebody consists of either galena or pyrite may incidentally, by drilling, develop an orebody of blende.

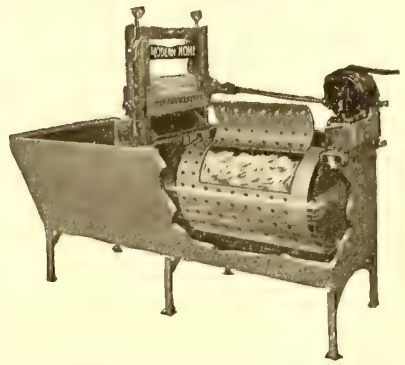
In order to operate with efficiency, an automobile truck has been equipped with self-exciting alternating-current generator, driven by a gasoline engine, and all instruments and machinery required for producing the high-frequency oscillating magnetic field are mounted in the truck body. An instrument box containing galvanometer, current rectifiers and switches is provided for convenience and portability when exploring the magnetic field to determine the contour lines. Portable reels carry the necessary wires. The entire equipment may be placed in the truck for moving.

For prospecting in any mineralized district, the first requirement is the tabulation of all ores liable to be found in that district, with their degrees of conductivity. I have been unable to find any record of work done toward such a tabulation of ores. A partial list of minerals, with their comparative degrees of conductivity, has been determined for this work, as shown in the accompanying table.

COMPARATIVE ELECTRICAL CONDUCTIVITY OF MINERALS

Proustite	18
Cerargyrite	0
Pyrargyrite	20
Bromirite	0
Chalcocite	115

MODERN HOME WASHER
"FITS IN ANY TUB"



Washing Without Work

This truly wonderful machine has revolutionized washing. It fits in any stationary washtub and does all the washing, rinsing and wringing by electricity. All you need do is turn on the switch. The clothes are washed cleaner and whiter than ever before and in the most sanitary way.

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The Modern Home Washer saves its cost many times over each year in washwoman expense and clothes savings. It solves the servant problem and the cost of electricity is only about three cents for a week's washing.

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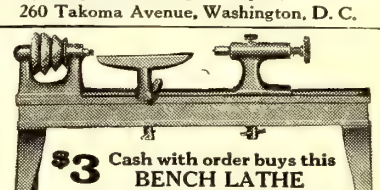


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Peter Austin 910 W. First. E E Muncie Ind.



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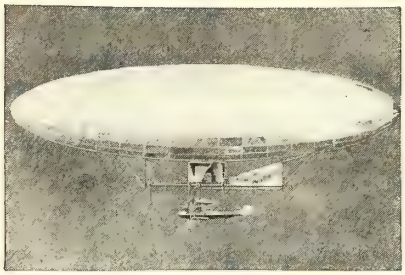
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UNITED STATES WAR KITE, Cloth Planes complete, set of Ailerons, Silk Parachute and Releasing Device, postpaid for $1.50. This kite is of Biplane type and will carry aloft a small Camera, Parachute and model Bombs at the same flight and drop them safely and with remarkable precision. An exact model of the Man-carrying Kites in use at the front today. **Both Fliers Prepaid $2.25.**

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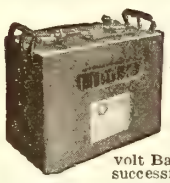
Not a Substitute

Tobacco Redeemer contains no habit-forming drugs of any kind. It is in no sense a substitute for tobacco. After finishing the treatment you have absolutely no desire to use tobacco again or to continue the use of the remedy. It makes not a particle of difference how long you have been using tobacco, how much you use or in what form you use it—whether you smoke cigars, cigarettes, pipe, chew plug or fine cut or use snuff, Tobacco Redeemer will positively banish every trace of desire in from 48 to 72 hours. This we absolutely guarantee in every case or money refunded.

Write today for our free booklet showing the deadly effect of tobacco upon the human system and positive proof that Tobacco Redeemer will quickly free you of the habit.

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Make your Row Boat an Electric Launch. Buy a Jewel Detachable Row Boat Motor run by electricity. No odor or dangerous gasoline. Simple, noiseless and powerful. Attaches to any Row Boat and runs on two six volt Batteries. This is our 5th successful year.



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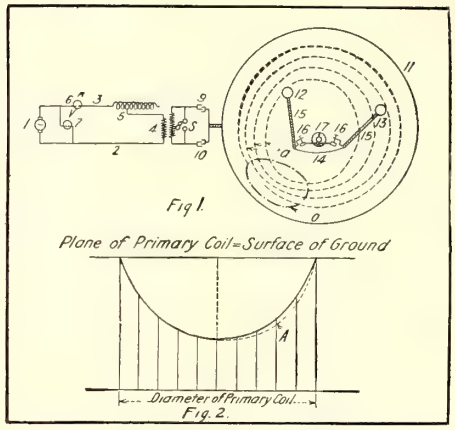
Look inside your storage battery through the patented open window. See condition of plates and height of electrolyte. If you need a new automobile starting Battery buy a Jewel and save money. 6-60 Special $8.50.

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The Jewel Generator Motorcycle Storage Battery and complete lighting system is in great demand. **Agents wanted. Write for prices and catalog E.**

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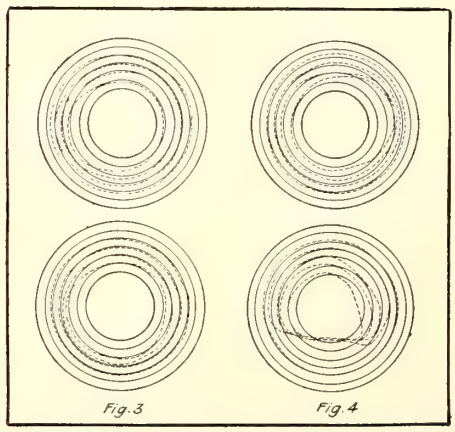
Chalcopyrite	115
Enargite	110
Tetrahedrite	110
Malachite	0
Chrysocolla	0
Cuprite	0
Tenorite	0
Azurite	0



Arrangement of Electrical Prospecting Apparatus and Plot of the Magnetic Field.

Atacamite	0
Galena	105
Jamesonite	40
Boulangerite	90
Zinkite	115
Blende	0
Hydrozincite	0
Calamine	0
Smithsonite	0
Willemite	0
Magnetite	120
Specular Hematite	50
Pyrite	110
Red Hematite	0
Limonite	0
Pyrolusite	115
Psilomelane	0
Manganite	0
Braunite	0
Hausmanite	0
Rhodonite	0

The main difficulties, in the district where the method was developed, are the frequent occurrence of pyrite, which is of no value, and the nonconductivity of zinc blende, which is the most desirable ore. The Joplin district, however, has proved a most advantageous place for the development of this method, since the ore-bodies are generally less than 200 ft. below the surface, and facilities for experimental work are ample and convenient. Field experiments have been carried on for over a year. Of eleven locations tested by drilling, after the electrical observations had indicated a



Actual Distorted Contour Lines Obtained in the Field. The Dotted Areas Result From, and Indicate the Presence of an Ore-Body.

conductor, seven proved the presence of the conductor, six cases being pyrite and one case galena. The four locations not proved by drilling occurred in the early part of the work, before enough data had been accumulated to assure proper interpretation of the contour lines.

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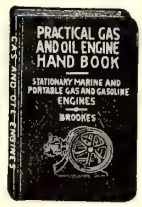
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"Erector" Building Outfits



The Mysto Erector Set No. 2

contains 205 parts and makes 120 models.

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Shipping weight 3 lbs.

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I. C. S. course on electric lighting in four volumes, $8. Dyke's Auto course, with models, $11; bookkeeping course, $2.50. Will sell or exchange for omnigraph. A. Hersee, Burlington, Ont., Can.

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FOR SALE—Carlisle & Finche Electric Motor. Good condition. Price $10. Earl Cook, Bernardston, Mass.

FOR SALE—One Premo film pack camera, postcard size, slightly used, best of condition. Price $10. E. R. Roesch, 13332 Forest Hill Av., East Cleveland, Ohio.

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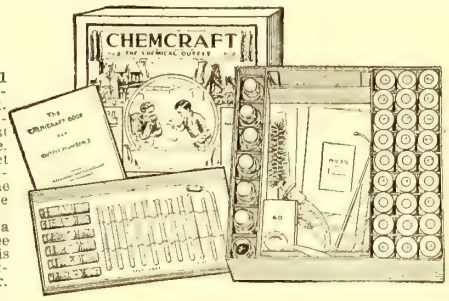
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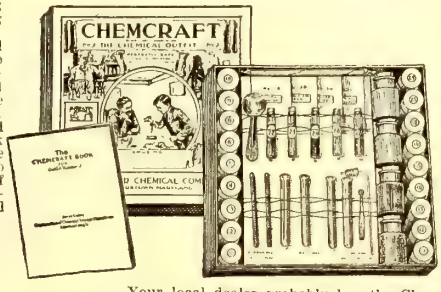


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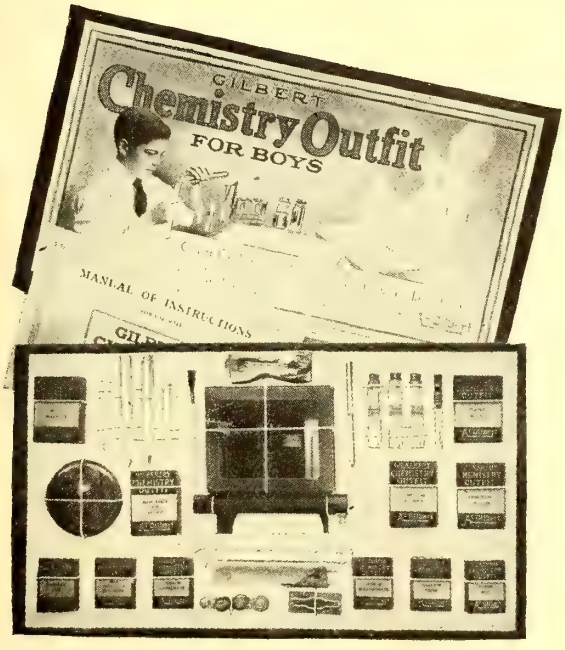
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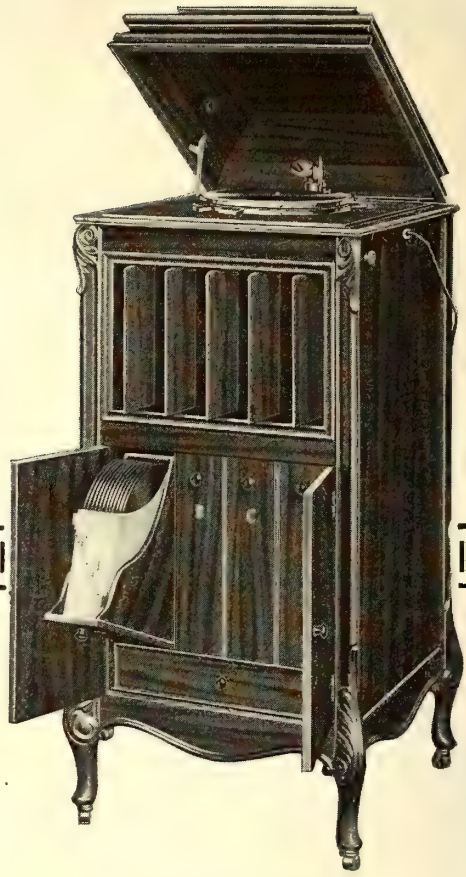
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SOLAR "HEAT"

WE may take it as an established fact that the sun is a huge ball of incandescent matter. Spectral analysis shows that the sun contains every element known to us as found on the earth. Every metal, every gas is represented in the incandescent photosphere, *i.e.,* the gaseous envelope surrounding the sun, burning at a tremendous heat.

We know the sun to be some 93 million miles distant from the earth. Enormous as this distance is—incomprehensible to the human mind—we receive daily from our luminary a quantity of energy nothing short of astounding. Only by remembering that a light-ray traveling at a speed of close to 186,000 miles per second, requires a little over 8 minutes to traverse the gulf separating the sun from the earth, do we begin to realize what sort of a problem we face, when we wish to make it clear to our minds how such a stupendous energy, which lights and heats our planet, is conveyed to us thru a vacuum. For the odd 93 million miles separating the sun from the earth constitute of course an almost perfect vacuum. Nevertheless the earth is lighted and heated. But how does it come about?

Now we know that if we go only 30 miles above the surface of the earth, we strike a temperature of —273 degrees *Centigrade,* the absolute zero of interstellar space. Nevertheless, heat in *some form* gets thru this tremendous cold, paradoxical as this sounds at first. Otherwise, how do we account for the earth being heated by the sun? If you doubt that it gets colder as you go up, you have but to climb a mountain of moderate height. Even three miles up the cold becomes so intense that the top of the mountain will be found covered with perpetual ice. Notwithstanding this, we are closer to the sun by 3 miles at the summit than at the base of the mountain! Also we find by way of further proof that if we expose a thermometer directly to the sun's rays at the top of the mountain, the temperature will be about the same as that of the ice at our feet. And it makes little difference if we perform this experiment on an ice covered mountain at the equator, or on a similar mountain in more northern latitudes.

Logically then we are forced to the conclusion that we do not receive heat rays from the sun at all. For the dark heat rays can not pass thru a vacuum. By placing a thermometer in an ordinary Thermos bottle this statement can be verified readily.

But where does the heat come from? How is the earth heated after all, for heated it certainly is?

By the sun's *light rays.* We know these rays not to be merely luminous rays, but they are in reality electro-magnetic rays. Now then, when these cold rays strike the earth's atmosphere at its lower strata, where the latter is heavily comprest, to some 15 lbs., per square inch, these cold light rays seem to undergo a transformation, and in the act greatly heat the surrounding air. Just what this transformation is we do not as yet know, mainly because we do not actually know the true composition of a light ray. We don't know what lies beyond the ultra violet, nor the ultra red section of the sun's spectrum. Nor do we know much of the light rays' electrical structure.

At this point we wish to make an interesting reflection. Not so long ago the famous Dutch philosopher Dr. Kamerlingh Onnes made certain experiments of tremendous import. He placed an electrical conductor in an almost absolute zero, and found to his astonishment that a current started in such a conductor would continue to flow *for* 19 *hours.* The tremendous cold robbed the conductor of all its former resistance, and the electric current finding no resistance to wear itself out in heat, became a sort of perpetual circuit, which lasted as long as the conductor was near the absolute zero.

Now the point is, the space separating the earth from the sun is at an absolute zero. Is this not perhaps the reason that the sun's light-rays which are of course electrical in nature—act in a like manner to the electric current in Dr. Onnes' experiments? This then would explain, why practically no energy is lost in the transmission thru 93 million miles of icy space.

H. GERNSBACK.

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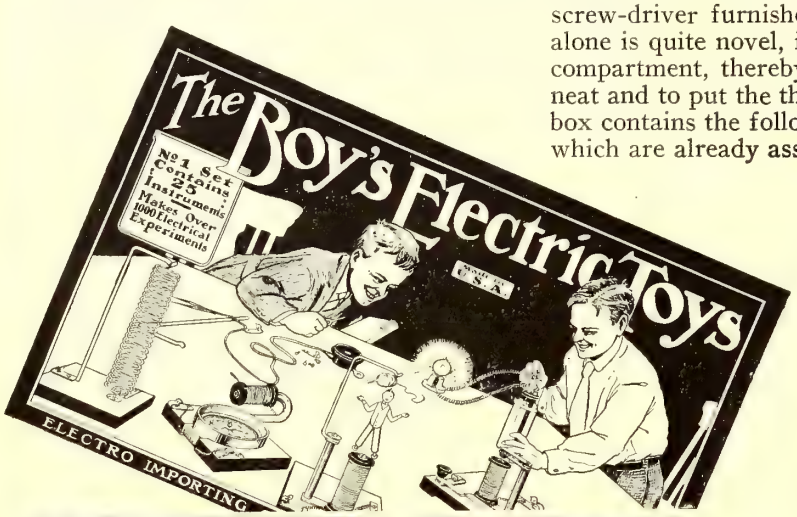
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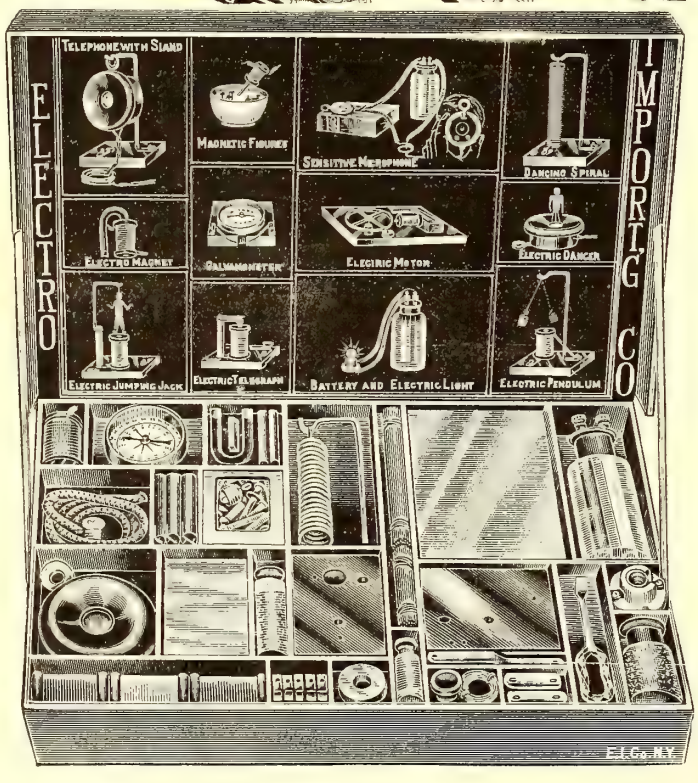
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There have been other electrical experimental outfits on the market thus far, but we do not believe that there has ever been produced anything that comes anywhere near approaching the new experimental outfit which we illustrate herewith.

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This does not by any means exhaust the list, but a great many more apparatus can be built actually and effectually.

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Among the finished material the following parts are included: Chromic salts for battery, lamp socket, bottle of mercury, core wire (two different lengths), a bottle of iron filings, three spools of wire, carbons, a quantity of machine screws, flexible cord, two wood bases, glass plate, paraffine paper, binding posts, screw-driver, etc., etc. The instruction book is so clear that anyone can make the apparatus without trouble, and besides a section of the instruction book is taken up with the fundamentals of electricity to acquaint the layman with all important facts in electricity in a simple manner.

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THE ELECTRICAL EXPERIMENTER

H. GERNSBACK EDITOR
H. W. SECOR ASSOCIATE EDITOR

NOV 23 1917
U. S. PATENT OFFICE

Vol. V. Whole No. 56 December, 1917 Number 8

Locating The Submarine by Radio

By H. WINFIELD SECOR

WHILE there have been hundreds of schemes proposed in the past few months, for the detection and destruction of submarine warcraft, there have been but very few really practical suggestions in the total number.

The present discussion deals with a new wireless scheme for detecting the presence of submarines as far as two miles away from a given base, which may be either on a ship or on land. Credit for this submarine detector is due to Mr. Leon W. Bishop, who is now associated with a staff of experts engaged in solving military and naval problems. Mr. Bishop invented the well-known *multi-audi-phone* radio and telephone amplifier.

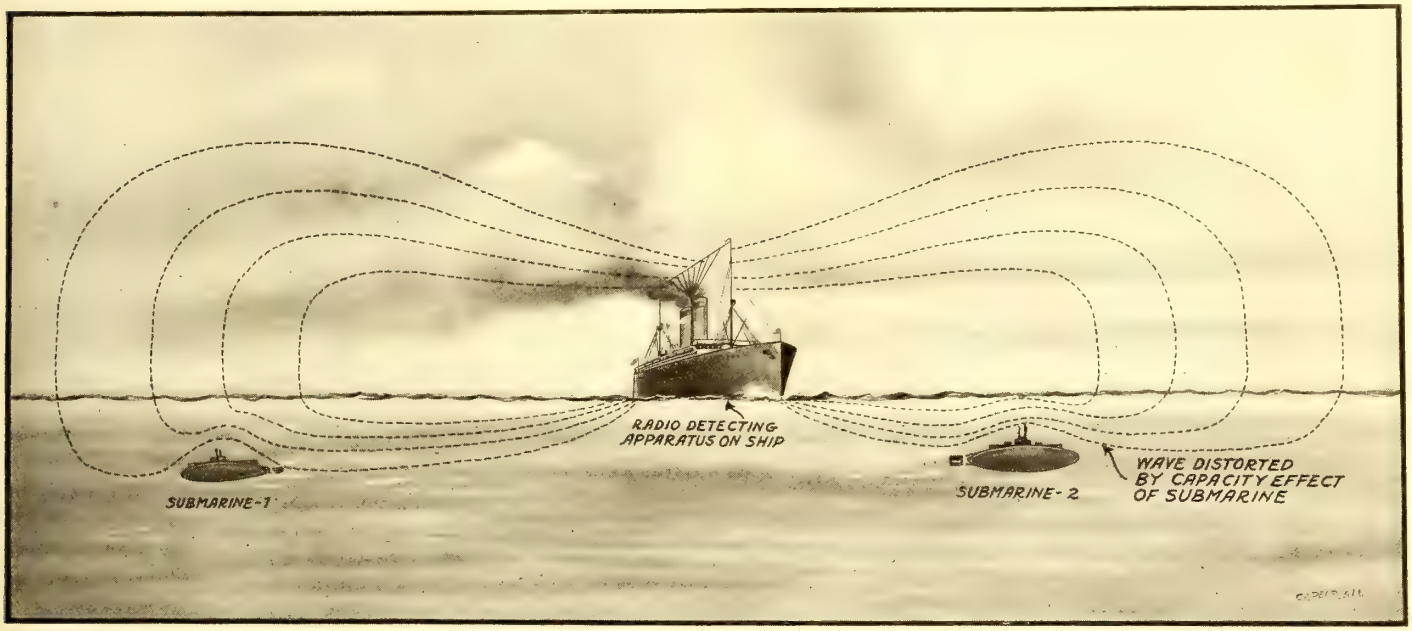
Mr. Bishop has done a great deal of experimenting with microphones for the detection of submarines and has evolved a number of very ingenious and advanced types of microphones, especially suited to these requirements, and for which purpose the ordinary microphone is practically worthless. At the present time very favorable results are being obtained with microphones for this purpose, but several problems have yet to be solved in order that these sound-sensitive devices will perform their functions under water properly in order to accurately spot the "Hun" in his stealthy U-Boat.

Among the different forms of subaqueous microphones devised by this inventor is one mounted in a special resilient substance so as to keep it free from ordinary vibrations and noises. Particularly has he devised special circuits for using microphones in this work whereby they are electrically balanced. He is also experimenting with microphones which produce direct current pulsations, thus conducing to the elimination of external noises.

Coming now to the wireless scheme for the detection of submarines, whether submerged or not, over ranges of two miles and more, (depending upon the wave length used), the general idea of the action taking place will be gleaned from the accompanying illustration. A vessel is here shown radiating a wireless wave of say three thousand meters length, which is equivalent roughly to two miles. Also for the purpose of bringing out the efficiency of the scheme more fully, two submarines are shown and also their effect upon the radiating wave from the antenna.

The inventor of this means of detecting enemy sub-sea boats, received his first demonstration of the ultra-sensitive electrical action involved while operating an undamped Audion receiving set some months ago, and which effect is quite well known.

It was found that when the Audion receptor was suitably tuned, so as to produce a regenerative effect, *i.e.*, producing radio frequency oscillations, that at certain times a peculiar sound effect could be noticed in the telephone receivers connected to the circuit. For sometime this change in the circuit, as manifested by the sound in the telephone receivers, remained an un-



This Radio Wave Method of Detecting and Locating Submarines and Even "Torpedoes" Has Been Tested Out and Gives Surprising Results. It Is Effective up to Two Miles and More and the Enemy Cannot Evade Its Action, so Long as "Subs" Are Made of Metal.

ELECTRIC PLOWING IN GERMANY.

The German farmers, being very hard prest in tilling large tracts of land with an heretofore unknown shortage of labor, have made extensive use of large electric plows and other agricultural machines, one of these immense plows being shown here.

Electrically operated agricultural machines of this type have been used for a number of years on German farms, the electric light companies distributing current for the purpose over very extensive areas, the current being transmitted at very high potentials, often in the neighborhood of 70,000 to 100,000 volts for distances of 75 to 100 miles and more.

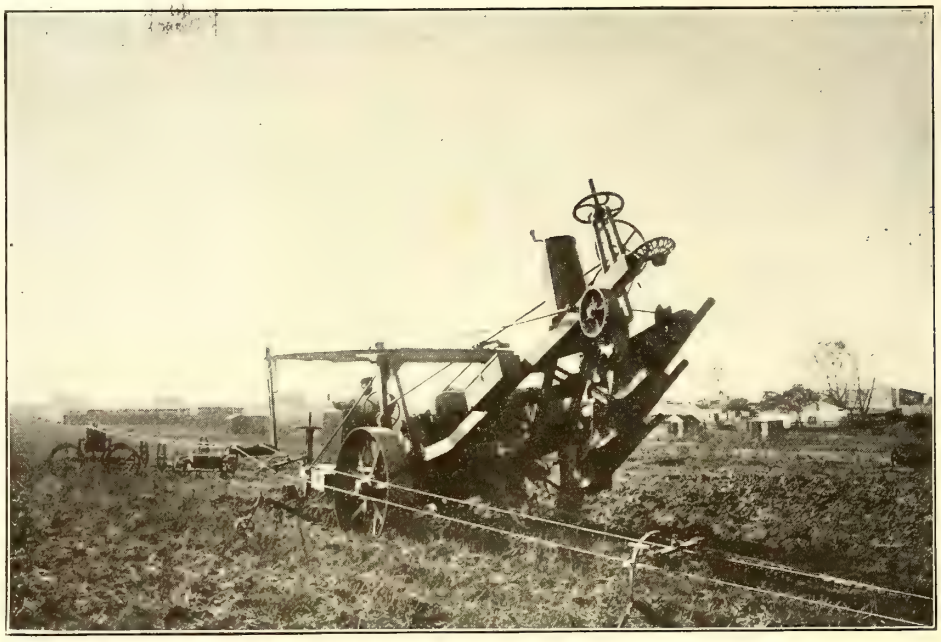
In some cases current is supplied to each individual machine by means of trolley poles, which make contact with trolley wires supported above the field under cultivation. In the installation here illustrated, current is taken from two trolley wires supported but a short distance above the ground, these wires being moved along as the plow starts off on each new run.

Two specially designed trolley wheels carried on an extension arm at the side of the plow conduct the current from the trolley wires to the electric motor on the plow.

The plow is under perfect control of the operator at all times, and this control is effected thru the means of a drum controller, similar to those used on trolley cars and small electric locomotives. These controllers, of which there are two, can easily be seen in the photograph here reproduced.

This particular machine possesses several novel and unusual features, one of which is the fact that at the end of one run across the field, during which it cuts several furrows, the machine is simply tilted up with the main axle as the center, and the operator then walks to the other end of the plow and controls it on the return run from that end of the machine. This overcomes the problem of having to turn the cumbersome machine around each time.

Two manual as well as electrical controllers are provided for this purpose, one set at each end of the plow.



The Teuton Tillers of the Soil Make Extensive Use of Electrically Operated Plows, One of Which Is Illustrated Above. Current Is Supplied the Motor Thru a Trolley Wire.

Probably there is no country in the world in which vast numbers of gigantic machines have been so extensively applied for cultivating and harvesting crops as in the western part of the United States, but in the application of electrically-driven machines for accomplishing farm labors on a titanic scale, the Teutons have far out-distanced other countries.—*Photo courtesy Society for Electrical Development.*

RADIO STATION FOR HONGKONG OBSERVATORY.

A receiving installation for the radio station, Royal Observatory, Hongkong, is now being constructed. The station is located at the observatory, in latitude 22° 18′ 13″ N., longitude 114° 10′ 15″ E., of Greenwich. The installation consists of a single triangular steel-lattice mast 150 feet high. The aerial (which is on order in America) will spread from the mast to six chimney stacks of a terrace of houses 150 yards to the south of the mast. The receiving apparatus consists of a receiving set to be used in conjunction with a Brown relay and high-resistance telephones.

At present the installation is to be used only for receiving time signals from Shanghai, Manila, and Hanoi, and possibly from Tsingtau and one or more Japanese stations by night. After the war it is proposed to install apparatus for distributing time signals via Cape d'Aguilar radio station.

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solved problem, but by careful observation it was ascertained that this was due to the effect of *a passing railroad train at a distance of about one quarter of a mile.* The railroad tracks did not approach the building in which the wireless receptor was located, and therefore it was decided upon that the *capacity effect* of the steel railroad train on the wave radiated by the antenna, was sufficient to change this wave in such a manner that the change could be readily noted in the translating apparatus, *viz.,* the telephone receivers in this case.

By looking at the accompanying illustration it will be seen how the presence of a submarine, whether submerged or not, will cause a reaction on the radiated wave from an antenna located on a ship or on shore.

Mr. Bishop has actually tried this out successfully over considerable distances, and has found that it is possible to detect the presence of not only a submarine a mile or so away, but even the presence of a *torpedo;* so ultra-sensitive is this method of locating a metallic body.

Moreover, the direction in which the metallic body lies may be ascertained by the use of a directional antenna, in somewhat the same manner as the wireless compass scheme.

This effect of bringing any form of capacity in proximity to an oscillating Audion circuit is well-known to most every radio experimenter. Those possessing oscillating Audion sets have found invariably that all of the circuits associated with this device are extremely sensitive to such effects. Even an approach of the operator's body, or for that matter his hand, toward the apparatus upsets the electro-static balance of the circuits. Some of the sets used have proven so sensitive in this respect that it became absolutely necessary to attach long insulated extension handles, sometimes two feet long to the various condensers and tuning switches, so as to eliminate as much as possible this untoward capacity effect of the body.

The accompanying diagram showing connections of Audion oscillator circuits as well as a third, or Audion detector circuit, suitably equipt with telephone receivers, gives an idea of the apparatus employed by Mr. Bishop in some of his researches along this line. Assume for instance an Audion oscillator with its proper capacity and inductance circuits all connected to an antenna as shown. This causes the antenna to radiate radio-frequency waves of a length depending upon the capacity and inductance in the circuit.

We may assume for example that the circuit is tuned to radiate a wave of 3,000 meters, or roughly two miles wave length, which gives a frequency of one hundred thousand cycles per second. Consider also that the second Audion oscillator circuit is set in operation in inductive relation to the first circuit, which is connected to the antenna. The second or inductively associated Audion oscillator is tuned to the same frequency or one hundred thousand per second. Further we note that there is a third coil inductively related to the oscillating circuits and which connects to the Audion detector and a pair of sensitive radio telephone receivers.

Now, if a submarine lies within detecting range, say a mile away, and the antenna is excited by the Audion oscillator No. 1 with a wave having a periodicity of one hundred thousand cycles per second, then its frequency will be slightly changed by the *capacity effect* of the submarine. Suppose it causes the oscillation frequency of the antenna system to change from 100,000 cycles to 101,000 cycles. If such should be the case, then there will be produced a beat frequency note in the third or detector circuit, having a periodicity of *one thousand cycles per second,* which is of course an audible frequency, and therefore

(*Continued on page* 572)

BACK NUMBERS!—Many readers desire to obtain back numbers of this journal. We have a limited quantity of these back issues on hand and can supply them at the following rates:—Back numbers of The Electrical Experimenter not over three months old, 15 cents each; over three months old, 20 cents each; over one year old, 35 cents each.

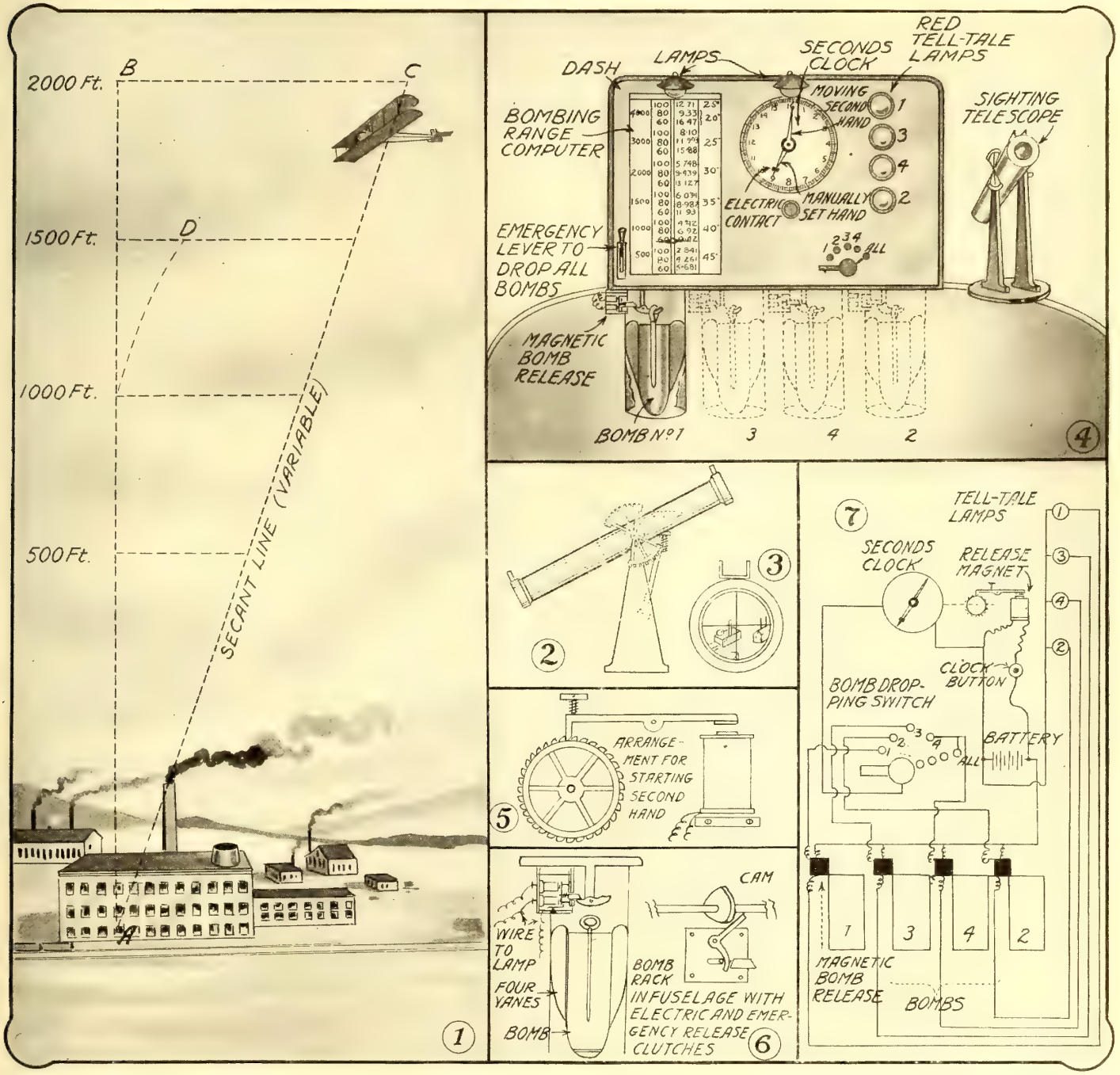
New Electric Bomb Dropper for Aeroplanes

BOMB dropping from aeroplanes can only be approximately accurate. It can be made at least seventy-five per cent more efficient by sighting and releasing the bomb by mechanical means and eliminating guess-work, as there is only one aviator out of five hundred that is really proficient in the work without some mechanical aid. One of the best bomb sights in use by the Allies is the C. F. S. (Central Flying School) in the British service. The sighting is done over two bars arranged vertically, one above the other, about six inches apart. The third is fixt in a slide, level with the upper sight, thus forming a right angle triangle, with the right angle forward and upward. The slide is graduated into seconds. The aviator decides in what direction the wind is blowing and in order to ascertain the speed at which he is flying, he picks out some object on the ground, having first set his slide at the altitude he is flying, taking a sight along the hypothenuse formed by the two bars of the sight, and as soon as the object comes in line he presses his stop watch, keeping the sight all the time on the object he has selected, until it comes in line with the two vertical bars of the sight. He then reads the time on his watch and adjusts his index slide to read that time.

But the great difficulty with this sight is that at a high altitude, or at night, it is very difficult or nearly impossible for the aviator to discern his object at all.

A Yankee genius, Mr. F. R. Lewis, has overcome this deficiency by employing a telescope mounted on a tripod or base, swiveled and hinged to turn vertically or horizontally, with quadrant and hand-screw to keep it in the desired position or angle, Figure 2. It is designed to have day lenses made interchangeable with night lenses, each provided with cross-hairs, and external locating sights, Figure 3, as it is very difficult to focus an object on the cross-hairs of the telescope, even when flying at sixty miles an hour, until after the object is located.

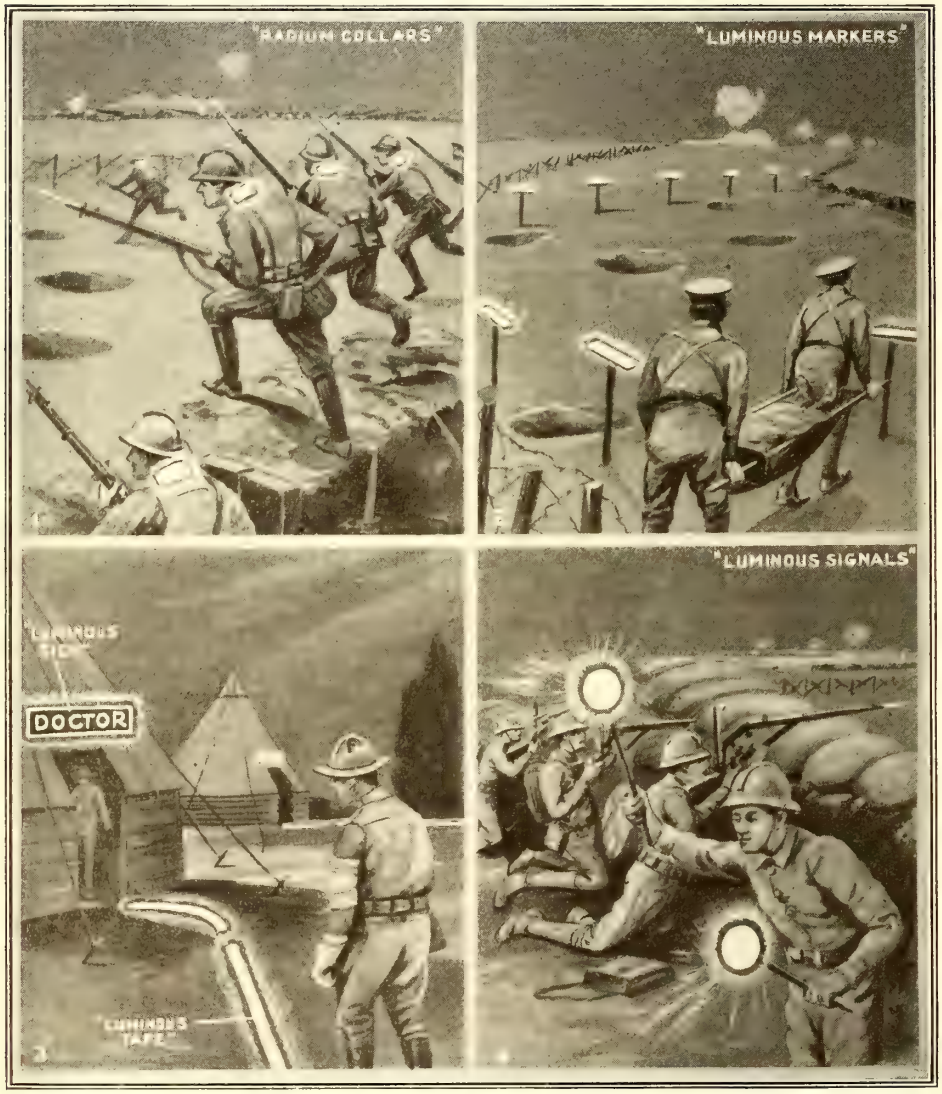
(*Continued on page* 754)



A Yankee Inventor Has Perfected the Simple Electric Bomb Dropper Here Illustrated for Use on Aircraft. The Aviator Checks up His Actual Flying Speed, Sets His Range-finding Telescope and Flies Over the Target. At the Proper Moment the Automatic Electric Clock Switch Releases the Bomb.

Radium Paint in the War

THE persistent electrical activity of radium, especially when used in combination with zinc sulfid, which gives rise to a luminous effect which is readily noticeable in the dark, has led to the adoption of this peculiar mixture for many different uses in the great world war. A large English concern has been extremely busy of late turning out these "luminous paint" articles for use by the soldiers and sailors of His Majesty the King.



Radium Paint Is Finding Many Diversified Applications in the World War. In the Form of "Beacons" It Guides the Stretcher-Bearers Thru "No-Man's" Land and Enables Signaling to Be Carried on Safely in the Front-Line Trenches.

Over 100,000 marching compasses are in daily use by the allied armies, each fitted with a luminous radium dial readable at any time, even on the darkest night. Aeroplanes skim along thru the night, the aviators guided by radium be-dialed compasses. At sea, the doughty little "sub" destroyers shoot hither and thither with never a light to be seen—the radium lighted compass dial answers the question. The man using it can see the dial all the time, but you cannot. Fig. 1 illustrates a clever use for "luminous paint" collars. These linen tabs present a luminous surface of 10 square inches, and are for attachment to the back of the tunic, so that when the first line of men go over the top, they will not be mistaken for enemies in the dark by the second line of men who follow.

The illustration, Fig. 2, shows a most useful beacon provided with a spike to be driven in the ground. They are also made in the shape of large buttons, the luminous painted top being covered with transparent celluloid, and surmounted on a small steel spike ⅜-inch long, which, by pushing, enters into any woodwork, and when affixt to the top of short stakes driven into the ground and placed 10 yards apart, afford a guide to relief parties going and returning in the dark. One hundred of these 10 yards apart will serve 1,000 yards, the stakes being placed in the day on chosen fairly level ground.

One of the most useful articles for dark night operations is "luminous tape." This tape, if placed on the ground and secured by stakes, metal rods or stones, is prevented from being shifted by the wind. The "tape layer" places the tape in position during the day, choosing a safe path across the country, and diverting from the straight path according to the condition of the ground. The path should be wide enough for men to march four abreast up one side of the tape and returning the other side, say, in all about 12 feet wide. Where this is not possible the tape layer makes a break in the tape every few yards, and starts again continuously when the path is wider. Any obstacle in the way, such as a tree or post, could have a small length of tape tied around it (see Fig. 3).

Should a ditch come across the path he would lay short pieces of the tape at right angles on either side of the ditch. In case of the ditch being over 4 feet deep, the man should have a luminous beacon with him and write on it the depth of the ditch, also the width, with a special pencil, and place it by the tape, when near the ditch.

It is readily possible to form large letters out of this tape by nailing it up with zinc nails. Such signs as "Fireman," "Doctor," etc., also direction arrows prove extremely serviceable, see Fig. 3.

The luminious tape is also very useful for the work of the medical corps—the tape-layer by daylight choosing fairly level ground to guide the stretcher bearers—thus saving their labor in the dark, with less jolting to the wounded. Moreover, lamps afford a mark for the enemy—whereas the tape can only be seen by those *immediately over it*—enabling work to be done silently in the dark, the darker the better.

Signaling in the front line trenches at night is always a precarious undertaking. Luminous paint beacons have been used very successfully for signaling silently by night. They are specially useful in trenches which are in close proximity to the enemy, saving the need of whispering the words of command, which causes a hushing sound, when complete silence is required for listening to the enemies' movements. These luminous beacons will carry a message a distance of 20 yards or 60 feet; sufficient for all average requirements. The signaling can be either done with the Morse code or by describing large capital letters of the alphabet the reverse way, and by the hand waving them in the air. The Royal Engineers of the English army are said to have been the first to use these novel, yet wonderful signaling devices.

TO TELEGRAPH PHOTOS BETWEEN BERLIN AND CONSTANTINOPLE BY KORN SYSTEM.

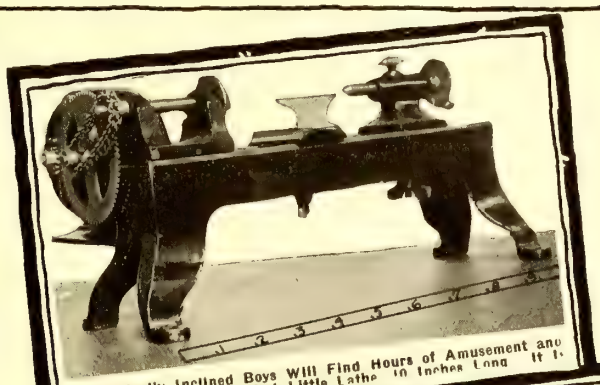
It is reported that Dr. Korn, the eminent German scientist, proposes to introduce his system for the telegraphic transmission of pictures on the Berlin-Vienna-Sophia-Constantinople-Bagdad route.

For this purpose either telegraphic or telephonic connections can be utilized. So far as telephone connections are concerned, one could conceive stations at Vienna and Budapest in connection with Berlin, the lines being occupied for a quarter of an hour only. In these circumstances pictures of an event taking place in the afternoon could appear the next day in the Vienna journals. Transmission for longer distances, such as from Berlin to Constantinople, would involve the use of telegraphic lines, which would enable an ordinary photograph to be transmitted in about an hour. The chief expense involved is the occupation of telegraph and telephone lines between such distances, but it is thought that the governments of the four countries concerned might grant very moderate rates if the lines were only used during hours when there is little or no traffic.

ELECTRIC XMAS TOYS



This Experimental Electric Outfit Contains 24 Pieces of Apparatus, Accompanied by An Instruction Book, Which Will Charm Any Boy for Days. The Owner Makes His Own "Juice." Explicit Examples Are Given for Making 1000 Different Experiments, Each One Illustrating Forcibly Some Important Electrical Law.

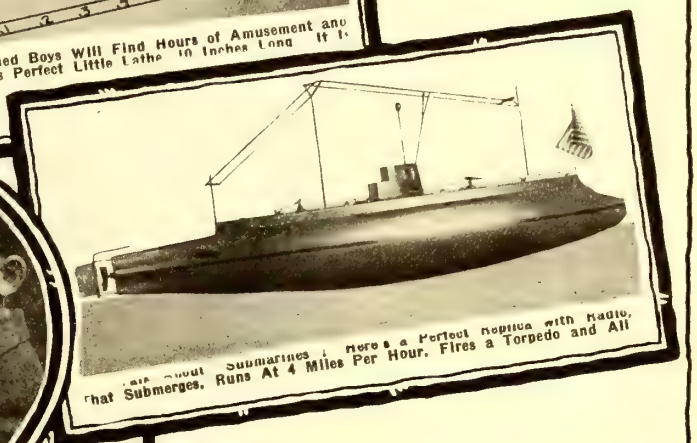


Mechanically Inclined Boys Will Find Hours of Amusement and Instruction In This Perfect Little Lathe 10 Inches Long. It Is Driven by An Electric Motor.





very Boy Will Enjoy a Toy Telephone



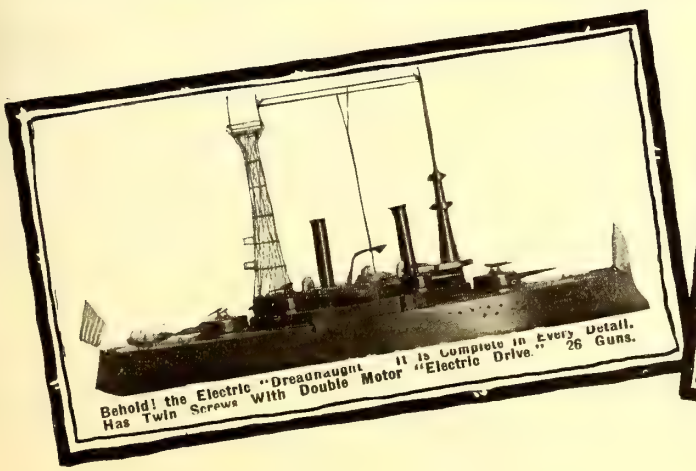
...about Submarines? Here's a Perfect Replica with Radio, That Submerges, Runs At 4 Miles Per Hour, Fires a Torpedo and All



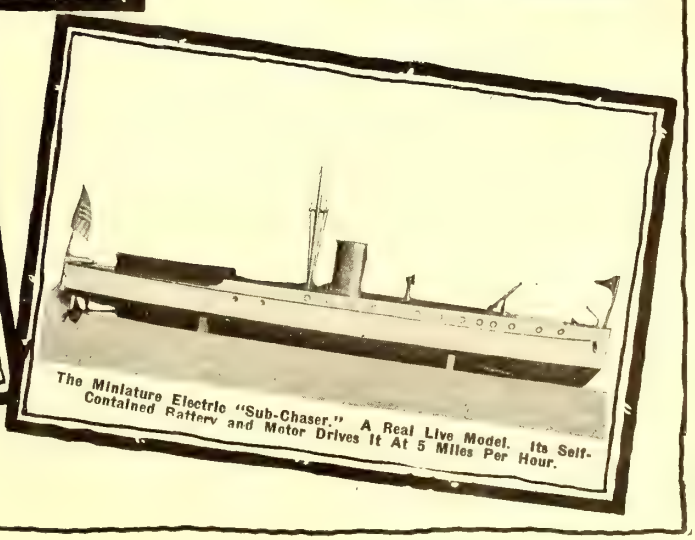
A Real Xmas Delight for Boys and Girls. This Toy Electric Stove Really Bakes Like Mother's. Perfectly Safe and Attaches to Any Lamp Socket.



The Electric "Teddy Bear"—Pushing the Button Lights His Eyes. Concealed Battery in Bear Supplies Current.



Behold! the Electric "Dreadnaught"—It Is Complete in Every Detail. Has Twin Screws With Double Motor "Electric Drive." 26 Guns.



The Miniature Electric "Sub-Chaser." A Real Live Model. Its Self-Contained Battery and Motor Drives It At 5 Miles Per Hour.

Daylight Signaling With Electric Searchlight

WHILE the electric searchlight is used very often for signaling purposes at night, by means of a suitable shutter device, enabling the operator to send out short and long flashes of light corresponding to the signals of the telegraphic code, it seems somewhat paradoxical to think of signaling in broad daylight with a small electric searchlight.

Such is the case, however, as the accompanying photograph tends to corroborate, this particular illustration showing a member of the French Signal Corps in the act of signaling to an aeroplane in flight.

While very efficient wireless communication apparatus have been developed for aircraft requirements, the range is somewhat limited under certain conditions, and this improved scheme of signaling in daytime as well as night, for carrying on communication between two or more aeroplanes or between an aeroplane and the ground, comes as a very welcome auxiliary to the aforesaid means of signaling gun ranges, etc.

As our front cover illustration shows, as well as the accompanying official photograph, the miniature searchlight used for carrying on communication by means of short and long flashes of light corresponding to the dots and dashes of the telegraphic code, is a very simple affair, and not as cumbersome as might be imagined off hand. When the searchlight is to be used, it is held in the hands of the operator in such a manner that it will bring the telescope into sighting position, the telescope member being attached to the top of the searchlight frame. The operator then aims the searchlight at the aeroplane with which communication is to be establisht and maintained. He then transmits the message by means of a telegraph key mounted on the side of the searchlight.

In this way, long and short flashes of light are sent out, spelling out the desired words or numerals in the telegraphic code. The telescope enables the operator to see the distant flashes of the answering light beam from the aeroplane, and thus it becomes possible to carry on communication both ways.

The searchlight is operated from a portable storage battery, which is contained in the carrying case, shown in the illustration, the case being provided with suitable rheostat and control switches, so that the light may be burnt constantly at the highest efficiency.

The entire outfit, altho it has a range of 10,000 feet or approximately two miles in broad daylight, and about twice this range at night, is very light in weight. It might be imagined that such a beam of light used for important and secret communication with a signal corps post on land, might be intercepted by the enemy, but such is not the case, and besides if such a state of affairs should happen to occur, it is quite possible that the enemy would not gain much valuable information. This is so for the reason that these messages are sent in a special cipher, and moreover the make-up of the code is changed frequently.

In order that the aviator may know where to look for these visual signals, the land operator is stationed near a sort of tent, made of four brightly colored cloth strips, as portrayed graphically on our front cover. From above, these strips appear as a bright cross, visible from a great height. Below, on the ground is placed another piece of cloth showing the aeroplane insignia, in this case the newly adopted red central spot on a white field, surrounded by a blue star—the American colors.



Photo © By International Film Service

The French Army Has Recently Perfected a Miniature Searchlight and Telescope for Signaling To and From Aircraft in Daylight, as Well as at Night. It Has a Range of Two Miles in Broad Daylight.

The winds at Curacao are so steady that three wireless stations depend upon wind mills for power.

GRAVITY REVERSED.

Absolute proof that the gravitational attraction between masses of matter varies with changes in their electrical potential due to electrical charges upon them has been obtained by Dr. Francis E. Nipher in a whole year of experiments in the private laboratory of Washington University, St. Louis, financially backed by the Carnegie Institution.

Dr. Nipher is one of the greatest authorities in the world on electrical measurements and the nature of electric currents.

He suspended two spheres of lead, one inch in diameter, from silk fibres about 5 feet 8 inches long inside an insulating screen specially constructed of wood, metal, cardboard, wax and glass, with a layer of air in the middle, and cut off radiation from the sky and all changes in temperature. Spheres of lead ten inches in diameter were adjustably mounted below and a telescope was set to peer thru a slit in the screen, opposite to a specially designed scale.

An influence machine, driven by a single phase motor, was used for varying the electrical potential in the lead spheres.

Dr. Nipher not only diminished the gravitational attraction by charges of electricity upon the large spheres, but he reduced it to zero and then turned it into repulsion. He was able to measure this repulsion, and at times it reached a decrease of 250 per cent in the normal value of the gravitational attraction.

HIST! GERMAN RADIO SPIES.

The wireless operator at division headquarters at one of the National Army camps got a shock recently that will not be duplicated until the troops start "over the top."

He was playing idly with the condensers of his apparatus trying to pick up a word or two from Arlington or Honolulu and not getting much when the receivers began to crack:

"C-Q" came the general call. "C-Q"—"C-Q."

And the character of the spark showed that the sending instrument was close at hand. All the sleuths of the signal corps prepared to chase this interloper to his lair.

He began to have visions of illegal plants hidden in the bayous of the gulf coast—of spies carrying on their work under the very fence of the camp.

"Who are you?" he flashed at once. "By what right are you operating a radio?"

It's hard luck to spoil a thrilling story like this, but right here the whole plot blew up.

"I'm Jones," came the answer at a rate of about 20 words a minute. "I'm Jones, sending from the 124th field artillery—use of set approved by Lieutenant-Colonel H. B. Hackett. Nice evening, isn't it?"

DATE OF ISSUE.—*As many of our readers have recently become unduly agitated as to when they could obtain* THE ELECTRICAL EXPERIMENTER, *we wish to state that the newsstands have the journal on sale between the twelfth and the eighteenth of the month in the eastern part of the United States and about the twentieth of the month west of the Mississippi River. Our subscribers should be in possession of their copies at these dates. Kindly bear in mind, however, that publications are not handled with the same dispatch by the Post Office as a letter. For this reason delays are frequent, therefore kindly be patient and do not send us complaints as to non-arrival of your copy before the twenty-fifth of the month.*

The Marvels of Radio-Activity

By JEROME S. MARCUS, B.Sc. (Ch. E.)

PART IV. (Conclusion.)

Heat Emission of Radio-Active Matter.

IN 1903, it was shown by Curie and Laborde that a *radium compound* was always hotter than the surrounding air and radiated heat at a constant rate of 118 gram calories per hour per gram of radium. This means that a gram of radium, or 0.0028 pound, will boil about 0.0045 pound of water every hour. Enough radium properly contained, would run a boiler continuously with only the addition of water. There is now no doubt that the evolution of heat by radium, and other radio-active substances, is a secondary phenomenon resulting mainly from the expulsion of *alpha* particles. Since the latter have a large kinetic energy due to their high velocity, and are easily stopt by matter, they are absorbed by the radium itself or its immediate container, and the energy of motion is converted into heat. From this, the evolution of heat is proportional to the time and number of alpha particles expelled, as the kinetic energy transformed is in turn dependent on the expelled particles. Rutherford and Barnes first confirmed this view by their experiments. They showed that emanation and the following products were responsible for about three-fourths of the heat evolved by radium in equilibrium.

The heating effect decays with the activity, as observed in studies of emanation. The products radium A, and radium C, each have a heating effect proportional to their activity. Measurements of the heating effect of thorium, uranium, pitchblende, and polonium have been made, the evolution of heat being in each case proportional to the kinetic energy of the alpha particles.

An enormous amount of energy accompanies the transformation of radio-active matter where alpha particles are emitted. It must be remembered that these particles are themselves matter, as was said before, and hence have energy when traveling at a high rate of speed, just as does a thrown baseball, for example, the emanation from one gram of radium in equilibrium, with its products, emits heat initially at the rate of 90 gram calories per hour. The total heat emitted during its transformation is about 12,000 gram calories, enough heat to change 0.12 pound of ice into steam. Since the initial volume of the emanation from one gram of radium is 0.06 cubic centimeters, one cubic centimeter of emanation will emit during its lifetime 20,000,000 gram calories of heat. Now taking the atomic weight of the emanation as 222, one gram, or 0.0022 pound, of radium emanation will

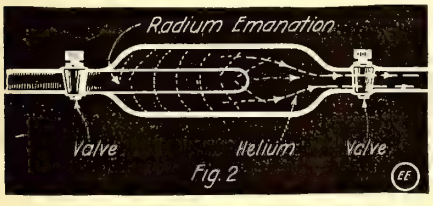


Fig. 2.—Apparatus Used in Producing Helium from Radium Emanation. The Alpha Rays Pass Thru the Thin Glass Inner Wall and Produce Helium.

give off 2,000,000,000 gram calories of heat.

Let us assume a boiler that evaporates 100 pounds of water per hour at normal boiling point and atmospheric pressure, the temperature of the water to be 15° C, or 60° F. Then, neglecting the absorption of heat by the boiler itself, the heat necessary per hour will be 100x (100—15) x1000/2.2. or 3,863,000 gram calories (1000 grams equals 2.2 pounds, and 100—15 or 85° is the rise in temperature). Then dividing 2,000,000,000 by 3,863,000 we have 516.7. So one gram of radium emanation will, by decaying, give off enough heat to run such a boiler 516.7 hours continuously, evaporating 51,670 pounds of water. (See Fig. 1.)

This evolution of heat is really enormous compared with that emitted by any known chemical reaction. And there is every reason to believe that the total evolution of energy from any type of radio-active matter during transformation is of similar proportions to that of the radium emanation. The atoms of matter must consequently be regarded as containing enormous stores of energy, which are released by the disintegration of the atom. Investigations along the lines of the electronic theory of atomic structure bear out this view.*

Production of Helium

In 1902 Rutherford and Soddy suggested that the helium which is invariably found accompanying radio-active minerals was derived from the breaking up of the radio-active matter. A year later Ramsay and Soddy, in their famous researches which recalled to us thru newspaper comment the old alchemy, definitely showed that helium, a gas we consider as an individual element, was produced by radium and also by its emanation. The presence of helium in the atmosphere of the sun is one of the arguments for radio-active matter in the body of the sun itself. It seemed very probable, that from its observed mass, the alpha particle was an atom of helium. This was proven by the work of Rutherford and Geiger who showed the alpha particle to be an atom of helium, carrying two unit charges of electricity. Hence, a form of transmutation of matter according to our general theories of chemistry has really taken place.

In order to prove this definitely, it was necessary to show that the alpha particles themselves give rise to helium. Rutherford and Rayes did this by allowing the alpha rays from a large amount of emanation to pass thru the very thin glass walls of the containing tube. The collected particles gave the spectrum of helium, proving them to be indubitably helium atoms. (Fig. 2.)

Hence, all radio-active matter expelling alpha particles gives rise to helium. The rate of production of helium as calculated by Rutherford and Geiger, who counted the particles and measured their charge, should be 158 cubic millimeters per year. Think of working with a quantity so small! A close agreement is shown by the observations of Boltwood and Rutherford, who found the production to be 163 cubic millimeters per year.

Products of Radium

The successive transformations of radium were shown in the table in the last article (part III) of this series. When a wire charged negatively has been exposed for some time to radium emanation it becomes coated with a thin film of radium A, B, and C. About twenty minutes after the removal of the wire from the emanation, radium A has practically disappeared and the rays arise entirely from radium C. This has proven of great value in measurements, as radium C is a source of an intense homogeneous alpha radiation. The wire, however, still shows a residual activity, very

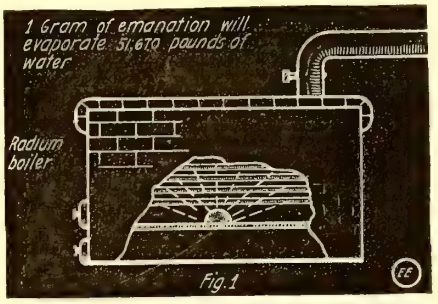


Fig. 1.—A Theoretical Radium Boiler. One Gram of Radium Emanation Will Evaporate 51,670 Pounds of Water, Before It Becomes Exhausted.

small and reaching a maximum in about three years. The slow change, of course, consists in the successive transformations in the series.

Radium D is rayless, and of a calculated period of 17 years. It was at first thought that radium E was complex, but no special evidence has been observed. Radium F is identical with polonium, the first active material separated by Mme. Curie. Similarly, radium D is the source of activity in "Radio-lead."

It is interesting to note the valuable results acquired from the observation of the extremely minute residual deposits from emanation.

Radium Emanation

The radium emanation has been purified by condensing it in liquid air, and then pumping off the residual gases. In a pure state the emanation is, weight for weight, 100,000 times as active as pure radium. Pure emanation in a spectrum tube gives characteristic bright lines. The electrical discharge in the gas (Geissler tube action) is of a bluish color, continued sparking driving the emanation into the tube walls and electrodes. Even with the minute quantities obtainable, the boiling point has been determined as 71° C. When first condensed, liquid emanation is colorless, at lower temperatures it freezes, while at the temperature of liquid air it has a bright rose-colored glow. The density of liquid emanation is about 5.5.

The emanation has definite chemical properties, and belongs to the group of monatomic inert gases, with argon, helium, etc. It is somewhat soluble in water, and readily absorbed by charcoal.

A large amount of work has been done in measuring the amount of thorium and radium emanation in the atmosphere, and in determining the quantity of radium and thorium in the earth's surface. Important theories regarding atmospheric electricity (the *aurora borealis*, etc.) and bearing on geology are based on this work.

Origin of Radium

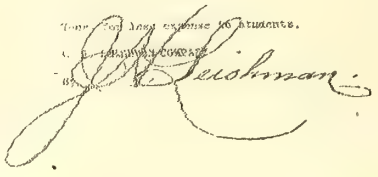
Radium is separated from the two uranium minerals, pitchblende and carnotite, the former coming from Austria, and the

(*Continued on page* 572)

* A few years ago, H. G. Wells, in a story appearing in *The Century Magazine*, used this energy as a weapon in the world war which he predicted. The story is really fascinating.

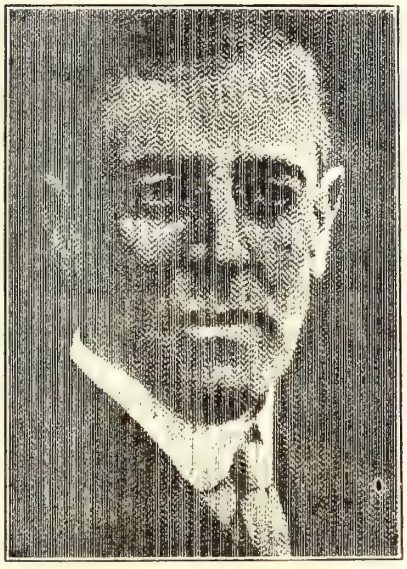
How I Telegraph Pictures

By



THE ELECTRICAL EXPERIMENTER has asked me to explain to its readers my system for the transmission of pictures by electricity —i.e., *Telegraphing pictures.* The actual workings of the instruments have never before been explained in detail to the readers of any periodical.

The idea of telegraphing pictures is not new; in fact, a scheme for accomplishing this was suggested fully seventy years ago. Of recent years, most experimenters that have entered this field have made use of the peculiar property of *selenium* for changing its electrical resistance when exposed to light. My system is far less complicated and expensive than those using selenium, and it is possible by its use to receive a very clear and distinct picture at almost twice the speed heretofore obtainable. It is needless to say that I make use of principles entirely different from those upon which other machines are based. This is due to the fact that I entered this field entirely ignorant of any other single wire system, my entire attention having previously been given to certain mathematical instruments.



Photograph of President Wilson As Reproduced At Distant End of Telegraph Circuit By Mr. Leishman's Recently Perfected Apparatus.

In order to make this discussion within the understanding of all, I shall avoid all technical language and make the explanation as simple as possible. Let it first be understood that the telegraphing of pictures is not *television;* it does not make it possible to *see* the person to whom you are telephoning, as that would necessitate the transmission of moving pictures, or about seventeen pictures per second. At the present time, such a thing is impossible for both electrical and mechanical reasons. It *is* possible, however, to send and receive *one* picture in a very few minutes. Some people ask what would happen should the picture collide with a building. This, as readers of THE ELECTRICAL EXPERIMENTER probably know, cannot happen because the actual picture being transmitted remains at the sending machine, a reproduction being effected at the receiving end by the building up of minute portions, one at a time, until the entire picture is received.

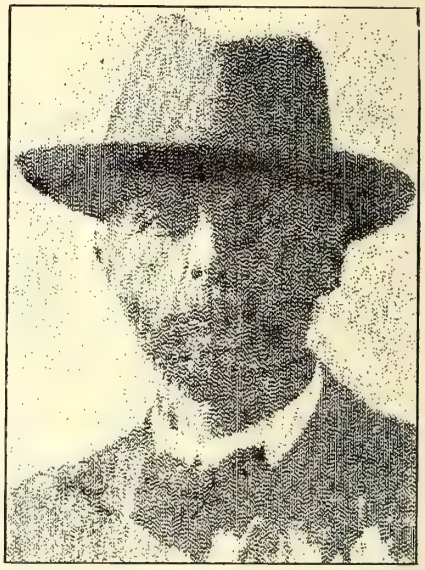
The telegraphing of pictures therefore resolves itself into the following distinct elements: A means for gradually covering the entire surface of the picture by some device capable of translating the light and the shade of the picture into pulsations or variations of an electrical current; and a means for successively recording these pulsations or variations in the form of what appears to be graduations of light and shade.

How I accomplish these things can best be shown by first explaining how the tiny parts of the picture are successively transmitted and recorded. Obviously, this can best be done by an arrangement similar to a cylinder phonograph or dictating machine, both the sending and receiving instruments using this mechanism. The carriage that is sending or receiving, gradually progresses from one end of the cylinder to the other on a spiral or screw, and the picture itself rotates on the cylinder. This makes it possible for all parts of the picture to be covered in the same succession at both ends of the line. The cylinders must of course revolve in exact *synchronism* to prevent distortion, but for the sake of clearness this will be explained later.

The next problem is that of causing light and shade to affect the passage of an electrical current. This, of course, properly constitutes the sending device. As previously stated, some systems vary an electrical current by causing the light and shade of the picture to act upon a portion of selenium thru which the current passes. This is a very direct way of solving the problem, because there must be an "eye" that recognizes light and shade and that will vary an electrical current accordingly. It is possible, however, to accomplish this in an easier, cheaper and less complicated way. I perceived immediately that a picture composed all of black and white could be made to make and break a current by forming the black or white on an insulating material upon a metal plate and causing a current to pass from the plate to a tracing needle, so that the insulating parts would break the said current.



Mr. Leishman and His Machine For Telegraphing Pictures, Photos, Script, Etc., Over Telegraph Or Telephone Lines.



Another Sample of the Work Which the Leishman Machine Will Reproduce In a Few Minutes Over Existing Telegraph Circuits.

This idea then had to be elaborated upon to permit the transmission of a *half-tone.* All newspaper half-tones, and the great majority of those in magazines, are really composed entirely of black or white; that is, any given point is either the one or the other. Examine one of these pictures closely and you will find it to be composed entirely of little black dots, the shaded effect being an optical illusion due to the size of the dots. There are a fixt number of these dots to the linear inch, varying in newspaper work from forty to eighty. If the half-tone is what is known as sixty screen, then there are sixty dots to the linear inch; and the light and shade, as before stated, is produced by the size of the dots, the lighter portions having *small dots* and the larger portions *large dots* that sometimes join and produce a mass of black.

These dots may of course be formed of insulation and will break the current for a period of time proportionate to their size. This is the general idea of transmitting a half-tone.

Before explaining the exact operation of my picture transmitting device, it may be well to explain the method of preparing the half-tone in order to obtain the insulating dots. For this, I follow up to a certain point the regular process of photo-engraving. The picture to be transmitted is first photographed thru a screen, the function of which is to break up the picture into dots whose sizes vary as previously explained. A copper or zinc plate is then

coated with a solution of glue, bichromat of ammonia and water. This is placed in contact with the developed negative and is exposed to strong light. The bichromat of ammonia is the element acted upon. When the plate is washed, the part that has not received the light washes away, leaving the rest fixt to the plate. Upon heating, the gelatine picture turns to a chocolate color. The regular photo-engraving process goes still further, but this is all that is necessary in the preparation of a picture for transmission, as the dark portions form a very thin and highly satisfactory insulation.

The plate is then rolled into a thin cylinder and slipt over the cylinder of the machine. The transmitting carriage consists of an arm into the end of which may be screwed an ordinary phonograph needle, which is held against the plate by a spring. A current passes between the needle and the cylinder excepting when an insulating dot passes beneath the needle. As previously explained, the mechanism permits the needle to cover every part of the picture. In this manner a picture is transmitted.

At the receiving end of the line, the current from the transmitting machine passes thru the coils of the electro-magnets on the receiving carriage. These attract a very light armature, causing the saffire or diamond in the forward end to press against the cylinder. This pressure does the recording. The stylus may be made to cut a stencil; scratch camphor smoke from white enameled paper; scrape white wax from dark paper; or press upon a carbon sheet, thereby recording and reproducing the picture upon ordinary paper. *The pictures illustrating this article were received by the latter method.* In this manner, all the dots on the sending machine are accurately reproduced on the paper at the receiving end. These dots, since they vary in size according to the light and shade of the picture, form an excellent half-tone likeness of the original object.

Some of the readers of this article may wonder why the recording is not done by making a pen out of the receiving stylus and causing it to write upon ordinary paper. The reason lies in the fact that a pen and ink arrangement is necessarily more complex than the system above explained; it gets out of order easier, and when recording at the rate of *two hundred and fifty-one dots per second,* which is the speed at which a picture is recorded, it is not as efficient as the methods described.

The construction of the receiving arm should be very light to overcome friction, gravity and inertia. It should also be sufficiently stiff to avoid vibration. Friction can be very largely eliminated by using jeweled bearings. The electro-magnets used for actuating this arm may be polarized so that the current has merely to change the degree of magnetization. It is possible to make a receiving carriage that will respond to feebler impulses, but this is not as desirable as speed.

By connecting a rheostat in series with the receiving carriage, the current can be adjusted to make the receiving arm record as efficiently as possible, and pictures can be made lighter or darker at will.

There is another detail worth mentioning in regard to the sending apparatus. Unless some means is taken to prevent it, a spark forms at the break of the current, which of course takes place as an insulating dot passes under the needle. This can be prevented in three ways. One terminal of a condenser may be connected to the cylinder,



This Reproduction of a Photograph By the Leishman Process Shows Particularly Well the Way In Which Features Are Brought Out. Hold Picture at Arm's Length to Obtain Best Effect.

and the other to the needle; or enough resistance may be introduced into the line to absorb the energy; or resistance may be shunted across the gap so that the current at break merely becomes too weak for the electro-magnets at the receiving machine to attract the recording arm. The latter plan has the advantage of reducing what may be called the inertia of the line, due to its capacity and inductance. This, however, is of little consequence excepting in long distance work.

So far as the use of this system with wires is concerned, there remains to be discust only the *synchronizing* of the sending and receiving cylinders. It sometimes happens that power is furnished from the same generator at fairly distant points. In this instance, synchronism is merely a matter of using synchronous induction motors. But in the great majority of cases, no such convenience may be resorted to. It is then best to use direct current motors operated by storage batteries with a sliding contact rheostat in the circuit.

The operator of the receiving instrument watches the recording of the picture; and, if the machines are not in perfect synchronism, he is warned by a deviation of the straight lines formed by the picture's upper and lower borders. If the line turns in one direction, his motor is going too slow, so he cuts out some of the resistance. An opposite deviation warns him to move the handle of the rheostat the other way. When storage batteries are used, the current is steady and very little adjusting of the rheostat is required.

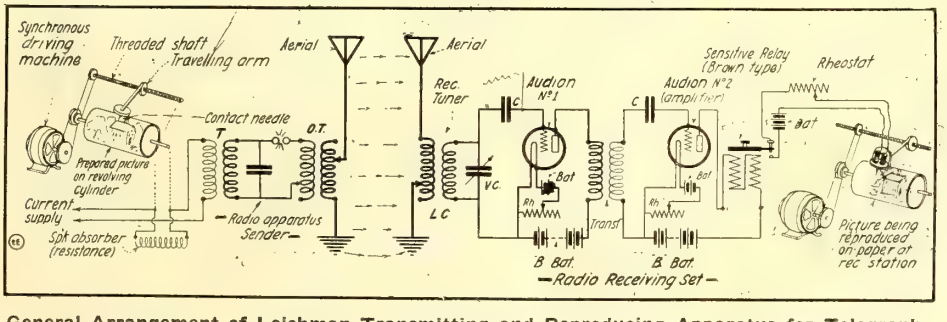
Automatic synchronization is of course desirable. One means of doing this, which greatly interferes with speed, very much resembles the method used by the Western Union Telegraph Company for hourly correcting their "standard time" clocks. At each revolution of the sending cylinder a heavy current is sent to the receiving machine, magnetically correcting the cylinder by stopping it momentarily. Some such means for synchronizing is absolutely necessary where the recording is not visible; but where the recording can be seen, manual control, of the nature described, may be used, altho mechanical synchronizing is preferable. I have recently designed a machine for this purpose—one that is far ahead of the system described above, but at the present time, I do not wish to disclose the details. The system permits the cylinders to revolve continuously, and the receiving machine may be started and stopt from the transmitting end.

A good deal has been said regarding the operation of my system by *radio.* It will be obvious that the transmitting apparatus may be connected into the circuit instead of the wireless key, and the picture transmitted in the usual manner. At the receiving end, an Audion detector and amplifier make the signals sufficiently strong to operate a relay, and this throws in a local circuit to record the picture.

It may be of interest that I have recently applied for a patent on an entirely different method of transmitting photographs, this scheme permitting the cylinders to revolve at about ten revolutions per second. This particular apparatus makes use of the automatic control previously mentioned. On this system, gravity and inertia have no effect, and all friction is eliminated, excepting that caused by the turning of the cylinders.

At the beginning of this article it was stated that *tele-vision* is at present impossible for both mechanical and electrical reasons. These facts are interesting, and I wish to mention them for the benefit of all electrical experimenters. As before explained, the best moving pictures require *seventeen flashes a second.* For the sake of explanation, let us consider the transmission of one picture per second, and let the picture be one of the easiest to transmit—a portrait, for instance. The picture should be gone over from top to bottom by the electric "eye" in the neighborhood of four hundred times. This would necessitate

(*Continued on page* 572)



General Arrangement of Leishman Transmitting and Reproducing Apparatus for Telegraphing a Picture Via Wireless.

PHOTOGRAPHING LIGHTNING.

To many timid persons the fine art—for art it really is—of snap-shotting "lightning" is actually about the most dangerous job to



An Excellent Photograph of Ribbon Lightning Taken in Iowa the Past Summer. This Is What We Mean by "Odd Photos."

be found. But many amateurs and professionals have taken excellent photographs of lightning discharges and still live to tell the tale. For instance witness the accompanying photo taken last summer by the Rev. C. Lilie, of Iowa.

To take a good "lightning" photo is more often than not a matter of pure chance. Having loaded up the camera, the first thing to do is to open the shutter for a time exposure; as soon as the first flash appears close the shutter quickly. The job is done. Simply develop the plate in the usual manner. *Heat* or *flash* lightning will give peculiar results. The writer took several photos of *heat* lightning recently and the results are—an ordinary photograph of the surrounding landscape, just as if the sun had been shining. Combinations of *forked* and heat lightning often yield excellent pictures. Chain or forked lightning will produce a startling photo if the camera is swung from side to side while taking the picture.

ELECTRICITY AND GOLD FISHES.

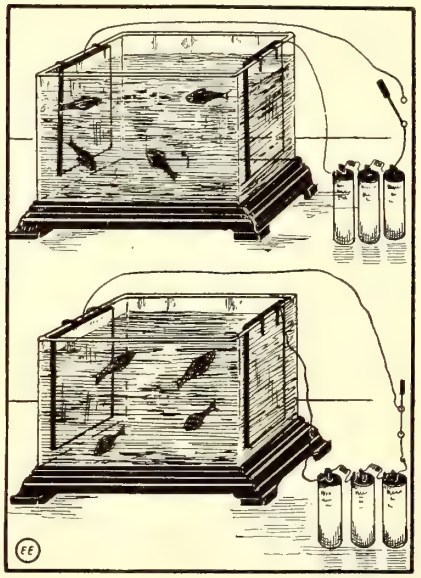
By H. Gernsback

Not so long ago, the writer, while watching some gold fishes at play in his aquarium had the idea of testing the fishes as to the effect electricity would have upon these highly sensitive animals. Accordingly two metal plates were sunk into the tank as shown in the illustration, and three batteries were connected to the two plates.

A curious thing at once happened. Using a current of three dry cells and upon closing the switch, all the fish immediately *grouped themselves parallel with the plates* and as long as the current was left on the fish remained in this position, refusing to swim or move in any other way but parallel to the plates.

The explanation of this phenomenon of course is that the current traveling from plate to plate, traverses the fishes' bodies, and as a fish is longer than it is wide, and as it is quite sensitive to the electrical current, it follows that inasmuch as the current probably proved disagreeable to the animal, it presented the shortest path to the current by placing itself parallel to the plates. It seems the fish did not cherish the idea of taking the full strength of the current thru the nose and mouth and thence thru the sensitive fins of the tail.

Another thing observed was, that the moment the switch was closed, there was a certain amount of excitement among the fish and if the closing and the opening of the switch was kept up, they would dart around in a most extraordinary manner, while thus under the influence of the current. As soon as the current was turned on and left on, however, the fish did not seem to be uncomfortable except that they only moved parallel with the plates as above mentioned. Another point observed was that while under the influence of the electrical current, the fish refused to come up and feed tho quite hungry, having gone without food for twenty-four hours. The instant the current was disconnected, the fish immediately would begin feeding, but did not seem to be quite so anxious as at other times. This would tend to show that the electrical current was not of immediate benefit to them, altho this can not be vouchsafed, the experiment having not extended over a sufficiently long period. At any rate, the fish did not seem to be harmed by the continuous application of the current, and after a few hours, seemed to be as lively as ever.



When Battery Current Was Connected to Two Metal Plates in a Gold Fish Aquarium, the Fish Immediately Grouped Themselves Parallel With the Plates, as Shown in Lower Cut.

Alternating current from a step-down toy transformer was also tried, but strange to say the fish were hardly affected by this form of current. This was rather unexpected, inasmuch as a rather convulsive action of the fish was thought to take place.

ELECTRICITY WASHES CLOTHES FOR U. S. TARS.

"Somewhere on the Atlantic," electricity is "taking in washing"—doing good work for Uncle Sam's Tars. On the supply, or "mother," ship an American electric laundry is operated, said to be the most complete and modern ever seen in that part of the world. The "boys" report that the work is perfect, and prices less than half those at home. One of the features of the ship's laundry is a complete soap factory.

NURSERY RHYMES TO DATE.

By John T. Dwyer.

Sing a song of sixpence,
Of "muckers" brave and bold,
Who turn the household upside down
In search of things untold—
Pins and needles; clocks and jars,
All articles of use
Are soon upon the missing list,
When a "mucker" is turned loose.

* * * * * * *

Little Jack Horner,
Sat in a corner
Eating a CURRENT pie.
He put in his thumb,
And then cried, "by gum!
This is SHOCKING indeed, Oh! my."

* * * * * * * *

There is a fellow in our town
And he is wondrous wise,
The things he doesn't know about
Would fill a "skeeter's" eyes.

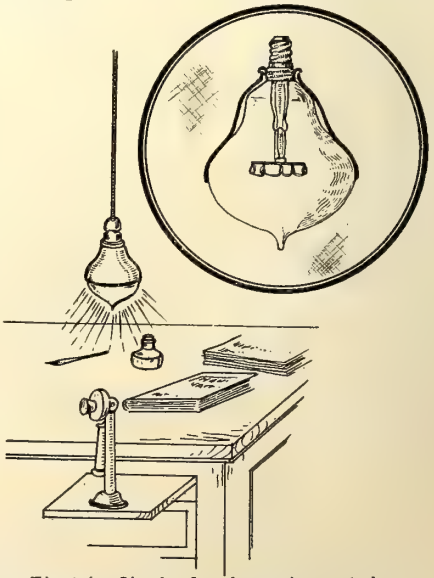
Now, it's got some folks a'guessing
How he could get such knowledge,
The more so, when they do consider
That he never went to college.

But to me the matter's simple—
And the reason can be seen;
He's merely one of many more
WHO READ THIS MAGAZINE.

NOVEL SHADE FOR INCANDESCENT LAMPS.

A simple design for an efficient incandescent lamp shade is described in a U. S. patent recently issued to Frederick R. Pope of London, England. This invention describes a type of shade which closely surrounds the upper portion of the lamp bulb, and which also serves as a reflector to direct and concentrate the light rays. It is claimed to be particularly efficient in locations where the supporting structure for the lamp is subject to a heavy vibration, as in factories and like places.

The arrangement, in brief, comprises an annular threaded collar, which screws on to a threaded sleeve on the lamp base proper. The collar is preferably U-shaped in cross-section, and forms a seat for a flange formed on the narrow end or neck of the shade. The shade may be of porcelain or any other material suitable for the purpose. It is very easy to replace the shade at any time, as the shade as well as the retaining collar both slip over the lamp base, as they are both of larger diameter than the screw plug forming the base of the lamp.



An Electric Shade for Incandescent Lamps That Screws Onto a Threaded Collar, so as to Be Supported by the Lamp Itself.

ELECTRICALLY HEATING THE FISH TANK.

The advantages to be obtained from the heat of electric energy are many and great, both as regards thermal efficiency as well as ease of application. Greater thermal efficiency is obtained in that electric energy is transformed into heat at 100% efficiency and is utilized at from 3½ to 4 times the efficiency of fuel combustion devices.

Here we have the Fish Tank electric heater. The customer has an aquarium in his residence containing fish brought from a warm climate. This necessitates warming the water which is accomplisht by installing a heater of the immersion type in the feed pipe supplying water to the tank. This heater unit is indicated by the arrow in the photograph.

Among other things, electrically made heat is clean, safe and sanitary. It can be used in any atmosphere and generated in any quantity or at any temperature desired. By its use the fire hazard is greatly reduced and the working conditions of labor vastly improved. It is susceptible of perfect and automatic control as regards localization, time and temperature to an extent not yet attained with any other method, and exact conditions can be duplicated at will.

The heating unit is invariably small, compact and substantially built, which allows of greater flexibility in application than with any other heating device. When applied to various industries or processes of those industries each unit has its own specific advantage.

In heating of liquids, melting of metal in pots and hotplate work, the units are so shaped and embedded in the apparatus used and of such thermal characteristics as to accomplish the work with the least possible expenditure of time and energy and at highest efficiency.

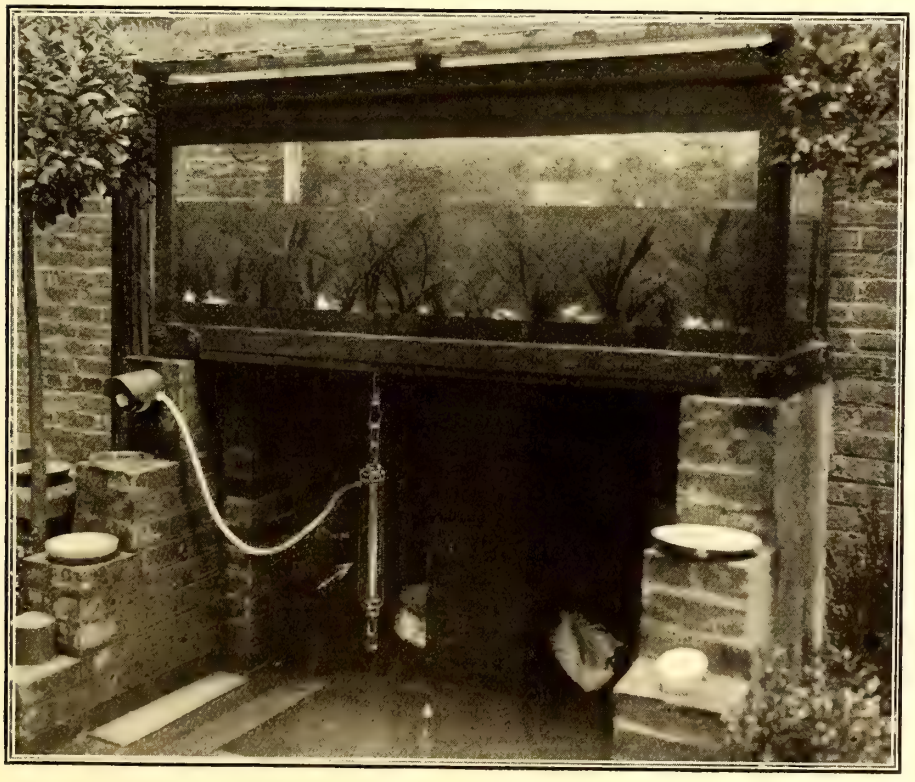


Photo Courtesy Society for Electrical Development

This Picture Shows How an Electrical Heater (See Arrow) Was Adapted to Warm the Water in a Fish Tank Containing Tropical Members of the Finny Tribe.

"GIVE SOMETHING ELECTRICAL THIS CHRISTMAS."

Higher wages, consequently more money to spend; a newly created desire for conveniences and the demand for thrift are all working to make this year the banner Christmas year for the electrical industry.

The strong appeal of practical electrical gifts for the home will bring scores of people into the electrical shops where formerly they have been buying toys and knickknacks, and realizing the trend of opinion, *The Society for Electrical Development* has planned a big nation-wide Christmas Gift Campaign. The broadside announcing this Campaign has been mailed to 20,000 persons. The features of "America's Electrical Christmas" are outlined and information given regarding the display publicity material available to help the electrical industry get its share of the $200,000,000 annually spent for holiday presents.

Remembering the success of "Electrical Prosperity Week, 1915", "America's Electical Week, 1916", "Wire Your Home Time", central stations, manufacturers, jobbers and contractor-dealers will realize upon this opportunity. The electrical industry never has gotten its share of the big money spent in Christmas gifts. This is the first concerted effort in this direction, and the time is opportune for an immense business.

The sales helps being prepared for the campaign with the slogan "Give Something *Electrical* This Christmas" include a special holiday edition of the Monthly Sales Service of the Society. Timely advertising suggestions will be given and special window displays will be shown.

WOMEN MAKE GOOD RADIO OPERATORS.

The accompanying illustration shows a number of women being taught the rudiments of Radio-telegraphy at one of the leading colleges in New York City.

The photograph is reproduced thru the courtesy of the *National League for Women's Service.* These women who take up the study of wireless will find plenty to do in helping their country to win the war.



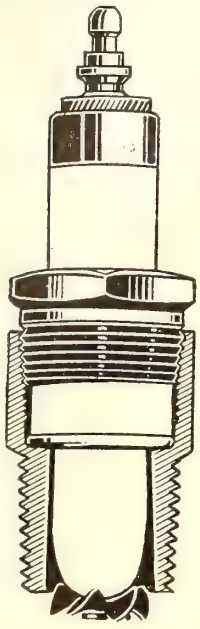
Women Radio Students Are Daily Increasing in All Parts of the Country. This Group Was Snapt Hard at Work in a New York City College.

CORRECTION NOTICE.

We wish to correct a statement made in the article entitled "Historic Electric Apparatus," which appeared in the November issue, concerning the history of "Wireless." The first trans-Atlantic radio signal (the letter "S") was recived at St. Johns, Newfoundland, instead of Cape Cod, Mass.

FAN FLAME SPARK PLUG THE LATEST.

Any plug will spark when it's new and clean. But no ordinary spark plug actually adds power to the motor, actually cleans itself, and still is so simple and sturdy in construction that it is unaffected by the most severe conditions of heat, speed and high compression, say the sponsors of the Fan Flame plug.



This Spark Plug Has a Fan Electrode That Revolves.

The center electrode of the fan flame plug terminates in a miniature rotary fan which is heat proof because it is 98% pure nickel. This fan is constantly rotated at high speed by the successive compressions and explosions.

The whirling fan produces a circle of flame instead of a mere spark. It literally throws a shower of fire in every direction, igniting the comprest gas several times as rapidly as an ordinary spark can do it.

By careful tests the makers claim to have proved that the nickel fan constantly rotates in the cylinder when the engine is in operation.

The effect of the rapidly whirling blades is to throw off all oil and soot by centrifugal force so that the sparking points are always clean, and the accumulation of soot on the rest of the plug is also retarded.

A 40,000 AMPERE SWITCH.

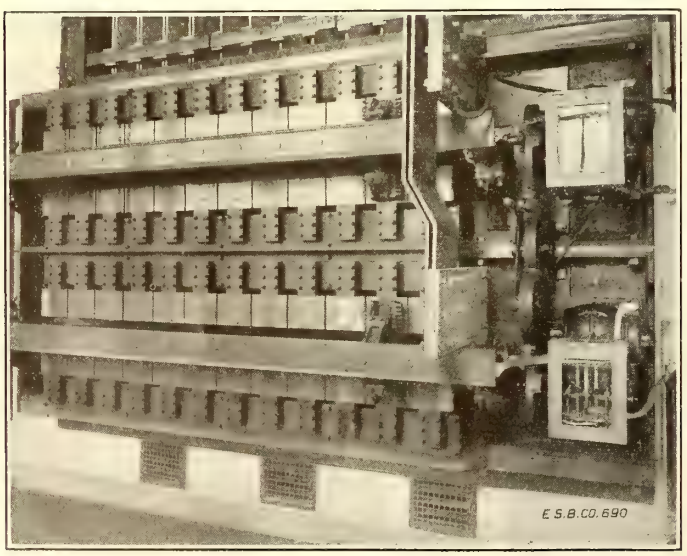
The accompanying illustration shows a remarkable end-cell storage battery switch which has a steady capacity of 10,000 amperes or a momentary load of 40,000 amperes for six minutes. It is used for regulating the voltage of storage batteries in large central stations.

The construction of the 10,000 ampere cell switches is shown clearly. Each switch has two horizontal rails of rectangular section and two rows of massive contact points, arranged alternately at the corners of an imaginary square, the four traveling brushes occupying the sides of the square. The brushes are mounted on and suitably insulated from a traveling carriage, driven by the horizontal driving screw. Two 10,000 ampere cell switches are shown in the illustration herewith.

The driving screw in each case runs the entire length of the switch, and is geared to a motor at one end. This motor is provided with semi-automatic distant control, so that the switchboard operator can start the brush in either direction from any point and bring it into full contact with any other point, but cannot stop it between two adjacent points.

Two electro-magnets, of the plunger type, located adjacent to the motor and excited selectively by the control circuit from the switchboard, serve to operate contact switches to connect the motor armature for either direction of travel, respectively. As soon as either plunger starts upward it breaks the exciting circuit of the other magnet, thus preventing any possible conflict between the two.

As soon as the motor starts, a cam wheel so geared to the motor as to make one complete revolution while the brush is traveling between two adjacent points, locks the active magnet plunger in position, thus maintaining the motor in constant action between switch points.



Rear View of the Largest Storage-Battery End-Cell Switch Ever Built. It Has a Continuous Carrying Capacity of 10,000 Amperes and a Momentary Capacity of 40,000 Amperes.

HEATING PERSONS INSTEAD OF ROOM IN WESTERN RESTAURANT.

In following up the policy of "localizing heat," a leading electric heating concern recently secured a contract covering the installation of 30 electric heaters in the Tuberculosis Sanitarium of Independent Order of Foresters in Lopez Canyon, a short distance from Los Angeles.

These heaters will be installed, without the stands, on the under side of the table in the dining-room, radiating the heat downward to strike the floor and be radiated up, by this means keeping the bodies of those at the dining table warm, rather than attempting to heat all the air in the room. In other words, they heat the *individual* instead of heating the room. Inasmuch as the diners will only be in the room 20 minutes, or half an hour during meals three times a day, it seemed unnecessary to attempt to heat the entire room, accommodating over 100 people, when it would only be occupied this short period of time.

COMBINED FLASHLIGHT AND LENS FOR DIAGNOSTIC PURPOSES.

The present invention shown in the accompanying illustration is an ingenious arrangement combining a special form of pocket flashlight with an adjustable lens holder on the side of the battery case, and also means for attaching several forms of diagnostic instruments, such as a tongue depressor, which is here shown in actual use.

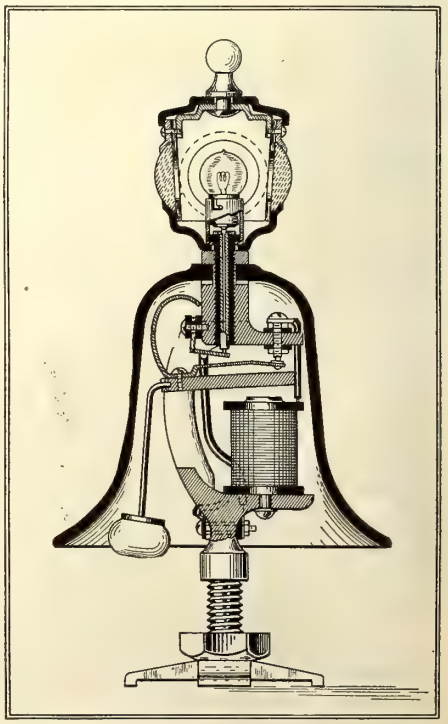
Several advantages are claimed for this particular form of flashlight diagnostic instrument; for one thing, no direct rays from the incandescent lamp are cast into the eyes of the physician, and more freedom of the hands is obtained by its use as becomes readily apparent, owing to the fact that three separate and distinct instruments are combined in one. A push-button switch is provided to open and close the lamp-circuit as desired. This idea has been patented by Hermann Weder, Sr., and Charles H. Wolff of Philadelphia, Pa.



A Recent Invention Comprises a Diagnostic Lamp, Lens, and Tongue-Depressor All in One Instrument.

UNIQUE COMBINATION SIGNALING LAMP AND BELL.

In many instances, the orthodox form of electric signal or alarm is not desirable, and with these objects in mind, Mr. Christian Reinker, an Ohio man, has devised and patented the unique combination signal lamp and bell shown in the illustration herewith. Current is supplied to the device from a battery or other source of current thru two binding posts carried on the central stem at the base of the bell, and when the circuit is closed, the bell vibrates, while the lamp remains lighted constantly, as long as the switch remains closed. The design of the signaling device is unusually artistic, the lamp being enclosed in an ornamental chamber which is provided with one or more white or colored lenses cut in the form of jewels.



Unique Electric Signaling Device for Use on Autos, etc. Pushing a Button Lights the Lamp and Rings the Bell.

OPERATING THE COFFEE CUTTER BY ELECTRIC MOTOR.

By means of the cutter shown herewith steel-cut coffee can be furnished by the grocer in bulk with convenience and at a profit. It is built along entirely different lines from any of the mills on the market, and has been evolved to meet the insistent demand for machines that would cut, not grind, coffee.

The coffee cutter cuts the coffee uniformly and evenly. Granulating and pulverizing are done on the same burrs, giving a sandlike grain especially adapted to all kinds of percolators or drip pots now in such wide use. There are two sets of burrs, one of which revolves. The other set is stationary. The burrs are especially designed with diamond-shaped teeth. They



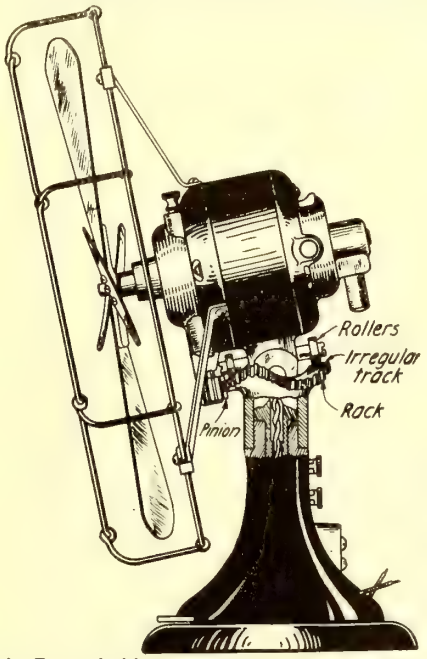
No Up-To-Date Grocery Store Is Complete Without an Electric Coffee Cutter.

are self-sharpening and self-aligning, having special ball bearings which take out all play. Thus the burrs cannot "wobble" and produce uneven granulation.

These machines are operated by totally enclosed, low-speed electric motors designed for heavy duty and without complicated mechanism to need adjustment. Due to the fact that a low-speed motor is employed, no gears are necessary. The motors are equipt with radial and thrust ball bearings, which reduce friction to a minimum and prevent wobbling of parts. They are silent and true running. The only parts needing lubrication are the ball bearings, and these need only be oiled about once a year. Thus there is no oil to accumulate in the burr case, none to get into the coffee, and all the nuisance of oiling is removed.

THIS FAN THROWS BREEZE "UP AND DOWN" AS WELL AS SIDEWISE.

The past few years have witnesst so many novel introductions in "Fanland" that



This Remarkable Electric Fan Revolves and Throws a Breeze Up and Down as Well as Sidewise.

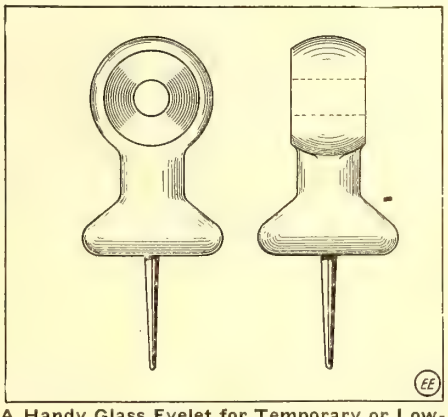
it would seem that about every imaginable form of electric fan had been perfected or thought of, but we have to salute Gustaf Olson of Chicago, Ill., for his very ingenious electric fan gear.

One of the most interesting points which had to be worked out in this idea was the shape of the gear teeth on the stationary rack, and also those of the pinion which meshes with this rack, as becomes clear from the accompanying illustration. The small driving pinion which rotates the fan-motor body proper, by means of this rack, is secured to a vertical shaft geared inside the motor casing to the armature shaft, so as to provide a positive drive for the rotational function.

Current is supplied to the rotating fan motor thru a set of slip rings and brushes mounted in the base. Thus, this fan will not only throw a breeze in every part of the room at a certain level, but will throw the breeze toward the floor and also toward the ceiling periodically or about four times in every revolution of the fan motor, which may be adjusted to occupy about one fifth of a minute.

GLASS EYELETS FOR TEMPORARY WIRING.

Glass push pins provided with an eyelet for use in temporary low-voltage wiring

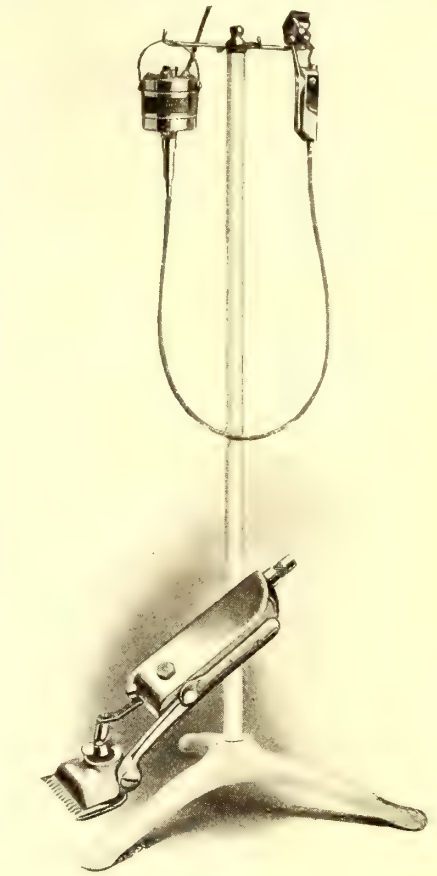


A Handy Glass Eyelet for Temporary or Low-Voltage Wiring.

are being made now. The pins are easily attached to woodwork or walls, and it is pointed out by the maker that they are particularly useful for amateur battery work where small wires are to be run about the house. They should prove particularly efficient in wiring up sensitive electrical apparatus such as galvanometers, radio receiving apparatus, etc., where a slight leak, such as thru wood, means a big difference in the efficiency of the instrument.

NEXT! WILL YOU HAVE AN ELECTRIC HAIR-CUT?

Barbering is one of the very old and universal trades. For years past there has been practically no advance or change in the general method employed of using shears, razor or clipper. It is true that the modern clipper with its improvements is a device which is of comparatively recent development, but aside from that the methods of the barber are the same as they were hundreds of years ago, so we



Good Morning! Have You Met the Electric Barber? Here's the Latest Tonsorial Device—A Motor-Driven Hair-Clipper.

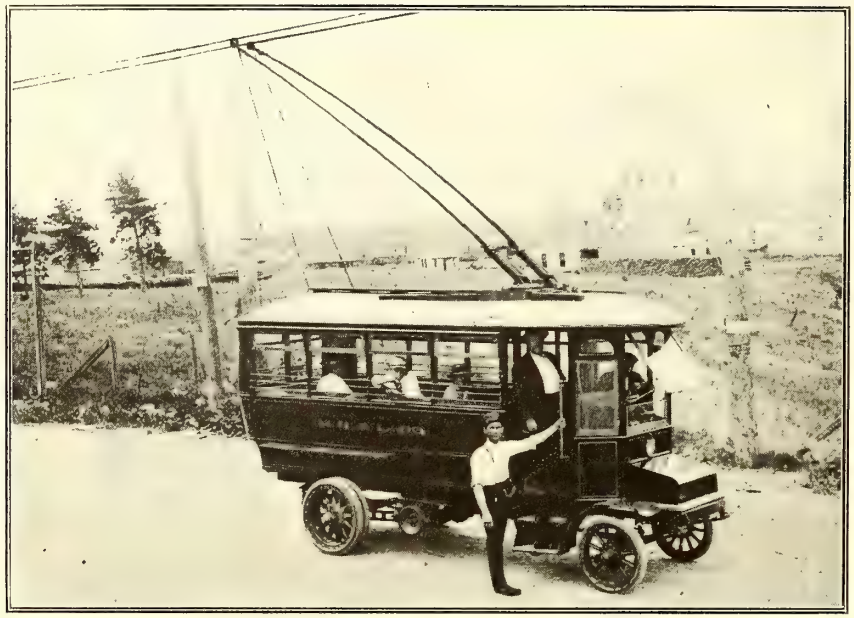
had begun to believe that it was only styles in trimming the hair or beard which change. But electricity can improve almost any unelectrified method or device. The electric hair cutter here illustrated is rapidly becoming popular, many Chicago barbers speaking very highly of it.

As will be seen from the illustration, the machine consists principally of a light iron standard with cross arms at the top supporting the small electric motor, which is connected to the clipper by means of a flexible shaft three or four feet long. This shaft enters a translating device in which the revolving motion is changed to a horizontal motion for the handles of the clipper. This is necessary in order to cause the shearing edges of the moving clipper blade to pass back and forth over the other in the usual manner.

A TRACKLESS TROLLEY SYSTEM.

By L. Schoolcraft.

In Massachusetts there are now several lines of trackless trolleys. These vehicles resemble automobiles more than they do street cars, but their motive power is electric and the current is obtained from overhead trolley wires.



Massachusetts Now Boasts a Trackless Trolley. The Current Is Taken from Two Wires Thru the Double Pole Arrangement Shown. The Vehicles May Pass One Another on the Road Without Trouble.

It will be noticed in the illustration that there are two trolley poles on this car as well as two over-head wires, whereas in the ordinary street car there is but one. This is due to the fact that these cars do not run on steel tracks but on an ordinary road or pavement. The second trolley wire being for the return circuit. The cars are controlled by the ordinary controller as is found in street cars.

There are two advantages of this system of trolley—

First—The car may pass around other vehicles which may be in front of it or passing it in an opposite direction, thus reducing delays.

Second—The elimination of one of the largest items of expense in constructing electric railways which is the track or foundation.

THE USE OF X-RAYS IN DISEASES OF THE CHEST.

By Dr. Leonard Keene Hirshberg, A.B., M.A., M.D.

(Johns Hopkins University.)

When you look thru the greenish glass used as a screen, when the X-rays are focused on anyone's torso, you see an old time bird-cage or wire hoop-skirt with the ribs as circular wires, with shadowy, fugitive, fleeting phantoms of birds within the cage. An X-ray photograph imprisons this picture.

The X-rays, with the ribs as precise guiding posts, allows us to make an exact and minute examination of the topography hidden from the unaided human senses. A man without senses is a mental wreck. A doctor with all his senses is a most incomplete creature. He must call to the aid of his best endowments, those instruments of precision, which reach out to hidden things undreamt of in his best senses, much less his philosophy. The X-rays is one of many such assistants.

The X-rays can sometimes tell you to the fraction of an inch, the exact spot in the lungs or in the pleural cavity, just where a sore is situated. If the child has swallowed a pin or a penny, it will be nicely revealed.

There are forsooth failures with it: not every use of the X-rays is successful in itself. Tuberculosis may be present and escape discovery, if the other facts found in a physical examination are not also taken into consideration.

In maladies of the lungs, Dr. Howard Lilienthal of the surgical staff of Cornell Medical College, holds that no final judgment should be given unless the X-ray observations are also checked up with other soundings and investigations of the individual's state of health. He describes a little boy's condition in support of this.

The little patient in question was three and a half years old. He began to have spells of unproductive cough. There was no evidence of fever or weakness for the youngster played about between the paroxysms.

When this had gone on about ten days, he really became seriously ill. Fever appeared and the little fellow began to cough up mucus.

An examination with the stethoscope and fingers on the back of the chest, showed it to be a bit flat and dull in sound with increased voice production. It was decided that there must be some fluid or pus between the lung and chest wall. This is pleurisy—not the popular fallacy of a pain in the chest.

An X-ray picture was then taken of the chest on the side affected. The solid patch of dark in the negative suggested pneumonia, but from the stethoscope examination this was properly interpreted as puspleurisy or "empyema."

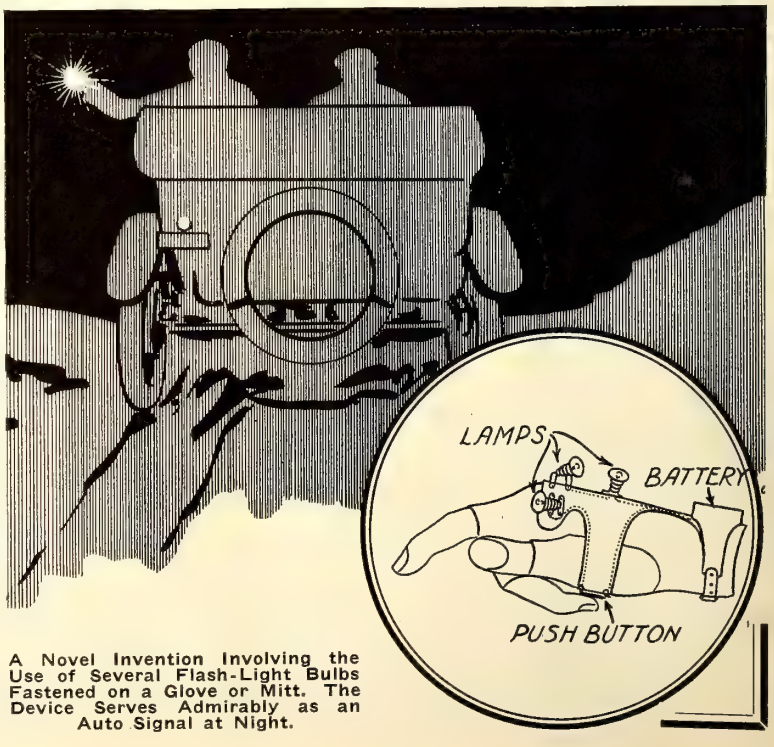
An anesthetic was then given and a tiny needle-tube was pushed into the pleural cavity much as a beer-keg is tapt, the matter and pus were drained away, and lo and behold a second X-ray photo showed a large watermelon seed in the child's windpipe.

This was removed and the youngster was soon well and happy. The two X-ray pictures alone would not have been enough to make a correct diagnosis. The stethoscope alone would not have done so. A wonderful doctor with all the fulness of sound senses could not have done so without the other aids.

UNIQUE BATTERY SIGNALING LAMP WHICH STRAPS ON HAND.

While the ordinary battery flashlight has proven its efficacy in many instances, an inventor, August Sundh, has devised and patented the flashlight signaling and illumination outfit here pictured. In his patent he states that the apparatus is intended and especially adapted for the use of persons working around machinery or in place where portable lights are used. Also it is pointed out that it will prove useful for automobiles and trainmen, such as for signaling purposes, and its use in this direction is illustrated in the accompanying view, where the autoist is shown giving a night signal that he is about to turn a corner.

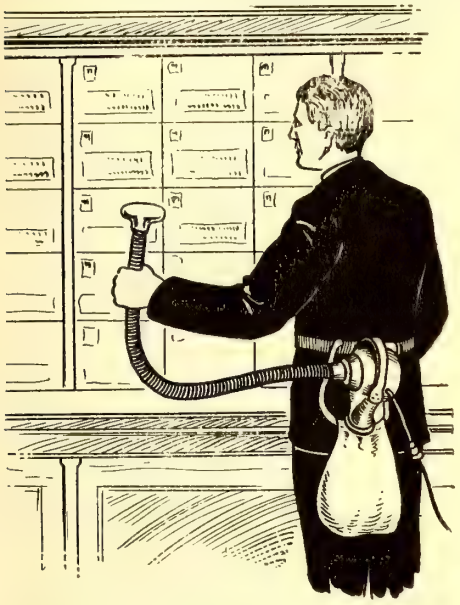
The device is quite simple and merely comprises a leather or other form resembling a glove, which straps on the hand and at the wrist. This glove contains a flap pocket to carry a small flashlight battery. Several miniature battery lamps are disposed in various positions at the back of the leather mitt as the illustration discloses, and the circuit between the battery and lamps is closed whenever desired by pressing on a small push-button switch secured on the inside of the mitt.



A Novel Invention Involving the Use of Several Flash-Light Bulbs Fastened on a Glove or Mitt. The Device Serves Admirably as an Auto Signal at Night.

CARRY THIS VACUUM CLEANER ON YOUR BELT.

We think vacuum cleaners have been perfected to the limit in this country, but here's an English type of portable electric "suction" cleaner, as they call it over there,



This Electric Vacuum Cleaner Straps to Your Belt. It Is Light in Weight and of Extreme Flexibility.

that will do real pretentious work, and weighs but 7½ pounds. It is really one of the most ingenious vacuum cleaners developed. A man can work right along with it without tiring and besides it is especially adapted to cleaning stock on shelves, books in libraries, et cetera.

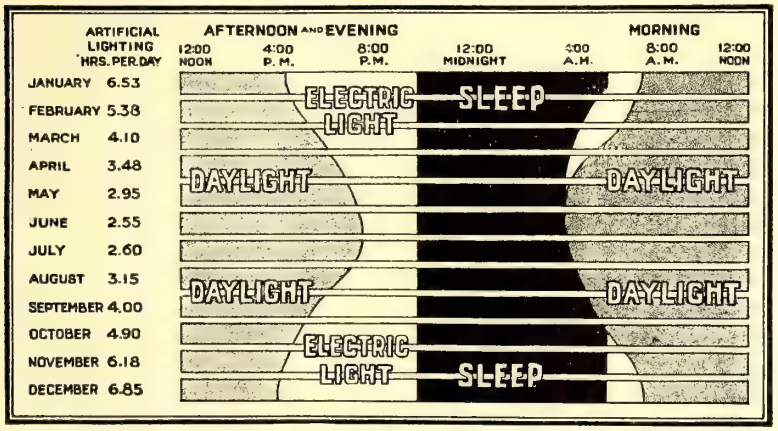
The belt type electric suction cleaner, by a turn of the switch and a guiding hand, sucks out the dust from fixtures, shelves, stock, stationery, machinery, etc., in a jiffy.

WHY YOUR WINTER ELECTRIC LIGHT BILLS ARE HIGHER.

The accompanying chart shows just why your electric light bills are higher in some months than others.

In winter you depend upon artificial lighting nearly *three times* as many hours in each 24 as in summer.

In June the average use of electric light, in a residence, is 2 hours and 35 minutes a day.



This Chart Shows Just Why Your Electric Light Bill Runs Higher in Winter Than in Summer. Daylight Is Shorter for One Reason.

In December the average use of electric light, in a residence, is 6 hours and 50 minutes a day.

This is perfectly natural. As the summer days lengthen, the "electric light hours" become longer, says the *Society for Electrical Development*. So on until January when the days grow longer and the "electric light hours" grow shorter.

There are other reasons, too, why your bills in fall and winter are larger than in the spring and summer—good reasons that show it is simply the result of the season's changes; your more extensive use of electric light, and not the fault of the electric light company at all.

When summer is over, vacations are over. Everybody is home again; more rooms are occupied; more light is needed.

Long evenings—late bedtimes. The outside cold keeps us indoors. The soft, cozy glow of electric light makes reading a pleasure. More people stay home on this account. The newspapers, magazines, study or a good book, music and games pass the evening all too quickly. It is bed-time before one knows it!

More entertaining is done—parties at home for the grownups and little folks. Sometimes the house fairly radiates with the good cheer of electric light.

RADIO-ACTIVE LUMINOUS COMPOUNDS AND THEIR DECAY.

At a recent meeting of the Royal Society, Mr. J. W. T. Walsh read a paper on this subject. The theory of destruction of "active centers" put forward by Rutherford to account for the decay of luminosity of radio-active luminous compounds leads to a simple exponential relation in the special case of a compound of constant activity. It has been found for radium zinc sulfid compounds that this relation expresses the observed results to a sufficient accuracy over short periods of less than 200 days, but that it fails to do so over longer periods, such as 500 days, the rate of decay of luminosity becoming gradually slower and slower, so that the brightness tends to a limiting value which is not zero. The present paper is an attempt to find a luminosity time relation which will allow of the prediction of the intimate behavior of compounds of varying composition

GRANDMA, RADIO EXPERT, VOLUNTEERS.

A grandmother has offered to conduct classes in wireless telegraphy in St. Paul. Mrs. Fredricka Bell, 58, of that city, learned to send and receive by wireless from her grandson, Harland Hall, now at the United States navy radio station, Duluth.

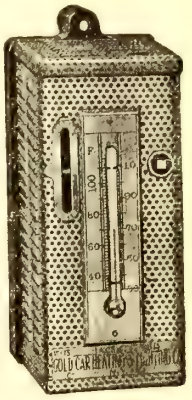
Before their station was dismantled she "listened in" and heard messages from all parts of the country.

If the government will grant permission for the erection of a wireless station in St. Paul, Mrs. Bell says she will teach all branches of wireless operating. If that is impossible, she probably will have classes at the Y. W. C. A. to teach women the continental code.

THERMOSTATIC REGULATOR CONTROLS RADIATORS.

One thermostat will control a number of radiators. The valve and thermostat are connected by electric wires conveniently placed; the operating current is so small that it is hardly perceptible and is obtained from the lighting circuit.

The opening or closing of this circuit operates the valve or valves connected to the radiators in the room. The thermostats are so arranged that a range of 30 degrees can be obtained.



Thermostat for Regulating Radiators.

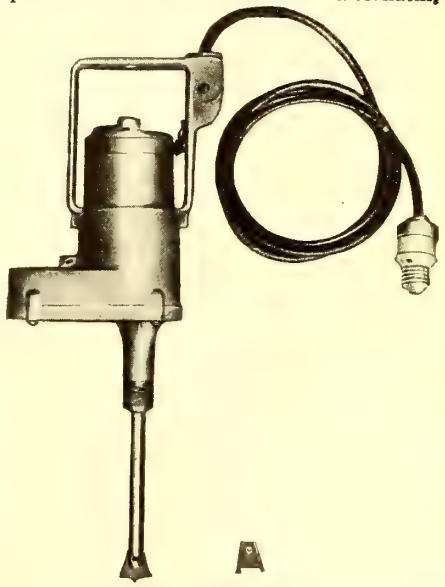
It may be necessary at times to shut steam off the radiators in order to make repairs or in case certain rooms are to be unoccupied. The makers provided for these emergencies by placing a valve stem in the top of each valve, which may be operated by a key which is furnished with each valve, to close the valve by hand.

In the thermostat is a small metal diafram capable of expanding and contracting. Within this diafram is sealed a small amount of a volatile liquid. The slightest variation of temperature either expands or contracts this diafram, expanding with rise of temperature and contracting with the fall of temperature. This diafram actuates a metal strip, thereby opening or closing the electric circuit as the case may be.

ELECTRIC VALVE GRINDER FOR AUTOISTS.

A valve grinder fitted with an electric motor and which may be connected to any handy lamp socket has been placed on the market by a Michigan manufacturer. This grinder develops speeds of 400 to 750 oscillations per minute. Between the mechanism of the grinder and the valve a flexible contact is provided for furnishing a light, medium or heavy pressure upon the valve.

The motor supplied with this grinder operates on either direct or alternating



A Motor-Driven Valve Grinder for Auto Engines.

current. A set of valves may be re-ground in an average time of thirty minutes.

ALLEN P. CHILD.

TELEGRAPH LINEMEN OF THE FAR NORTH.

The line gang of a telegraph company operating in temperate climes may think



Instead of Spurs These Telegraph Linemen of Alaska Wear Snow-Shoes. The Poles Are Tripods Which Rest on the Ice and Snow.

they are roughing it some, when the snow and chill winds begin to blow, but consider the hardships experienced by a lineman in such frigid countries as Alaska.

The accompanying photograph shows linegang employed in stringing the wires for the government railroad telegraph lines in Alaska. Instead of the old reliable "climbers," or spurs, each man is equipt with a pair of snow-shoes. In the lower right corner of the picture may be seen a string of porcelain insulators and a coil of wire.

Did you ever stop to think how the linemen place their poles in such localities, covered the year around possibly with snow and ice? "Dig a hole"—is your first answer. Well they don't use poles, not as we know them down here in the States. In the background of the present photo can be seen an Alaskan telegraph pole. It is really a tripod formed of three fir poles, nailed together and surmounted with one, or more insulators, depending upon the number of circuits in use.—*Photo courtesy Donald McNicol.*

RADIO FOR WOMEN AT UNIVERSITY OF CALIFORNIA

Wireless telegraphy for women is to be one of the University of California's courses and the new study has been added because of the request of the wife of an officer stationed at the Presidio. It is the first time such a course has been offered by the extension department.

The class will be held at the Polytechnic high school in San Francisco every Saturday beginning September 1. There are to be two sections, one in the morning and one in the afternoon. Professor A. L. Jordan, head of the department of science in the Polytechnic High School, will teach the course in the wireless laboratory of the school building.

CLEANING YOUR CLOTHES BY VACUUM.

Here is a device which will keep your clothes, and upholstered interiors of automobiles, et cetera, as fresh and clean as the day it left the respective work shops. By using the principles of brushing and suction this instrument thoroly cleans out the dust and collects it so that it will not settle again.

The brush does not revolve but contains an open center thru which a fan located in the metal container draws the dust. The dirt is loosened by the brush and the fan suction catches it and it is carried on into the dust bag. A special attachment is made for this device which permits the thoro cleaning of the buttons in the tufting of upholstery, which always hold, so tenaciously, against sweeping a great quantity of dirt.

This cleaner may be used as well for cleaning draperies, mattresses or upholstered furniture. The device will attach to any socket.—*Photo by Allen P. Child.*



Here's the Best Way to Dry-Clean Clothes—Use an Electric Vacuum Cleaner. This Method Spells Results with the Work Left Out.

The Submarine and Kindred Problems*

THE thousands of suggestions and plans presented to the Naval Consulting Board for assisting the Government in the present emergency indicate the patriotic fervor of the mass of our citizens.

The Board makes a careful examination of every proposal presented. To facilitate this work, by suggesting the elimination of impractical ideas, the Board calls to the attention of those who desire to assist it some of the popular misconceptions as to certain fundamental principles which are most frequently misunderstood by the layman.

A careful consideration of the following statements will greatly simplify the work of the Naval Consulting Board.

Electro-Magnets and Magnetism

The *Electro-magnet, the Magnetic-needle, Permanent Magnets and Magnetism* have been carefully studied for many years; and the laws governing their application may be found in any book on the subject.

Although these laws are generally known, and applied in a practical manner, in a multitude of devices in common use, even the man of wide experience will be astonished at the limited range of practical effect of electro-magnets of large size. For instance, the magnets used in our manufacturing plants for lifting heavy masses of iron or steel are designed to exercise maximum magnetic effect, and for operation require a very considerable amount of electrical energy; yet a magnet *which can lift twenty tons, when placed in contact* with an iron plate of that weight, will not lift a two-inch cube of iron or steel *if separated from it a distance of two feet.* Therefore proposed devices which depend on the attractive power of magnets for their operation in deflecting or arresting torpedoes, mines or submarines, must be governed by the simple laws of magnetism. A torpedo weighing approximately 2,500 pounds, and traveling at a speed of 25 to 45 miles an hour, will not be deflected to any practical degree by any known application of magnetism; and it is not believed that an enemy torpedo, mine or submarine will ever be found in a position to be interfered with effectively by any electro-magnetic means, however powerful.

Electrical Effects in General

There is a general misconception regarding the "electrification" of water and the atmosphere. There is no known method of "charging the sea with electricity," or "shooting a bomb of electricity," or of "charging the atmosphere with electrocuting current." Suggestions along these lines should show that the writer has made research in the laws governing the application of electrical energy and should contain sufficient proof of their feasibility to insure serious consideration.

On the other hand, applications of the transmission of electrical energy by means of alternating or pulsating currents—as used in wireless systems, for example—belong to a different class of electrical development. Inventive genius is rapidly improving apparatus of this type for the sending and receiving of signals and messages, and the possibility of valuable results in this field is unlimited.

Protection Against Submarine Attack

This subject, which is occupying the public mind as is no other, divides itself into a number of problems, the most important being the following:

(a) *Means of discovering* the approach of a hostile submarine and locating it so as to permit of prompt action for combating its attack.

(b) *Protection of cargo-carrying ships* by nets, guards and screens.

(c) *Protection thru decreasing the visibility of vessels.*

(d) *Methods of destroying or blinding* a hostile submarine.

Submarines, to operate most effectively, must approach within close range of the vessel which is intended to be torpedoed. The installation of offensive weapons on the merchant marine has increased the necessity for the utmost care being exercised by the submarine commander in remaining unseen by the officers on the vessel to be attacked.

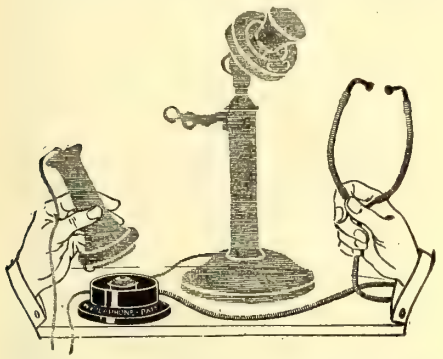
Reports from abroad indicate that in many cases submarines must have remained along certain lanes of travel for periods extending into weeks of waiting with the expectation of torpedoing certain vessels. Under certain favorable conditions, where the waters are less than 200 feet in depth, a submarine might lie at rest on the bottom, and if equipt with sensitive listening devices attempt to detect the approach of a vessel. As soon as this evidence was secured the submarine might come to the surface for a quick observation by means of the periscope and in this manner obtain the proper aim which would be required to register an effective hit.

(*Continued on page* 579)

*Publisht by Naval Consulting Board of the United States.

A TELEPHONE AMPLIFIER THAT LEAVES HANDS FREE.

The telephone as it stands today is practically a perfect instrument. There are times, however, when the hearing efficiency is far below normal. At such times you are forced to ask the person at the other



This Telephone Amplifier Is a Distinct Advance. It Has No Direct Connection with the Telephone. You Simply Place the Receiver on the Amplifier, Leaving Both Hands Free.

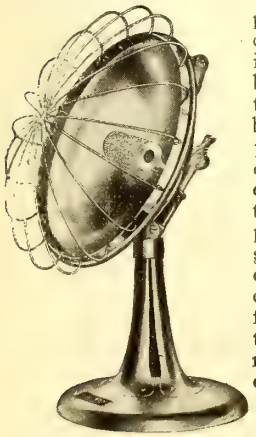
end of the line to speak louder, sometimes to shout. Even then you don't always hear clearly. You must ask him to repeat almost every word that is said.

The new telephone amplifier here pictured, greatly increases the hearing efficiency of the telephone, all harshness disappears and you hear the voice in its natural tones, its inventor claims. This is accomplisht by the accurate tuning of the sound chamber in the instrument. This sound chamber contains no mechanism to get out of order. Just as a sounding board behind the speaker increases the voice volume, so this new amplifier amplifies the telephone sound.

It often happens that while telephoning you wish to write down some note, consult a catalog or read a letter over the 'phone. At such times the busy man will welcome such a device.

NEW ELECTRIC HEATER.

A novel portable electric heater for home use is shown herewith. The outfit is substantially constructed of prest steel, on the principle of the portable lamp. A steel reflector 9½ in. in diameter is connected to the top of the pedestal by a hinged joint which is adjustable to numerous positions from horizontal to diagonal, upward. This reflector, which is of a special parabolic design, is heavily plated with a triple coat of highly polished copper. The back of the reflector is finished in black enamel. Wire protecting guards over the heating element are attached to a copper-plated rim. These guards may be easily removed for cleaning the reflector or changing the heating element, which is also easily and quickly detachable.



Portable Electric Heater.

The heating element consists of a composition core 1 in. (2.54 cm.) in diameter, around which is wound high-resistance wire. The wire is first wound into a small coil and then wound around the composition core, giving a large amount of resistance material in a small area. This coil will attain a temperature of about 1,200 deg.

A New Combined Stereoscopic and Fluoroscopic Table

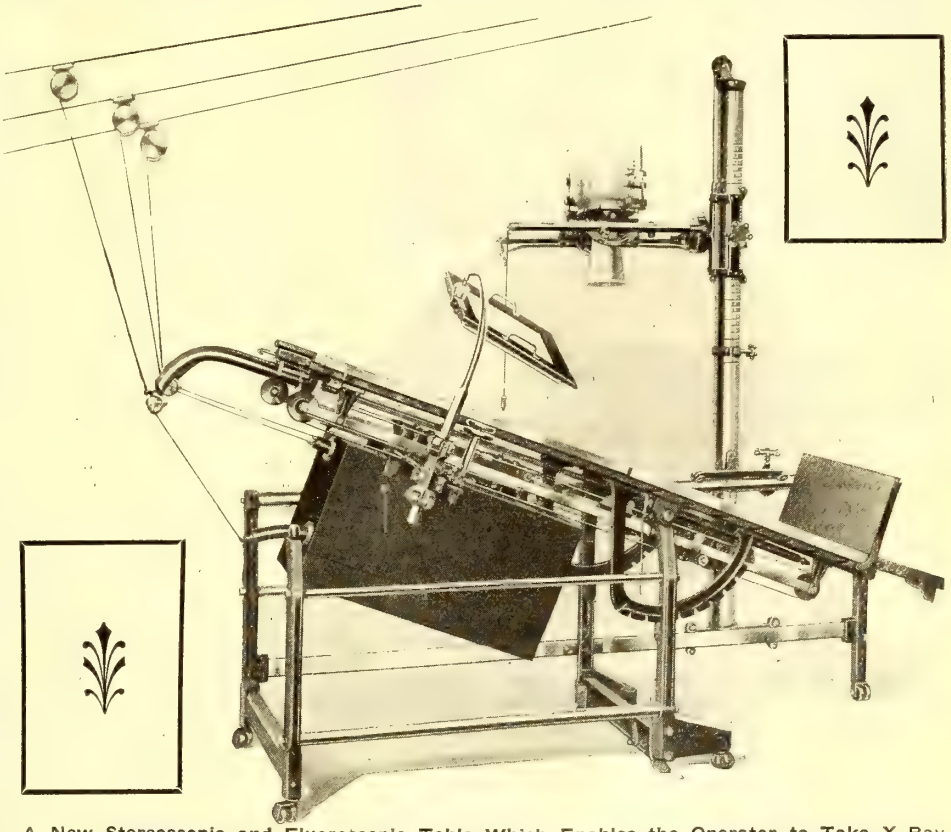
The new X-ray table here illustrated has recently been evolved by a New York concern. It combines a tube stand with table, which may be used for stereoscopic roentgenography and also for fluoroscopy, both in either the horizontal or vertical position. All moving parts are so poised and balanced that they may be smoothly manipulated by the operator without assistance.

Suspended beneath the table is a trochoscope tube box running on ball bearings and so designed as to afford ample protection from rays to the operator and patient. A special feature of this tube box is that it is lined with opaque rubber and covered outside with sheet lead. This affords the necessary protection from rays, while at the same time preventing condenser effect and resultant tube trouble. Another innovation is that of a vacuum reducing switch within the trochoscope tube box. By this means the operator may lower a gas tube without leaving the table. Provision is also made for the use of the Coolidge tube. The movement of the tube box gives a large field of vision and moves freely, no matter in what position the table top may be placed. Attached to a bracket, in conjunction with this tube box, is a curved support which suspends over the patient a fluorescent screen which can be twisted around in any direction required. This fluorescent screen is so constructed that it will accommodate a plate holder for the purpose of recording certain findings immediately by utilizing the rays from the tube beneath the table.

The stereoscopic plate changer within the table top is a feature which has evidently received considerable care. This works very smoothly and decisively in the horizontal position and yet works without jar when used for vertical stereoscopy. The tube stand, which is a part of the equipment, travels along the full length of the table. The tube bracket is well counterbalanced and is free to swing around, away from the table for use in conjunction with stretcher or other apparatus.

The insulation of the high tension current has been well designed and is such that tubes can be safely worked up to 9 inches back-up without fear of sparking or flashing across to the table.

All moving parts of the tube stand are carefully graduated so that records can be made of actual positions and it is thus possible to duplicate these conditions if necessary at any further time.



A New Stereoscopic and Fluoroscopic Table Which Enables the Operator to Take X-Ray Pictures in Either the Horizontal or Vertical Position. All Parts Are Balanced So as to Be Easily and Quickly Manipulated.

TO TREAT WOUNDED WITH ELECTRICITY.

Plans developed by Dr. Virgil C. Kinney, of Wellsville, N. Y., one of the best known electro-therapists in the country, for the formation, equipment and administration of an electro-therapeutic hospital unit to be establisht in France for American fighting men, were indorsed recently at the twenty-seventh annual convention of the American Electro-Therapeutic Association at Atlantic City.

"The remarkable results achieved by European belligerents thru physical treatment for crippled and nerve racked soldiers, whereby from seventy-five to ninety per cent. of invalided men so treated have been returned to the trenches, should stimulate the whole American medical profession to procure similar results for our own fighting men," Dr. Kinney said in presenting his plan for Government sanction of electricity and light in place of surgery and drugs in combating battlefield casualties. "This large percentage of cures is practically impossible under old methods."

ELECTRIC MOTORS IN NOVEL ROLES.

A large new Western manufacturing plant was made electrical thruout; the human hand and brain were strengthened by that magic force. Because the ten thousand horse power on the two million feet of floor space was to be electrical the production units were arranged with the sole thought of making an unbroken stream of operation which would catch the raw metal in its current at the source and discharge finished valves and fittings at the mouth.



The Nuttiest Job Agoing. One Operative with This Electric Nut-Screwing Device Can Screw Down Nuts at the Rate of 100 a Minute at a Cost of 1 Cent an Hour.

The stream idea of production was so perfected that now the work, where it formerly eddied and swirled, flows thru with the speed of a mill race. Castings are handled red hot,—sorted, tumbled and cleaned, they never stop until delivered to the machine room still warm. The very dust that comes from them is electrically collected and forms a valuable by-product. Every operation is animated by electricity.

Even the day of the spanner wrench has past. Note the accompanying photo of a curious, unassuming little machine used in the assembly room to replace the old hand wrench by screwing down nuts at the rate of 100 per minute, and with a cost of but one cent an hour.

It is difficult for the eye to distinguish brass from iron in a miscellaneous assortment of filings, but here a two horse power motor rotates an electro-magnetic sorting machine which stacks the metal up in two piles at the rate of a ton an hour.

The heavy job of handling the coal for the heating plant is easily mastered by one man with an electric crane at the rate of twenty tons per hour.

The second photo here reproduced shows one of the plant's electric storage battery locomotives. It runs anywhere and everywhere, without having to depend on rails or trolleys. Fourteen electric trains of this type are operated with speeds up to fifteen miles per hour attainable.



Fourteen of These Busy Electric Locomotives Haul Heavy Loads Up to 15 Miles Per Hour in One Industrial Plant. They Operate on Storage Batteries.

MAGNETIC SEPARATOR PULLEY GREAT TIME SAVER.

By Frank C. Perkins.

THE accompanying illustration, Fig. 1 and drawing Fig. 2, shows the construction and method of operation of the magnetic pulleys development at Milwaukee, Wis. These magnetic pulleys are used where coarse material is to be handled, where the iron to be extracted is limited in quantity, and where large capacity is important. This equipment is used extensively to protect crushing and grinding machinery from breakage and damage due to "tramp" iron found in various kinds of material. It is also used for removing iron from material for other reasons, both mechanical and chemical.

It is pointed out that a good magnetic pulley must possess qualities not generally given sufficient consideration. To be efficient a magnetic pulley must be strongly effective at any point on the surface of its face. The magnetism must be distributed as evenly as possible and not be short-circuited within the pulley, but radiate outward far enough to be attractive thru a heavy conveyor belt and any thick layer of material that is to be treated. The area of the surface of a pulley is the width multiplied by the circumference. To thoroly magnetize this whole area so that it will exert the strongest possible attractive power at any point, requires experience in designing and the careful use of every bit of available space from shaft to circumference. The pulley is built of dynamo steel and insulated copper magnet wire.

It will be seen that when completed it is practically a solid mass of metal wire and insulation. The energizing coils are carefully protected from all possibility of mechanical injury by heavy, hard brass shields. When in motion the heat is rapidly dissipated by the conveyor belt, so that it runs practically cool. However, all machinery is more or less subject to abuse by careless operators. Any magnetic pulley left standing idle for a long time with the energizing electricity not switched off, an dthe pulley partly enwrapt in a heavy rubber belt, is liable to become hot enough to injure common insulation.

In order to meet such contingencies and to avoid all possibility of damage from internal heat and to make magnetic pulleys

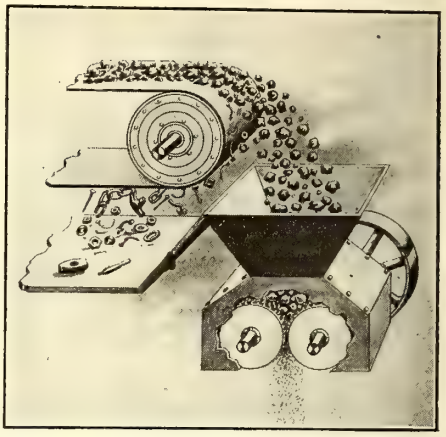


Fig. 1. The Magnetic Pulley Separates Magnetic Substances, Such as Iron, from a Constantly Moving Stream of Mixed Material.

as near "fool-proof" as possible, the very best grade of fire-proof magnet wire and fire-proof insulation is used.

It is urged that the advantages of this separator over the ordinary drum type separator are in its greater magnetic strength; in having no commutator to flash and cause trouble, as the electric circuit is not broken; and in having no brush or scraper to remove the attracted iron.

It will be observed that the operating principle of these machines is very simple. The material to be separated is fed upon a horizontal (or a horizontally inclined) belt conveyor, passing over a magnetized pulley. The non-magnetic material falls by gravity from the brow of the pulley vertically into a suitable receptacle or to a conveyor leading to final delivery, while the iron and magnetic materials are attracted and held firmly against the belt until it is carried to the point where the belt leaves the pulley on the under side and is there discharged back of a partition set a few inches beneath the pulley in line with its axis as shown.

It may be stated that the conveyor is usually a rubber belt of the best grade, heavy, and mechanically strong enough for the material to be handled. It should be made endless, so that no dust or fine material can work thru at the splice. The belts are usually run at a speed of about 100 feet per minute.

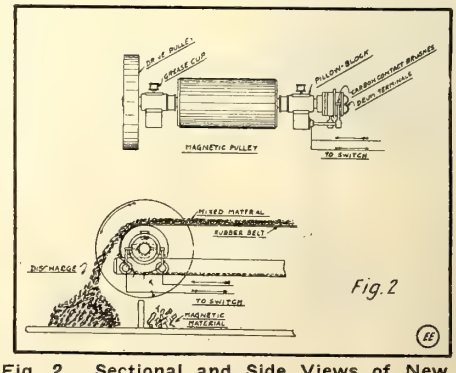


Fig. 2. Sectional and Side Views of New Magnetic Separator Pulley.

ERECTING OVERHEAD MOTORS A CINCH WITH THIS DEVICE.

Recently quite a number of concerns have been using a unique method of putting up overhead motors which permits of installing



A Time and Labor Saver Which Every Electrician Will Appreciate, Is This Latest Portable Elevator for Erecting Ceiling Motors.

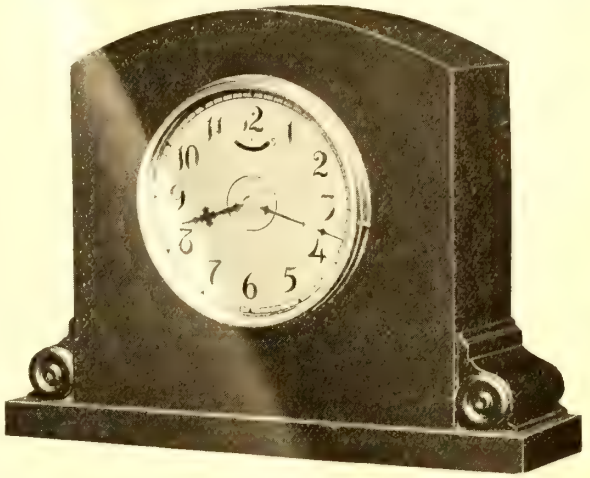
from 4 to 6 motors in the time formerly required for one. This method simply involves the use of a Revolvator, as it is called, to elevate and hold the motor in place until it is secured to the ceiling. It insures absolute safety in elevating the motor and does away entirely with scaffolding, special heavy platforms, blocks and falls and other hoisting arrangements which were formerly used for this purpose.

The Revolvator as may be seen from the accompanying illustrations is a portable elevator or tiering machine. It consists essentially of two uprights or elevator guides, an elevating platform and a revolving base which can swing around on its ball-bearing center like a turntable. The unit is mounted on strong truck wheels and is equipt with a floor lock. A motor or other article to be raised is placed on the platform when down, and by means of a crank and gears the platform is raised to the level desired. In elevating, the load is sustained independently of the crank, for a ratchet is provided with a special patented pawl which sustains the load at every point, eliminating all possibility of the platform being dropt.

The illustration shows the device lifting a 30 H.P. 1400 lb. motor into position.

NOVEL ELECTRIC SELF-WINDING CLOCK.

The idea of a clock that you would never have to wind is very old, and men have spent their fortunes and even their lifetimes in attempting to perfect and market *self-winders*. With few exceptions these clocks were electrically operated, but difficulties arose in each attempt that seemed insurmountable, such as cost of manufacturing, poor electrical contacts, batteries lasting but a few months, and usually the construction was entirely too delicate and complicated for practical purposes.



Why Waste Several Hours Every Year Winding Up Clocks, When the Electric Self-winding Clock Here Shown Will Keep on Going Without a Grumble for a Few Cents a Year?

You never have to wind the electric self-winding clock here illustrated. The *works* or movements are standard timekeepers with the added attraction of being wound electrically by two standard sized dry batteries which fit neatly in the cases. The batteries will run from a year to eighteen months, and new ones can be easily installed by anyone. The style shown is supplied in mahogany and measures 13" wide, 10" high and has a 5" coppered dial.

NEW CORE TYPE TRANSFORMER DESIGN.

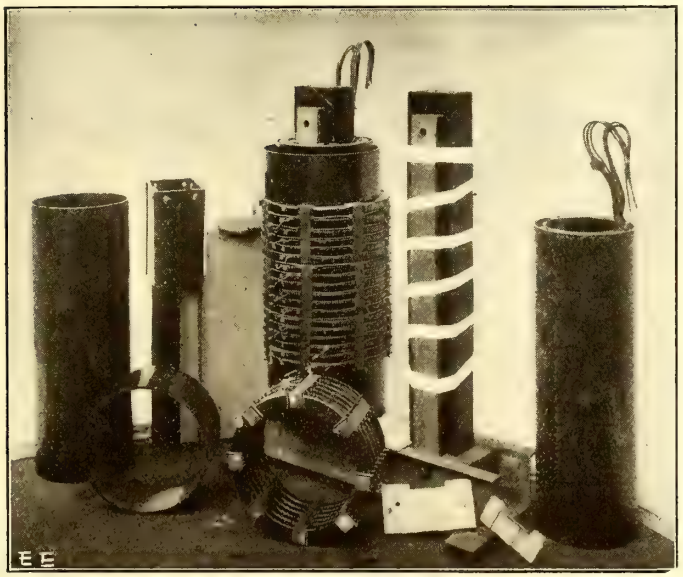
The new core type transformers here illustrated have concentrically arranged high and low tension coils. The low-tension winding is on the inside, and is separated from the high-tension winding by a heavy insulating barrier of Bakelite-Micarta in the form of tubes. These tubes are strong mechanically, have a high dielectric strength, are unaffected by oil, and are in every way the best barrier devised for insulation between high-voltage and low-voltage windings of concentrically wound core type transformers. Ample ventilation is secured in both high- and low-tension windings by means of liberal size ventilating ducts.

The high-tension coil is wound with small round wire. It is given a layer of tape to bind it together, after which it is impregnated in gum. Another layer of tape is then applied, followed by successive dippings in varnish and dryings, in order to fill the tape and give the coil a good gloss.

The low-voltage coil is generally wound in cylindrical or rectangular tube form, depending upon the shape of the core over which it is to fit. It is generally wound with one layer, altho it is not uncommon to have two layers or more, if proper ventilating ducts are provided.

For the lower voltages, the core is sometimes rectangular, but for the high voltages it is usually cruciform in shape. Round coils fit well over a cruciform core and this form is adopted for high voltage windings for which round wire is used.

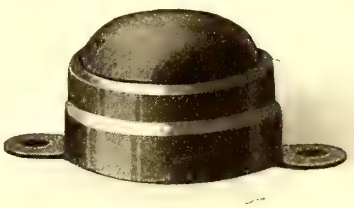
The coils are braced at the ends of the columns so as to hold them rigidly in place and to prevent distortion or destruction in case of short circuit.



New Core Type Transformers with Concentrically Arranged High and Low Tension Windings.

NEW PUSH BUTTON WORKS WHEREVER TOUCHED.

Here is the latest in push buttons. The entire top is movable so when it is prest at any point the contact is made. The button shell is finished in black enamel, and the top is a black composition, making a neat and attractive article. If you have an electric horn on your car this button will enable you to operate it easier.



This Push Button Works no Matter Where Touched.

DIVISION CREATED TO HANDLE ARMY RADIO.

Creation of a radio division under the chief signal officer of the army, to handle radio matters for both the aviation section and the signal corps proper was announced on July 17, by the war department. Major Nugent H. Slaughter, reserve corps, is detailed to take charge.

EFFECT OF MOON ON WIRELESS.

Mr. J. W. Cohen, a wireless expert, states that while stationed in the tropics for several years as a wireless operator he observed that in the period of the full moon the atmospheric interferences are slight and the ether seems to carry the wireless waves with less absorption than when the moon is in its quarter periods. With the full moon he could receive signals from stations two hundred miles farther away than when the moon was in the first and last quarters.

FLASHLIGHT IN FORM OF BOOK.

The accompanying illustration shows one of the latest novelties in pocket flashlights, the containing case being made in the form of a small memorandum book, which will just fit the vest pocket.



A Flashlight That Resembles a Book.

It is equipt with special high power tungsten lamp and push button on the side in the usual manner. An efficient dry battery furnishes current for the lamp and can be easily replaced at any time.

This particular form of pocket flashlight will appeal to many people for the reason that it does not look like a flashlight, and also it serves as a very appropriate gift to most anyone.

LITTLE THINGS.

Little drops of water,
On the turbine blade,
Make the total horsepower,
Something fierce and great.

Little volts and amperes,
Flowing thru the "grounds,"
Make the meter's reading,
Grow by leaps and bounds.

Little dots and dashes,
Little signals grand,
Span the mighty oceans,
And the busy land.

Little shocks of tension,
Little battery leaks,
Make the 'dabbler's" verbiage,
Emanate blue streaks.

—*By Edward Schultz.*

NEW STEP-DOWN TOY TRANSFORMERS.

The toy transformers here illustrated will operate ordinary toys such as small train outfits, small motors, etc., from the ordinary lighting circuit. The transformer, shown at Fig. 1, has a voltage range of from 3 to 30 volts in 3 volt steps—this eliminates the need of a toy rheostat for varying speeds. It is provided with spring clips for secondary terminals, making it possible for boys to quickly and accurately connect up their toys. There are no binding posts to become loosened or nuts to get lost. The special construction of the voltage regulating lever insures good contact at all times—this prevents sparking at contacts which occurs after short usage in many toy transformers. It has a capacity of 30 watts, or 2 amperes at 18 volts.

For the operation of large sized toys and for other purposes requiring varying voltages, the same concern supplies the Automatic Cut-Out Transformer shown at Fig. 2. For the operation of electrical toys and experimental work, the automatic secondary cut-out not only protects the transformer from short-circuits and over-loads, but it eliminates any danger of injury to toys or apparatus in circuit. It is said to be very positive in its action. It has a capacity of 125 watts, or 5 amperes at 25 volts maximum.

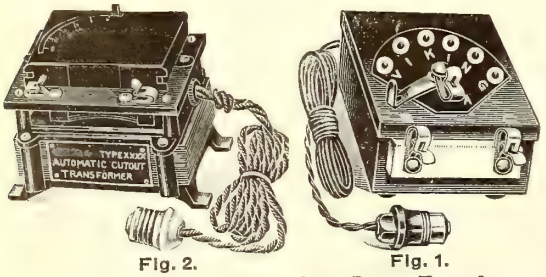


Fig. 2. Fig. 1.

Fig. 1, Right, 30 Watt Toy Step-Down Transformer; Fig. 2, Left, 125 Watt Step-Down Transformer.

In the January "E.E."

The January number of The Electrical Experimenter *will be a record breaker. Don't miss it friends. It will be replete with science, electricity, wireless and mechanics. Do you know that thousands of our soldiers and sailors "over there" as well as "over here" look forward eagerly to the monthly arrival of the "E. E."? If they read it to learn the newest things in electrical and radio science, why not you? And don't forget to remail this magazine when you are thru with it. See notice on front cover. For the January issue, among other attractions we offer:*

"The Electric Depth Bomb—Terror of the Submarine," by F. R. Lewis, Military Expert.

"The Electron—Just What It Is"—a remarkable treatment of the subject with some wonderful photographs by Prof. R. A. Millikan.

Baron Münchhausen's New Scientific Adventures, by Hugo Gernsback.

"Machine Shop Kinks for Amateurs"—a new series for the practical man, by Samuel Cohen.

"The Home Treatment of Tuberculosis with High-Frequency Currents"—a most valuable article by an authority—Dr. Frederick Finch Strong, M.D.

"An Electrical Entertainment de Luxe," describing a host of unusual and instructive experiments as presented by Mr. William J. Hammer.

"Ham" Aerials—A wireless tale with a kick, by W. J. Howell.

Detail Construction of a Damped and Undamped Wave Receptor. With full working drawings by F. MacMurphy.

A New Electrical Time Recorder, by H. Hartman, C.E.

The First Edison Electric Light Station—with some interesting photos.

BATTERY SAVER FOR TELEPHONES.

On rural telephone lines there are often times when subscribers desire to "listen in," as for example, when market and weather reports are being issued from the central exchange. This "listening in" habit is a great battery consumer and to eliminate it, but at the same time preserving the farmer's joy, a progressive telephone manufacturer has devised the simple battery-saver illustrated.

The invention consists of a latch device which is made to attach to the hook switch



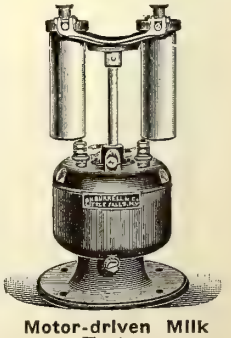
This "Battery Saver" Telephone Attachment Permits One to Listen in on a Line Without Wasting Battery Current.

escutcheon plate on the left side of the instrument. When the receiver is removed from the hook the lever springs up but is caught half-way by the bent finger of the battery-saver latch. In this position the circuits of the telephone are connected so that the user may hear but not talk; the transmitter is not connected to the battery and no current is consumed.

If the person using the telephone wishes to talk he presses the latch back as in illustration herewith. This disengages the hook switch lever and allows it to resume its upward movement to the full operated position. When the lever is in this position the battery is connected to the transmitter and telephone may then be used for talking purposes.

A MOTOR-DRIVEN MILK TESTER FOR DAIRYMEN.

This is a machine for rapidly and accurately determining the percentage of butter fat in milk and milk products, such as cream, skim milk, buttermilk, etc. A definite quantity of the liquid to be tested and a definite quantity of sulfuric acid are thoroly mixed in the special bottle provided with a graduated neck. The object of adding the acid is to dissolve all the solids in the milk except the fat. Its strength must be proper for this purpose, say about 1.82 specific gravity. This bottle is then rotated at sufficient speed so that the centrifugal force generated throws the lighter part of the liquid, in this case the butter fat, up into the neck of the bottle, where its percentage of the total amount may be read. Such a machine is nominal in cost and saves much trouble and work for dairymen.



Motor-driven Milk Tester.

AMONG the hundreds of new devices and appliances publisht monthly in The Electrical Experimenter, there are several, as a rule, which interest you. Full information on these subjects, as well as the name of the manufacturer, will be gladly furnisht to you, free of charge, by addressing our Technical Information Bureau.

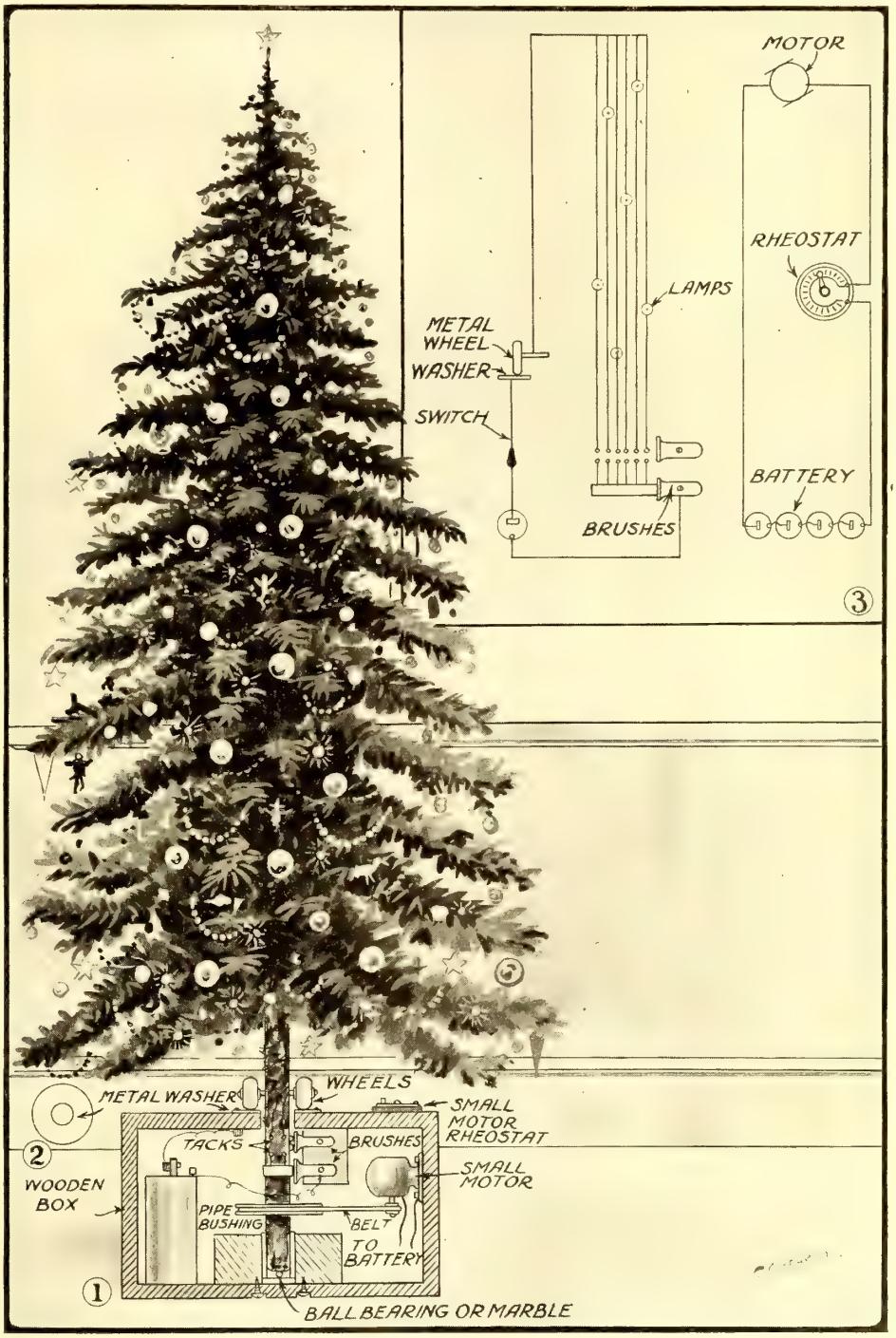
A Revolving Electric Christmas Tree

By JOHN T. DWYER

FOR those experimenters who have not a storage battery or whose homes are not equipt with a 110 volt house circuit, it is a difficult matter to rig up an electrical Christmas Tree display, even with only six or eight lamps, as for efficient results, it generally takes about a half dozen dry batteries at the least, and at the present "war prices" this is prohibitive to the average "mucker". However, the hook-up here shown not only possesses several novel features but can also work well on as low as six batteries—two for illuminating the lamps and the other four for running the motor. This is made feasible by the fact that only one light is brought into the circuit at a time and, as the revolving of the tree by means of the motor (see Fig. 1) automatically makes and breaks the circuit to each lamp alternately, the result is a charming "twinkling" effect, which is very pleasing to the observer.

While the drawings are practically self-explanatory, a few remarks concerning some of the details may make them even more readily understood. Regarding the two wheels in Fig. 1, these act as a smoother bearing for the revolving tree and may be obtained from either an old pair of roller skates or else discarded furniture castors. The axle on which they turn passes thru the stem, or trunk of the tree, and has soldered to it the main wire in the circuit. The metal disc or washer shown in Fig. 2, can be made from the bottom of a tin can but must present a flat surface. The commutators, of course, are preferably of brass and it will be noticed that one is connected directly to the battery while the other acts as a closing switch between the upper and lower contact points. These latter are simply round brass headed tacks, hammered into the tree and their number depends on how many lamps are employed. For the purpose of regulating the speed of the motor, a rheostat of the small coil type available on the market, should be used, and if the reader has not this instrument, he may readily construct a simple one in a few minutes by referring to back numbers of the ELECTRICAL EXPERIMENTER magazine.

The wiring diagrams are shown in Fig. 3. Provided that the tree is a small one, say not over 4 ft. in height, a toy motor will be strong enough to revolve it freely. For the purpose of cutting out the lighting circuit, as during the day-time, without however interfering with the motor, a switch may be inserted as shown.



The Electrical Xmas Tree Can Be Made Twice as Charming by Arranging It to Revolve in the Manner Illustrated. The Groups of Lamps Blink on and off Alternately, Giving a Most Beautiful Effect That Will Please Kiddies as Well as Grown-ups.

RADIO BETWEEN SAYVILLE AND HAWAII.

The navy's new wireless station at Pearl Harbor, Hawaii, has a radius of five thousand miles, and its opening on September 29th, was signalized by an exchange of messages with the station at Sayville, Long Island. When the stations now building in the Philippines are completed communication between Washington and the Philippines can be carried on with only one relay by way of Honolulu.

The Pearl Harbor equipment makes it the most powerful radio station in the world. It is one of a chain of high power radio stations under construction by the Navy Department. The principal stations completed in the chain are at Arlington, near Washington, at Darien, in the Canal Zone, and at San Diego. The remaining stations, at Cavite, Philippine Islands, Guam and Tutuila, will be completed in the next two months. The outfits include three masts at each station to support the aerial, each mast being of steel and self supporting. The apparatus is of the Poulsen arc type, which is standard in stations of the high power chain. Suitable and comfortable quarters are provided for the personnel of each station.

Wireless telegraphy has been wonderfully developed since the experiments made by officers of the United States Signal Corps during the Civil War. These began with the use of water-courses to carry the current. Aerial telegraphy was then attempted and demonstrated to be practicable for short distances in experiments whereby messages were transmitted from one height to another across valleys in the Cumberland Mountain region. As late as the period of the Spanish War it was possible for Dewey to debar the Philippines from communication with the outside world by cutting an ocean cable—a feat which cannot be repeated, for progress in electrical science has been going forward with electric rapidity since the spring of 1898, and the world is now in a new age, the age of *wireless telegraphy*.

How to Use High Frequency Currents in the Treatment of Disease

By Dr. FREDERICK FINCH STRONG.
Lecturer in Electrotherapeutics, Tufts Medical School, Boston

NOW that the exigencies of war have temporarily suspended the activities of amateur Radiotelegraphers, many of those possessing transmitting outfits are using them for the experimental study of the phenomena of High Frequency currents.



This Photo Shows Dr. and Mrs. Strong with the Elaborate Apparatus Used in Lecturing in Different Cities. Note the Large Conical Oudin Coils in Full Activity.

In the ELECTRICAL EXPERIMENTER for May, 1917, the writer described the construction of a Tesla D'Arsonval high-frequency outfit made from standard "Wireless" apparatus, consisting of a ¼ or ½ K.W. transformer with glass plate condenser and oscillation transformer, the latter used as a series inductance to obtain various effects from the Tesla coil, or as a "D'Arsonval Solenoid" for obtaining the "Diathermic" and "Auto-condensation" currents so valuable in the treatment of certain diseases.

Many excellent results can be obtained from high-frequency treatment administered by those who have little or no knowledge of medicine. A physician's advice should always be obtained before undertaking the treatment of any serious case, but the amateur may safely employ moderate doses of Tesla currents, and even mild diathermy and autocondensation, provided he makes himself reasonably familiar with the elementary principles of electrotherapeutics.*

In a few States there is a law prohibiting the therapeutic use of electricity by any but licensed physicians, but even this would not apply to treatments given gratuitously by amateurs to relatives or friends. A number of the writer's former pupils have become successful practising electrotherapeutists, altho they are not physicians. Most of them wisely refrain from the use of the sinusoidal, Galvanic and static currents; these belonging more to the field of the electro-medical specialist.

A simpler and cheaper apparatus than the one described in the May issue of this journal will give all the varieties of therapeutic high-frequency currents that may safely be used by the amateur. It is made up as follows:—

Transformer,—Any standard ¼ K.W. radio transformer (E. I. Co., Clapp-Eastham, Thordarson, etc.)

Condenser,—Standard wireless glass plate condenser, one section of .005 microfarad; two sections of .01 m.f., each in series will be safer.

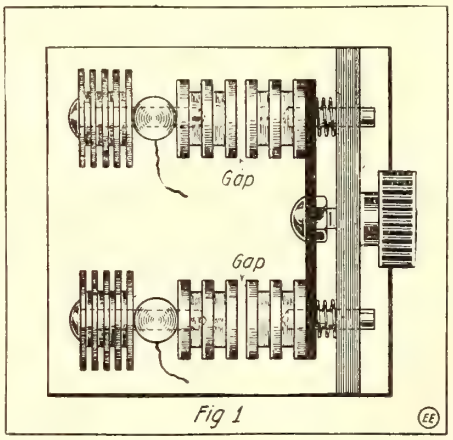


Fig. 1. A Simple Form of Fixt Spark Gap, Found Very Satisfactory for High Frequency Outfits.

Inductance Coil, ("D'Arsonval" solenoid), thirty turns No. 12 bare copper wire, wound around a wooden cage 8" in diameter., ¼" between turns.

Spark gap,—Adjustable series gap, made as shown in the diagram, Fig. 1. The sparking surfaces are of copper, turned in annular or concentric grooves as described in a previous article. Copper washers of ½" and 1" diameter, are slipt alternately on an 8-32 machine screw, and form the heat radiating wings. The further construction and operation of the gap is indicated in the drawing.

Tesla Coil,—Identical in winding to that previously described, viz.,—secondary—on a 2" diameter paper mailing tube wind 480 turns of No. 34 S. C. C. magnet wire (40 turns to the inch; 12" winding, 1" margin on each end). Slip the secondary into a 4" mailing tube, center accurately by means of three corks in each end, seal one end by standing coil on end in a shallow pan filled with melted resin, and when cold fill the annular space between tubes with a mixture of beeswax (yellow) one part, to resin, 5 parts. Wind primary, consisting of six turns "Magneto" cable (which can be bought for five cents a foot) around center of outer tube; turns spaced ½" apart. Secondary leads, of magneto cable, should be connected to the outer posts of the writer's "triple terminals." One arrangement of the complete apparatus is shown in Fig. 2. The triple terminals greatly facilitate the therapeutic use of the Tesla Currents, and also afford an opportunity for studying different forms of the high-frequency discharge. The actual terminals, A and C, are formed of two moulded high-tension insulators, surmounted by 2" brass bed balls, (known to the furniture trade as "brass vases"); thru terminal A slides a brass rod having a rubber or hard-wood handle on the outer end, and a 3" flat brass disc on the inner end. Terminal C is similar but has a small brass ball on the inner end of the sliding rod. A "Dummy" terminal, B, is mounted as shown, midway between the actual terminals. By closing the gap between the brass discs and opening that between the balls B and C, an arc discharge is obtained, while by closing gap B C, and separating the disc electrodes, the discharge forms a beautiful purple brush or "effluve."

In giving treatments the patient is seated on a folding *condenser pad* of thin fibre of Bakelite, Fig. 4, backed with copper or tin foil to which is attached an insulated cord connected with terminal C. The operator will require a set of vacuum electrodes, Fig. 5, a metal hand electrode formed of an eight-inch length of 1¼" nickeled brass pipe, "effluve" electrode made from the gong of an old electric bell screwed on the end of a hard-wood handle, and two pieces of sheet block tin 3" x 3" x 1/32" with insulated conducting cords soldered to their corners, Fig. 6. The condenser-pad can be obtained from any electro-therapeutical supply house, as also the vacuum electrodes and other materials.

For ordinary general treatment to promote nutrition, increase circulation and elimination—a treatment of value in almost any condition of impaired health—the balls and discs are widely separated and

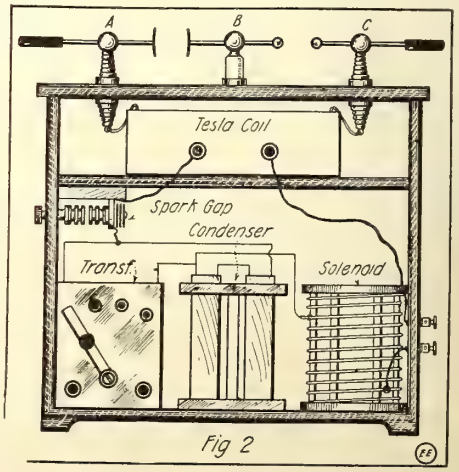


Fig. 2. Assembly of Apparatus in the Author's High Frequency Therapeutic Outfit.

* The new edition of the writer's book, "Essentials of Modern Electrotherapeutics," now in press, gives all needed information, with an alphabetical list of various diseases and the method of treating them electrically.

the patient is seated on the condenser pad connected to the terminal C. Open the spark gap until a vacuum electrode lights up when held about a foot from the patient: this shows that the body is being charged inductively to a high potential, the charges alternating some 1,500,000 times per second. The patient feels nothing and is absolutely insulated from all electrical connection with the apparatus, yet hot sparks can be drawn from any part of the body showing that the whole organism is being subjected to a rapidly alternating molecular massage, which has the effect of increasing all the vital functions without acting as a stimulant. In other words the treatment tends to bring the patient into a normal condition, but it has no more effect upon a perfectly healthy person than pouring water into a pail already full. This is the reason why high frequency treatments may be safely given by those who are not physicians, whereas all other forms of therapeutic currents act as stimulants or counter-irritants and must be employed with precise knowledge and discrimination.

The condenser treatment as described above, is usually given for about fifteen minutes after which the bulb-shaped vacuum electrode is applied for a few minutes over the spine and solar-plexus. It is applied either directly to the surface of the body or thru one thickness of clothing. The insulating handle of the vacuum electrode is connected to the middle post B, in Fig. 2, and after turning on the current and placing the electrode on the patient, the discs A and B, are closed, being opened again before lifting the electrode from the surface of the body: if this is not done painful sparks will pass from the glass electrode to the patient. In treating obstinate cases of recurrent neuralgia, chronic rheumatism and partial paralysis, this vacuum sparking treatment is often beneficial, but it is rather unpleasant for most cases. A milder form of this counter-irritant effect is obtained by using the vacuum electrode over two or three thicknesses of clothing; it must be moved rapidly from place to place, otherwise the skin might be blistered.

For sedative effects and to reduce local inflammation and congestion, the vacuum electrode should always be applied directly to the skin or mucous membrane; this applies to such conditions as acute rheumatism, neuritis, tonsilitis, etc., an acute "cold in the head" (coryza) can often be aborted in one treatment by the above technique, using the vacuum electrode over the nose and the thin slender vacuum electrode in the nasal cavity.

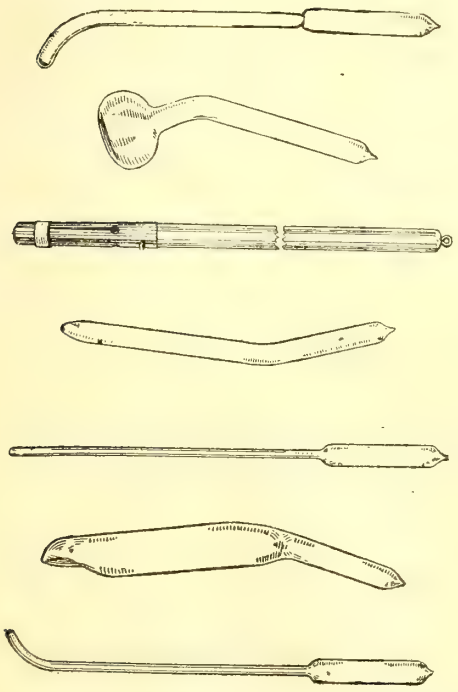


Fig. 5. Various Forms of High Frequency Treatment Electrodes. They Are Made of Glass.

In treating skin diseases, such as eczema and acne, where we wish to avail ourselves of the antiseptic and tonic effects of the "effluve," we connect the effluve electrode in place of the vacuum electrode, close the discs and gradually approach the bell of the electrode to the patient until a full, blue violet effluve plays upon the surface to be treated (see Fig. 3). To obtain the best effluve effects several turns of the tuning coil should be used in series with the Tesla primary (see article in May issue). The effluve is also valuable as a general tonic in sluggish conditions of the digestive system, also in nervous depression and functional nervous diseases.

For the relief of abnormal arterial tension—("high blood-pressure"), and in the treatment of *arteriosclerosis*, as well as in conditions involving excess of uric acid, we employ "D'Arsonval autocondensation." To obtain this current we short-circuit the Tesla primary by means of the single-throw switch, and attach the condenser pad to the lowest turn of the "Solenoid" or tuning coil. The patient clasps both hands around the metal "pipe" electrode connected to the upper turn of the coil, the current is turned on and the spark-gap opened until a pleasing sensation of warmth is felt flow-

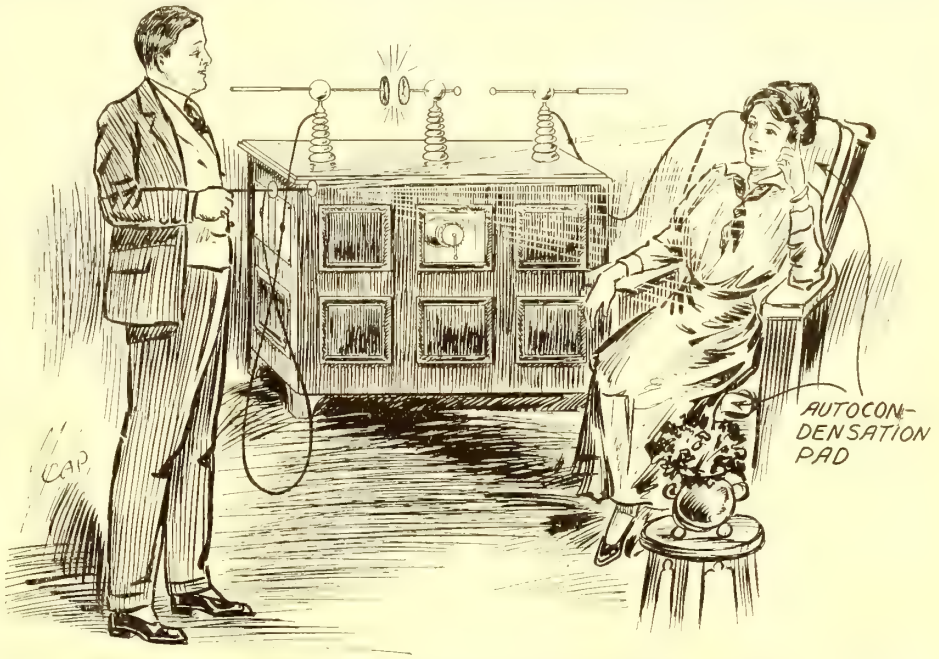
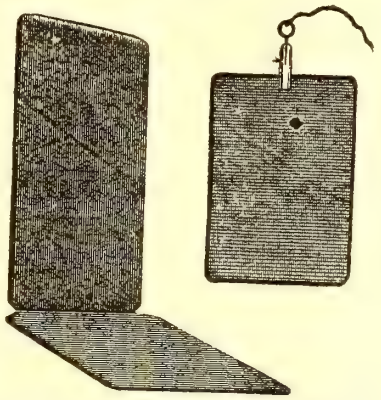


Fig. 3. Showing How a Patient Is Given the High Frequency "Effluve" or Spray Treatment The Patient Sits on a Folding Condenser Pad Placed in the Chair.



Figs. 4 and 6. Condenser Pad Used for Giving Auto-Condensation Treatment and Auxiliary Tin Electrode.

ing up the patient's arms. In all regular therapeutic high-frequency outfits, a hot-wire milliamperemeter is placed between the patient and the machine. This is not necessary in connection with the above described apparatus, as it only delivers a maximum of 800 milli-amperes to the patient—an amount well within the limits of safety. In chronic cases autocondensation should be given daily in twenty-minute treatments. This treatment should never be given immediately after eating, or in cases of "Bright's Disease," or in organic heart trouble. High frequency treatments are of great value even in these conditions, but they should be applied only by a skilled specialist.

In inflammation following acute infection, as in acute bronchitis, incipient pneumonia, etc., we employ "local autocondensation" or "indirect Diathermy." In this method the patient sits upon the pad as for autocondensation, but instead of the metal handle we employ one of the plates of block tin; this is applied in close contact with the skin over the affected area, covered with a folded towel and held in place by the patient; a sensation of deep penetrating heat is felt, and relief from the pain and congestion follows. This is one of the most valuable methods in electrotherapeutics; were it available for the general practitioner, or better still, in the patient's home, there is no doubt but that nine-tenths of the cases of acute local infectious disease could be aborted. This is also of great value in the treatment of asthma.

Statistics show that one-seventh of all recorded deaths are due to Pulmonary Tuberculosis ("Consumption,"): proper treatment in the home by high frequency currents would greatly increase the percentage of recoveries from this dread disease. Dr. Howard Van Renssellaer of the Albany Tuberculosis Hospital has reported 80% of cures by high frequency treatment, and an even higher percentage is reported by Dr. Alfred Geyser of New York. The writer feels that this subject is of sufficient importance to be treated in a separate article, which will appear in next month's ELECTRICAL EXPERIMENTER under the title "The Home Treatment of Tuberculosis with High-frequency Currents."

The RADIO LEAGUE of AMERICA

HONORARY MEMBERS
CAPT. W.H.G. BULLARD, U.S.N. NIKOLA TESLA.
PROF. REGINALD FESSENDEN. DR. LEE DE FOREST.

H. Gernsback, Manager *W. H. Kirwan, Master of Radio Relays*

The Spirit of 1917

AMATEURS of America! Read the accompanying letter, and after you have read it, read it again. If you are a red-blooded American Radio Amateur, to whom the honor of his country means anything at all, you cannot fail to see the moral contained in Mr. Leland Allen's letter.

Here is a young man with wife and children dependent upon him, and who as a rule would be readily excused from serving with the colors. But no! HE realizes for what ideals this country is fighting. *He* is willing to do his share, nay, lay down his very life if need be to make this world free for democracy. *He* knows that this is not just an ordinary small war. *He* don't think about letting the other fellow do the work. Far from it. *He does* know that if we don't fight the enemy "over there," we surely will fight him over here, just as sure as the sun will rise tomorrow.

Now fellow amateurs what are YOU doing about it? Does it not make you blush when you read Mr. Allen's letter, while you sit securely in your home, fooling away your time? Where is your far-famed and oft' boasted American fighting spirit? Don't you single fellows with no *real* ties to keep you home, feel small and ashamed of yourselves, when the married men come forward, while you do nothing? Red-blooded Americans! Yes, where are they? Hiding in the security of their homes. And you pride yourselves as being the descendants of Washington and Lincoln! Both would blush with shame were they to return today to witness the spectacle of seeing only 1,000 Amateurs out of a possible 300,000 step forward to do their share for their glorious country. For up to this writing only about one thousand amateurs have shown their willingness to help their Government by becoming operators in either the Army or the Navy. Just think! 1,000 out of 300,000! What a disgrace to the Radio Fraternity!

Could you blame the officials in Washington after the conclusion of the war if they said:

"We have before us the question of reopening the Radio-amateur stations. The American amateurs demand of their Government the free use of the ether. They had it before the war. Of all countries in the world, the American amateurs had the greatest liberties. These liberties were given them so that in case of war the Government would be assured of obtaining an unlimited number of operators. Now let's see what happened. The war came and the Government wanted operators. It needed some 25,000 of them. Rather a small percentage out of a possible 300,000. Did the Government get these operators after sending out distress calls thru the daily press and thru the technical publications? Not much. Either there are no Radio amateurs in the United States or their Americanism has gone bankrupt. In either case let's wash our hands of the matter. If the amateurs don't need their Government, the Government does not need the amateurs, who at best are a nuisance anyway. Seems to us that these fellows don't believe in the doctrine of 50-50. Their religion is 90-10—ninety for themselves and a bad ten for their Government! Move that we "can" the whole tribe! The Amateur Radio Stations STAY CLOSED. Finis!"

Now Amateurs this is exactly what will happen if the situation does not improve soon. No, we are not as a rule calamity howlers, but we can see ahead of the times, and frequently we have our ears to the ground. We know what's coming, but you apparently do not. If you did, you would come forward and sign your application blank.

Now before you close this magazine, go into your den where no one watches you and have speech with yourself. Just say:

"What on earth is wrong with me anyway? Why am I such a confounded, slow-moving, unappreciative, unimaginative, good-for-nothing radio-slacker? Yes why? I am a husky brute, know all about Radio that's worth knowing, (and then some), eat three square meals a day, loaf a good deal, act the great knows-it-all when the girls are around, but my patriotism has gone bluey. Of course nobody suspects this but myself. When I am with the gang I can wave the Stars and Stripes and shout *"Amerika über Alles"* as well as the best of them! To be sure I mean to sign that old "Radio Honor List" blank *sometime*. But why hurry? Let's first see how many others sign it. Then *sometime* I'll sign it too.

"Yes, let the other fellow be the patriot first.

"But why do I always put things off till tomorrow? Why? I really ought to know better. This procrastination of mine has given me nothing but trouble all my life. It has been my greatest single liability—my great handicap. *Some day* it will cost me my neck . . . . *Damn some day . . . . damn tomorrow . . . .* I'll sign that blank NOW!"

P. S. And be sure to mail it tonight!!

H Gernsback

Woodbine Light and Heating Company
LELAND ALLEN, ENGINEER
WOODBINE, - - IOWA

October 4th 1917.

The Radio League of America.
233 Fulton St.
New York City.

Gentlemen:-

You will please find enclosed the membership blank , filled and signed. I have a family to support but I will start the ball rolling and send in my membership card. If dear old Uncle Sam wants me I'll be there. Of all the single fellows that had wireless sets , and to have hung off this long when the chance of thier life-time is now calling them. The government ought to have been over-run with applications. But if need be , I will step forward , leaving behind a wife and two babies.

Yours for Radio,

Leland Allen

RADIO WRITERS — ATTENTION ! ! !

Can you write radio articles dealing with the practical problems of wireless operating? We can use some good papers on such subjects as "the tuning of radio transmitters"; "the use of the wave meter, including its application to measuring the frequency, wave length and decrement"; "operation of commercial transmitting and receiving sets"; "the operation of army trunk sets"; "improved ways of receiving undamped wave signals," also new ideas and short-cuts for learning the codes. We pay well for all articles accepted. Help yourself, your magazine and your country.

Radio Roll of Honor

Editor's Note. For obvious reasons, the city addresses of the applicants listed below have been left out. Only the name of the Radio Amateur as well as the State in which he resides have been publisht. Every applicant listed in these columns has pledged his services to his country as a radio operator.

All honor, and our sincere congratulations to every young man whose name appears here.

Alabama

Harold L. Mitchell
Paul Draper

Arkansas

Miles Sharp
J. Walter Moore

Arizona

W. N. McKnight
W. H. Buntin

California

Hugo Pearson
H. J. Schnarr
James Glenn
Floyd Hollister
E. E. Twombly
Arthur Munzig
John Stevens
Wm. G. Harris
William Siegel
Joseph A. Axen, Jr.
Howard R. Lee
Jack Rosenberg
Geo. Shong
David Spowart
Roy A. Wilkins
Gilbert A. Trosper
G. A. Trosper
A. W. Martin, Jr.
Chas. F. Filstead

Colorado

Elliott Buchanan
Ed. B. Landon
D. P. Deich

Connecticut

Leslie A. Didsbury
Bud Hartman
Howard Simons
C. S. Keatinge
Walter Payne
Arthur Barney
Ed. J. Heffernan
Suno Larson
F. A. Mulvihill
Wm. F. Murray
William H. Mansfield, Jr.
Adelmer R. Bryon
E. Gaynor Brennan

Delaware

R. A. Gentman

District of Columbia

Edwin A. Emerson
Barton White

Florida

R. C. Holtzclaw

Georgia

Edward Merritt
C. D. Short
Geo. Hamilton

Idaho

Floyd Taylor
Loy Hagerman
Robert Eldridge

Illinois

Folke Martin
Wm. Schrand
H. N. Johnson
Otto Meyer
H. E. Bergae
E. A. Blum
O. L. Keller
C. N. Larson
Richard Rea
Earl Pratt
B. F. Chiles
Jos. H. Chapman
Rowell Herrick
Wm. J. Langan, Jr.
Marvin Messing
Leo. L. Hamilton
Marcus Potter, Jr.
Stanley G. Jones
Ira F. Coon
Lawrence Armantrout
P. J. McGee
R. J. Iversen
Verner Hicks
T. S. Lively
Chas. Bare
Kenneth Baldwin
Chas. D. Thomas, Jr.
Jesse D. Weast
R. C. Kingsley
H. O. Reitsch
Chas. Coe
Harold Sever
Carmi Edward Miller, Jr.
E. Jerome Wolff
Walter S. Franseen

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Leroy F. Bremmer
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G. Windenburgh
F. Starzl
Homer D. White
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Ray Farmer
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Carl A. Mathiasen
Glenn F. Dunfee
B. Harold Miller
Leland Allen
R. H. Smyth

Indiana

Robt. H. Douglass
Richard Boharavoz
W. H. Keller
Clarence F. Kramer
H. A. McIlvaine
C. A. Powers
Leland Miller
G. Bloom
H. Schlemmer
Tom Frazer

Kansas

Carl Paulsen
D. I. Shepherd
J. L. Smith
W. T. Wilshusen

Kentucky

Elby Becker
Lawrence O. Davis
E. A. Hahn
Oscar Ward

Maine

Elwell C. Dyer
Walter Marr
Walter G. Stone
C. A. Rounds
Emery D. Austin
Harold Wilson
Reginald J. Curtis

Maryland

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Wm. A. Needs
Allan C. Poore
Paul A. Burrier

Massachusetts

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Wm. Lewis
G. A. Werner
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M. Stearns
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Alvin R. Mattson
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Robt. J. Engler
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Robt. Hall
M. Bergstrom
Sam Wilkeson

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E. S. Bodine
Hall Anderson
Arthur S. Hughes
Chas. Albert Pfisteres
Irwin Umbright
Lawrence Wilhelm
A. L. Fluesmeier
Lawlon Andrews
Joe P. Rynearson

RADIO AMATEURS! IS *YOUR* NAME HERE?

The Editor of THE ELECTRICAL EXPERIMENTER has patriotically proposed the "Radio Roll of Honor," the first signatures having been publisht in the November issue. Let every Radio Amateur and Expert not at present engaged on work for the government or in the government service sign the blank on page 571. Red-blooded Americans, it is the least you can do. Uncle Sam needs your services NOW! not next year or the year after that. He is calling for tens of thousands of RADIO OPERATORS—not thousands. No other country in the world treats its fighting men better than the United States. The food, clothes, and pay are right. Advancement is rapid and sure. If you are ready to help your country sit right down, sign the appended blank, and mail it to us. We will record your name for next month's "Radio Roll of Honor" and forward the blank to Washington. Come on—"Buck Up" as Tommy Atkins says, and sign up. We have got to have thousands of names.

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Thomas Saunders
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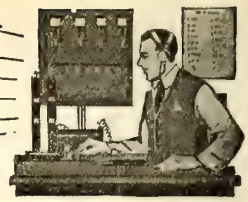
South Dakota

Esli H. Daniels
John A. Miller
Alfred Shaw

(*Continued on page* 571)



RADIO DEPARTMENT



Notice to All Radio Readers

As most of our radio readers are undoubtedly aware, the U. S. Government has decided that all Amateur Wireless Stations, whether licensed or unlicensed, or equipt for receiving or transmitting, shall be closed.

This is a very important consideration, especially to those who are readers of THE ELECTRICAL EXPERIMENTER, *for the reason that we desire to continue to publish valuable articles on the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have publisht in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools thruout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment. Remember that you must not connect up radio apparatus to any form of antenna.—The Editors.*

Some Interesting New Radio Apparatus

THE interesting new radio apparatus shown herewith has been recently developed by Mr. Melville Eastham, the well-known radio engineer, and much of it has been recently employed for use on Government radio equipment. The apparatus is of particular interest to radio experimenters, as while it is of first class design and workmanship, the cost of the instruments is very nominal.

A correctly designed direct-reading wave meter is unequaled in many points, convenience and ease, and speed of readings being important features to consider in all ordinary classes of work with a wave meter. When we achieve accuracy, essential in any wave meter, and extreme compactness and portability, we have an instrument peculiarly adapted to some uses,—such as tuning up transmitters on submarine-chasers, etc. Within the wave lengths adapted to it the wave meter shown in Fig. 1 is unapproached in convenience.

This wave meter is constructed to read from 300 to 1000 meters, resonance for transmitted signals being indicated by a sensitive hot wire meter. For use with required signals a simple crystal detector is mounted on the panel, with binding posts for 'phones. The wave lengths are read directly from a scale which passes beneath a circular window with cross-hair. The inductance is mounted beneath the panel, out of sight, together with the variable air condenser and the body of the hot wire meter. The entire instrument is mounted in a strong oak box which measures 8½ by 5½ by 5½ inches, with a handle for carrying; the total weight is 4¼ pounds. There are no adjustments to be made at any time—simply hold the meter a few feet from the helix, and on the maximum deflection of the hot wire meter, read the wave length directly from the circular window.

The laboratory type wave meter shown

(*Continued on page* 577)

Fig. 1. New 300 to 1,000 Meter Range Direct-Reading Wave Meter. A Hot Wire Meter Indicates Resonance.
Fig. 2. Laboratory Style of Wave Meter Which Is Fitted With Thermo-Couple and Galvanometer, as well as Phones, Detector, Buzzer, etc.
Fig. 3. Radio Relay Key Good for 5 K. W. Equipt with Emergency Lever.
Fig. 4. Flame-Proof Key for Use on Balloons and Aeroplane.

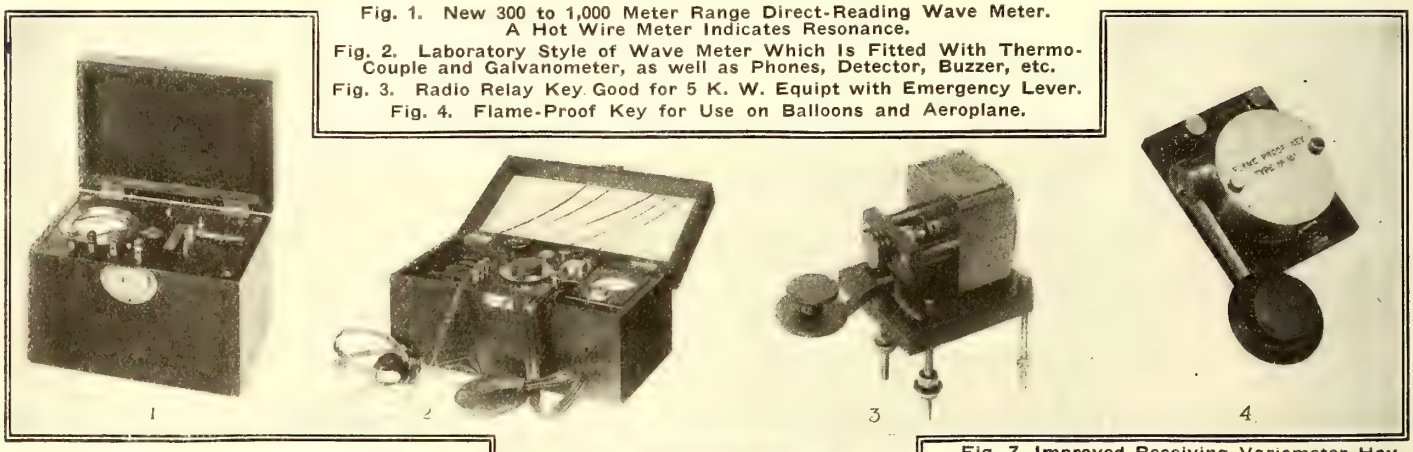


Fig. 5. Wave Meter of Similar Pattern to that in Fig. 1, But Uses 'Phone and Detector to Determine Resonance Point. Normal Range 200 to 2,600 Meters.

Fig. 7. Improved Receiving Variometer Having Three Windings, Connected to a Special Switch Permitting of Series and Parallel Combinations of the Coils. Coils Are Wound Self-Supporting.

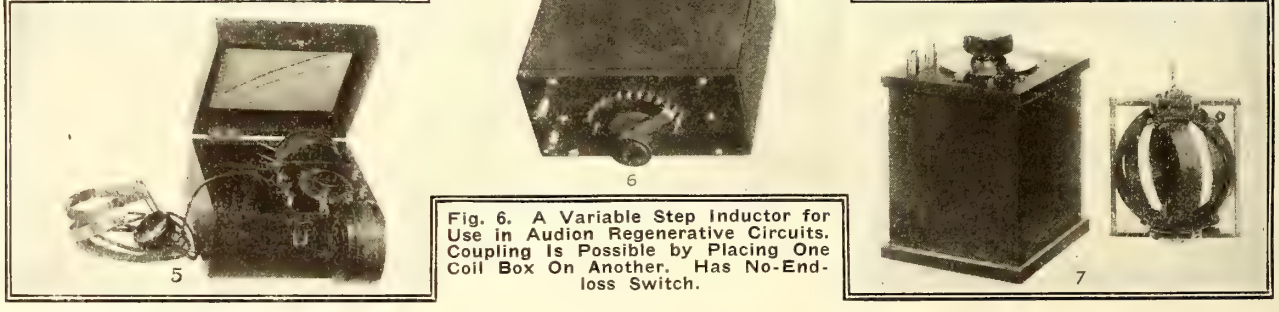


Fig. 6. A Variable Step Inductor for Use in Audion Regenerative Circuits. Coupling Is Possible by Placing One Coil Box On Another. Has No-End-loss Switch.

BLIND OPERATORS IN THE GERMAN ELECTRICAL WORKS.

The authorities in Brandenburg, Germany, have been endeavoring to find occupation for men who have lost their eyesight, and a number are now being employed in the Siemens-Schuckert Electrical Works. They are found quite serviceable for such work as gaging small parts, stamping numbers, packing small articles and testing fuse plugs acoustically. A room is given up to their working, and special precautions are taken in the location and fencing of machines and the elimination of sharp projections that might cause injury. The workers are paid a minimum wage of 28 pf. (about 7 cents) per hour, but some earn as much as 55 pf.. (about 14 cents). It is stated that they prefer machine work to hand work, the noise of the machines being apparently a useful guide to the progress of each operation.

PHONOGRAPH TEACHES WIRELESS CODE QUICKLY.

Perhaps the most useful application of the phonograph to the radio art at present is its adaption to the teaching of the Wireless Code. By the aid of new records invented by Mr. Walter P. Phillips, author of the Phillips code, it is possible to use them on the regular home talking machine, and learn the code without any expensive apparatus.

There are two ways of learning to read by sound. The old way was to have the letters very slowly made with dots and dashes at long intervals apart, and painfully guest out by a combined effort of the intellect and imagination. But the letters made in this manner do not sound as they do when the dots and dashes are placed in close connection, as the pupil must eventually learn to read them. The true way to learn to read by sound is to follow regular and moderate sending from a written or printed slip. In this way the letters reach the ear as they will always sound, and it is not difficult with a copy of the message being ticked out before one to follow it.

The phonograph is an ideal and perfectly adapted machine for this purpose, and it hardly can be realized that it was not invented for this particular purpose. The code records come in a set of eight 10-inch discs—one lesson on each side, making 16 lessons in all, after which time it is possible for the student to advance rapidly.

It is well known that students invariably copy the style of their tutors. Realizing this, only the best of professional men have been chosen to make these records, and the operator chosen for this task holds the Diamond Medal for proficiency in the art.



The Phonograph Has Proven Extremely Valuable in Teaching the Radio Code.

These records are the best means of securing practise in Radio codes at a very small outlay, and I earnestly recommend every student to investigate the merits of these records.—GEORGE HOLMES.

DR. L. W. AUSTIN ON THE AUDION.

Results of observations made on the de Forest-Hudson filament Audion at the United States naval radiotelegraphic laboratory are cited by Dr. L. W. Austin, in the *Journal* of the Washington Academy of Sciences. The gas pressure used in Audion detectors is generally below 0.001 mm. of mercury. By substituting nitrogen for air, to prevent the burning out of the filament, it has been found possible to construct detectors at all pressures up to that of the atmosphere. The action at 3 mm. is entirely normal. Local oscillations are easily produced, and the sensitiveness is fully as great, both for continuous and damped signals, as at the usual pressure. At 10 mm. the sensitiveness is about normal, but local oscillations are more difficult to produce. In the neighborhood of atmospheric pressure no local oscillations have been observed and the sensitiveness to spark signals is much less than at the low pressures. The conditions in this case would undoubtedly be much improved by bringing the electrodes closer together. Even with the ordinary arrangement of electrodes, the changes in the grid and plate currents due to the incoming waves are similar to those observed in the usual vacuum. With 200 volts, the plate current amounts to 20 or 30 micro-amperes. Data are also given on the effect of the D. C. voltage between grid and filament on grid and plate signals.

WIRELESS SETS ARE LIGHT.

One of the wireless sets, employed by the United States Signal Corps, succeeded in communicating over a distance of 119 miles, from an aeroplane, weighs only 60 pounds. Another set, developed at North Island, San Diego, Cal., weighs about 45 pounds, and it has covered a distance of more than 150 miles, while flying at an elevation of 700 feet.

Some of these light weight aeroplane radio transmitting sets utilize a buzzer and "kick" coil, such as featured by Dubelier.



The Wireless Class Maintained by the South Jersey Radio Association at the High School in Collingswood, N. J. This Is What Every Radio Club and Association Should Do to Help Their Country.

NEW JERSEY RADIO ASSOCIATION TO TEACH WIRELESS CLASS.

The South Jersey Association Radio Class opened in the High School at Collingswood, N. J., recently with a large number joining the wireless telegraphy class, including seventeen persons who were not members of the association. Harry W. Densham, secretary of the association, is the permanent instructor and gave the first lesson in radio experiments and wireless telegraphy at this meeting. Several women joined the class and it is expected that nearly one hundred will become members. Those who desire to register and for information 'phone or write H. W. Densham, 410 Woodlawn avenue, and C. Waldo Batchelor, president, 207 Woodlawn terrace. Mr. Densham gives his services and instruction free as "his bit" for Uncle Sam.

BIG RADIO PLANT PUT UP AT CAMP DEVENS.

A portable wireless station, said to be the most powerful in the country, is being set up at Camp Devens, Ayer, Mass., and completed, as a monument to the zeal and patriotism of a group of college men, scions of wealthy families.

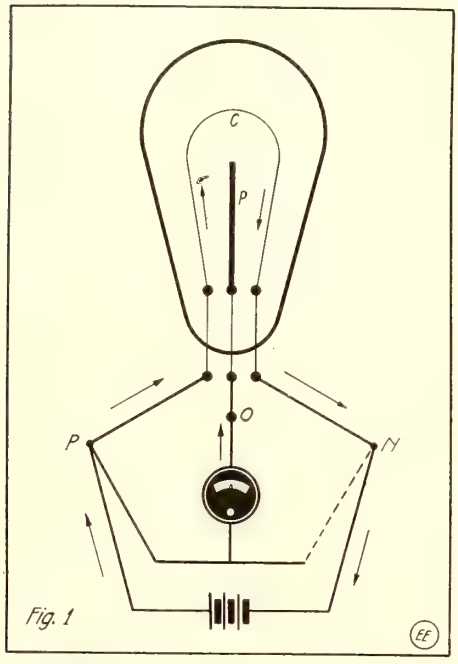
Capt. J. J. Fanning is the skipper of this crew of signal corps experts, crack radio and telegraph operators, mechanics and electricians, who bear the label of 301st Field Signal Battalion, Reserve Corps.

Departmental red tape having interfered with the furnishing of their equipment, they bought their own, and have erected a pole 70 feet high on which the antenna will be spread to intercept messages from Panama, London and other places, and also German messages.

The Audion and The "Edison Effect"

By GEORGE HOLMES

MUCH has been said both pro and con on the Audion of late and considerable litigation has taken place between various claimants for the discovery of same. This naturally has set our vast numbers of amateur and professional



The Simplest Form of "Edison Valve," Having a Platinum Electrode Mounted Between the Legs of the Filament. When the C. P. Was Raised a Current Was Found to Flow Thru the Galvanometer.

radio men wondering where to secure their Audion apparatus and as to what will develop that will place this instrument on the market again or some substitute equally as efficient.

De Forest and Fleming both have certain claims, it is true, altho it has been shown that both their types of bulbs are used differently and achieve excellent results; especially is this true of the Audion.

At a recent meeting of the *Institute of Radio Engineers* at New York, the why and wherefore of the Audion was thoroly discust and the fact presented that the same could be used as an *oscillator* and *amplifier,* whereas with the Fleming valve, it was impossible to do this.

Then again there is a call from Mr. Meadowcroft, Edison's associate, to the technical press, to the effect that Mr. Edison has first place as the inventor of the principle from which was derived the present day *valve,* Audion and other hybrid forms of vacuum bulb detectors.

Looking up the history of the subject, the writer succeeded in locating the fact that in a paper presented before the first meeting of the Institute of Electrical Engineers, way back in 1884, there was shown the principle of the valve as discovered by Edison, and bulbs containing *third members* (electrodes) were displayed.

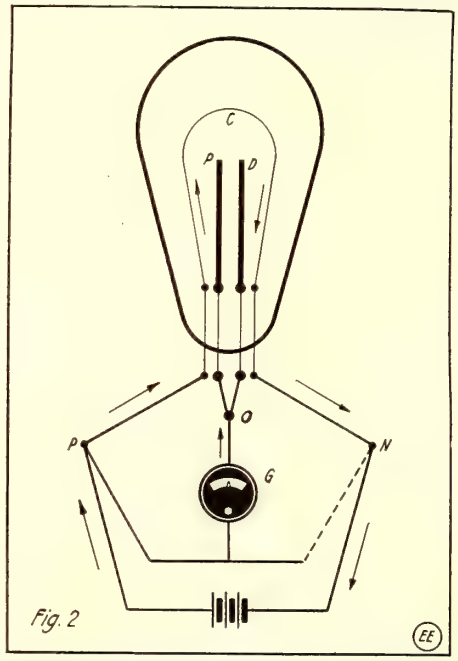
Due credit must be given to Edison for his practical improvements of the incandescent lamp and it seems that while experimenting on this device with various elements that the following phenomena were noticed and recorded.

It is not my object or purpose to make any certain claims, only to give the readers a light on a very obscure point as to the first discovery of the principles of the vacuum valve. Later, with certain improvements and different forms of elements the present day valve was brought out, but it seems that Mr .Edison should receive credit for it in some way, altho he probably had no conception at that time of the application his principle would be put to.

Referring to Fig. 1, a platinum strip or plate (P) will be seen supported between the two branches of the usual looped filament. The posts P and N are connected to the ends of the carbon loop, and O to one end of the platinum plate; P is the positive and N the negative terminal of the electric source. The lamp is placed in the circuit of an electrical source or battery; the current will then flow as per arrows. The galvanometer G, has one of its terminals connected with the positive terminal P and the other with the platinum plate.

Now, it was proved that if the ordinary current used in producing incandescence is passing thru the filament, no unusual effects were noticed. But if the current is increased, so that incandescence is raised above normal, for instance eight candle power to twenty, thirty, forty, fifty, or perhaps one hundred candle power, then the needle of the galvanometer is violently deflected by a current passing thru its coils.

When the connections were reversed, that is to say the galvanometer terminal



A Similar "Edison Valve" to Fig. 1, Excepting That Two Auxiliary Platinum Plates Are Used. Galvanometer Deflections Were Also Obtained With This Arrangement.

from P to N terminal as per dotted line, then a current of negative polarity flowed, but greatly reduced, or about one fortieth of the previous flow.

It was thought at the time that a Crookes' discharge from one of the poles might produce an electrical bombardment against the plate, each molecule taking a small charge that might produce the effect of a current.

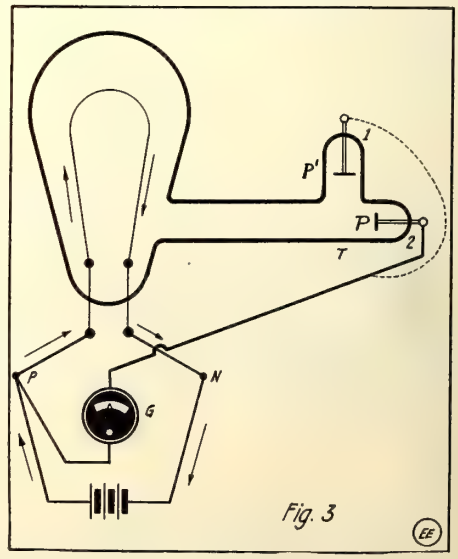
Such being the case, if we conceive a flow of molecules passing from the platinum electrode to the heated carbon, then the phenomenon may readily be explained as a *Crookes' effect,* since we can regard a current flowing in a parallel circuit, from P to N thru the carbon loop and from P thru G, O and P to the carbon loop. But remembering that the direction of the current is reversed or apparently so, then when the galvanometer is connected to the negative terminal N, the difficulty is to understand how the current there produced could possibly overcome the current from the source supplying the lamp. It was also noticed that the deflection of the galvanometer needle was quite feeble when connected to the negative terminal.

In Fig. 2, we have another lamp whose parts are the same as in Fig. 1 only two platinum strips, PD, placed parallel to each other are incorporated. Prof. Edwin J. Houston at that time said that if a current is produced when terminals, O, are connected to the galvanometer, then the phenomena is still more difficult of explanation, but he believed that one pole of the electrical source or power is always connected with the galvanometer, the other being connected with either or both of the platinum plates; such being the case the phenomena would simply be a modification of the action in bulb shown in Fig. 1.

He also believed that in some way the molecular bombardments against the platinum plate produced an electrical current; such being true, then if terminal N, is connected with the galvanometer, the current would flow thru the galvanometer in an opposite direction to the current from the electrical source, rendering the previous idea untenable, owing to the fact that the phenomena could not be described as a *Crookes' effect.*

But if we suppose this opposite current out of the way, then it may show the sufficiency of the Crookes' effect as an explanation of the phenomena. This was illustrated by further experiments performed by Mr. Edison, which threw no little light on the matter. Referring to Fig. 3, instead of placing the platinum pole, P, inside the carbon loop, it was placed at the end of a long tube T, this tube forming a part of the lamp chamber. When connections were made, as shown, with the platinum plate at P, so as to place it in line with the carbon, and therefore expose the filament to the bombardment of the molecules shot out from the charged platinum disc, the needle of the galvanometer was deflected, even tho the tube T was surrounded by a freezing mixture. However, when the platinum plate was placed at P^1, in the branch tube, out of

(*Continued on page* 578)



Modified "Valve" Tried by Edison, In Which the Auxiliary Electrode "P" Was Mounted at the End of an Extended Chamber "T." Distinct Galvanometer Deflections Were Easily Obtained With This Device.

The How and Why of Radio Apparatus

No. 5—Radio Transmitting Inductances.

From time to time we will describe one particular instrument used in either the radio transmitting or receiving set, explaining just how it works, and why. We have received so many requests from new readers asking for such explanations, that we have decided to publish this matter in serial form. In the course of several issues all of the principal transmitting and receiving apparatus will have been covered. The subject for the second paper is RADIO TRANSMITTING INDUCTANCES.

RADIO transmitting inductances are of several types. The principal characteristic of this particular piece of apparatus is that it invariably has an "air" core, in contradistinction to the ordinary alternating current inductance, which is most always provided with a laminated iron core.

The difference between these two forms of inductance as just described is due to the fact that the frequency is so high in radio oscillatory circuits that iron cannot be efficiently used for several reasons. There may come a day when we shall have radio inductances with iron cores, but up to the present time it has not been found practicable to provide them, even tho there is a very large loss due to the electromagnetic induction which has to take place thru air which, as is well-known, is a very poor conductor of magnetism. Iron at radio frequencies and in such circuits as these tends to lag behind the rapidly changing current, and gives a very low power factor, besides producing a high loss due to hysteresis.

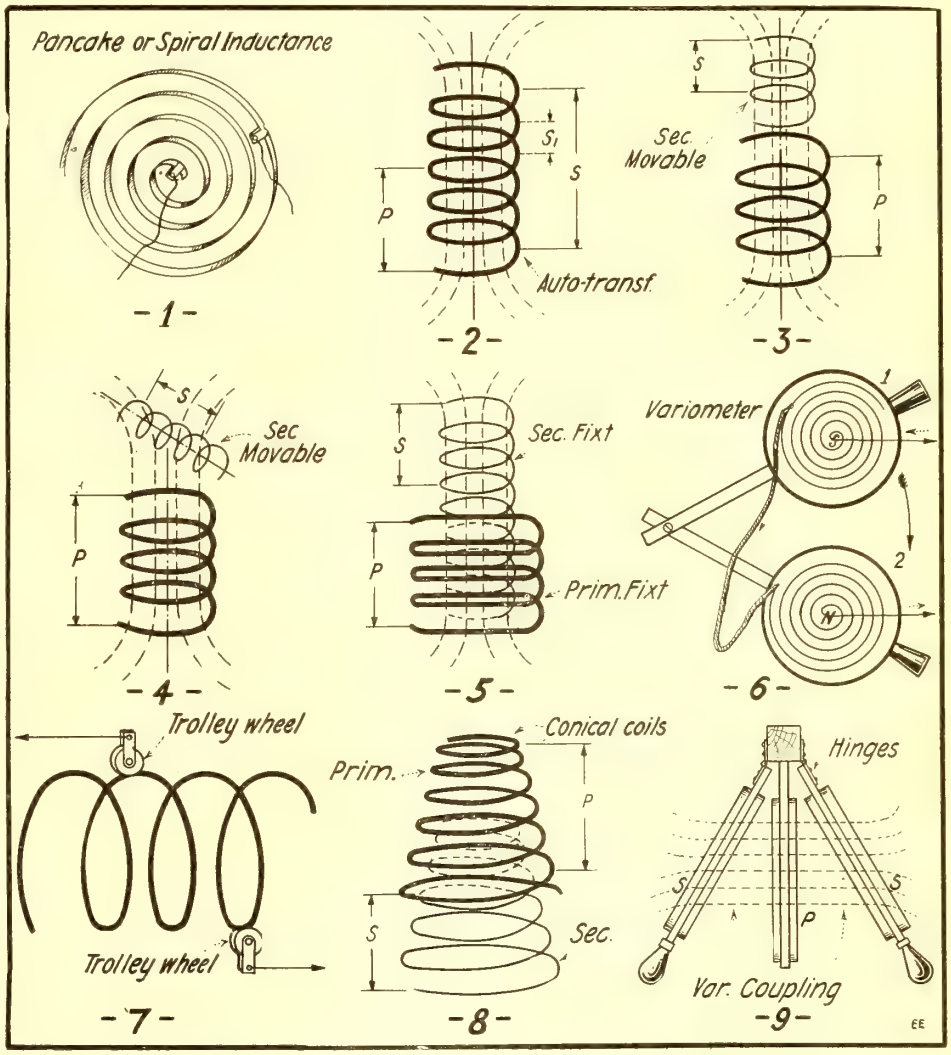
We will take up in this paper several types of tuning inductances used in radio transmitting circuits, and which have been adopted in actual practise. Fig. 1 shows what is known as the "pan-cake" or spiral inductance. This is a very effective form, particularly when wound of flat copper ribbon. It is sometimes built of heavy round wire, but the flat ribbon of course gives the most efficient results. Spring clips are provided with practically all inductance coils of these types, so that any part thereof may be included in the circuits to which they are connected.

The inductance illustrated in Fig. 2, comprises what is known as an *auto-transformer.* In this case a single winding serves as both primary and secondary. The primary circuit being connected across at P, and the secondary circuit connected across the clips at S or Sl, etc. It is possible to vary the coupling between the primary and secondary circuits to some extent with such a transformer, by connecting one of the circuits to the position Sl (*i.e.,* widely separated), for instance, as related to the second circuit at P.

The dotted lines running axially in diagrams here shown indicate the magnetic field set up when current passes thru the coil, and the action of the auto-transformer becomes evident from Fig. 2, as it will be seen that all of the turns in the coil are threaded or cut by magnetic flux created in it. Thus it is possible to increase the potential of a circuit with a single winding as shown. When potentials are to be increased by auto-transformers, the ratio between primary and secondary voltages is usually not greater than 3 to 1 or 8 to 1.

Diagram Fig. 3 shows the simplest form of *loose-coupled* oscillation transformer for transmitting circuits, and which comprises a helix P, into which a smaller coil S, or secondary, may slide. The spark gap circuit is usually connected to the outer coil or across the clips P, while the aerial and ground connections are made to the movable secondary coil S. In any case, the number of turns, or fraction of a turn, in either circuit are adjusted, with a hot-wire ammeter connected in the ground lead, until a maximum radiation current is obtained. Of course, the wave length must be checked on a wave meter, or else computed, but the wave meter method is always preferable. The action of this two-coil oscillation tuning transformer is evident from the illustration Fig. 3, where it is seen that the magnetic flux lines from coil P, cut across the turns of the secondary coil, even tho the thus variable and the amount of inductance in either circuit is adjustable as in other types of transformers; *i.e,* by changing the numbers of active turns in circuit. The position for maximum coupling with this oscillation transformer occurs when the secondary and primary coils are placed in the same axial relation; when the secondary coil is rotated 90 degrees, or in a position at right angles with respect to the primary coil, a position of minimum coupling is obtained. The magnetic flux field is shown by the dotted lines as in the other diagrams.

There is another form of two-coil oscillation tranformer which has been used quite



All of the Principal Types of Radio Transmitting Inductances Are Illustrated Above. The Peculiar Characteristics of Each One Are Explained in the Accompanying Text.

coils are often quite widely separated.

Maximum coupling is obtained when the secondary coil is all the way within the primary coil, and vice versa. A unique type of transmitting inductance having two coils, one for the secondary and one for the primary, is shown at Fig. 4.

This type has found much favor in commercial radio circles, and works very efficiently when it is properly related to, and designed for use with a certain type and size transmitting set. The primary coil which is usually the larger one is shown at P, while S, or the secondary coil, is rotatably mounted in a fixt axial position above the primary. The degree of coupling is extensively in commercial radio work as well as in experimental and amateur stations, and this is illustrated at Fig. 5.

Here the secondary as well as the primary windings are fixt and mounted upon a stationary frame. Considerable variation in the coupling can be obtained by causing the secondary active turns to be at the upper end of the fixt secondary winding, while the active primary turns are caused to be at the lower end of the fixt primary winding, and vice versa.

One of the easiest ways of making a two-coil oscillation transformer is based upon this principle, and necessitates the cutting

(*Continued on page* 574)

Efficient Dry Battery Service for Audions

By RALPH BATCHER

NOTWITHSTANDING the progress made in storage battery construction in recent years still the uses for dry batteries are increasing as never before.

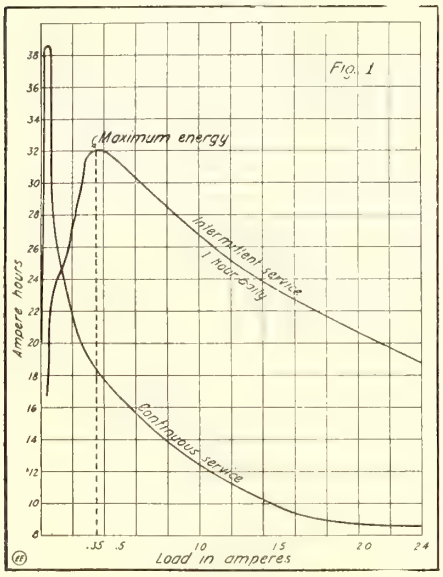


Fig. 1. Graphic Curve Showing the Energy That Can Be Obtained From a Dry Cell with Various Discharge Rates. The Maximum Ampere-Hours Output Was Obtained with a Load of .35 Ampere, as Will Be Observed.

Since the advent of the "Radio vacation" all amateurs who are really experimenters have been planning improvements for their stations when the day should come when the "lid" was removed. Those who have not used an Audion are planning a way to procure this important piece of apparatus. But with an Audion a storage battery is necessary, they are told. But since all amateurs have not access to charging facilities they must use dry batteries.

The question now remains to find out if dry batteries can be used with any degree of efficiency, and if so how they should be connected.

A tubular Audion bulb has a resistance [hot] of about 4.25 ohms. This value is the average of several bulbs burned at about normal brilliancy. Such a bulb takes from .9 to 1.1 amperes (generally nearer the former value). From Ohm's Law (voltage equals amperes multiplied by ohms resistance) we find that it will take from 4 to 4.5 volts imprest on the filament to furnish this amount of current. A dry cell gives 1.5 volts so at least three cells in series will be required. It may be necessary to use a rheostat with a lower resistance and finer variations than the one generally used, if but three cells are used. With this arrangement but very little current would be lost in the rheostat resistance itself.

Referring to Fig. 1 a curve is given showing the energy that can be obtained from a dry cell with various discharge rates. The curves are plotted from data furnished by the National Carbon Co., obtained with ordinary batteries. In the computation of the life of a cell, the time was taken until the voltage dropt to .8 volt.

It will be seen that for intermittent use of 1 hour daily, that the greatest number of ampere-hours are obtained when .35 ampere is taken from a cell. Thus three cells must be used in parallel if 1 ampere is to be used to give efficient dry cell service. The battery must contain nine cells connected in series-parallel to give the 4.5 volts and 1 ampere. The combination will give a little over 325 watt-hours of energy. It will be necessary in time to either add another cell to each series set, or reconnect them so that four cells are in series to maintain sufficient voltage to operate the bulb.

There is another idea that can be followed up when it is desired to furnish the greatest amount of energy to an external circuit with the minimum consumption of current, from the dry cells.

Ohm's Law states

1. $I = \frac{E}{R}$, where I equals the current in the circuit, E the voltage, and R the total resistance.

The electrical expression for energy is

$$P = RI^2$$

Therefore, since $I^2 = \frac{E^2}{R^2}$ $P = RI^2 = \frac{E^2R}{R^2}$

R is equal to the total resistance of the circuit, which in the case of a circuit using dry batteries, is equal to the sum of the external resistance (load) and the internal resistance of the cell or cells. (It should be remembered that the internal resistance of cells in series adds up, while the resistance of cells in multiple follows the reciprocal law) which we will call R and r respectively, as in Fig. 2.

Then $P = \frac{E^2 R}{(R+r)^2}$

Now what value of R can be found so that the useful energy in the circuit is at a maximum with the smallest amount of current, this is: RI^2 is greatest for the smallest value of I. This value can be found

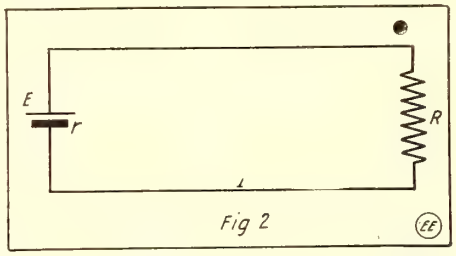


Fig. 2. To Obtain the Greatest Value of Energy in a Circuit the "External Resistance" Must Be Equal to the "Internal Resistance" of the Battery. That Is R = r.

by a simple application of differential calculus.

Differentiating Eq. 3,

$$\frac{dP}{dR} = \frac{-2E^2R+E^2}{(R+r)^3}\frac{(R+r)}{} = \frac{-2E^2R+E^2R+E^2r}{(R+r)^3}$$

$$\frac{E^2(r-R)}{(R+r)^3} = 0$$

Solving the above equation for the real roots gives for the maximum value

$r - R = 0$ or $R = r$

The same thing can be shown in a rough way by substituting values for R and finding the value RI^2 in each case.

Therefore to obtain the greatest value of energy in a circuit the "external resistance" must be equal to the "internal resistance" of the cells.

RUSSIAN SOLDIERS AMAZED AT WIRELESS.

An interesting description is given by a Russian officer of one of the numerous little mobile field wireless outfits operating near the front. The whole wireless station can be unloaded from its auto truck, rigged up, and be ready for work in twenty minutes. The seventy-foot masts are hollow and made in sections, which are screwed together when taken off the truck.

The simple peasant soldiers, many of whom come from remote villages where wireless has never been heard of, are greatly fascinated by the station, and like to stand around when they can get a chance and watch the flashing of the spark and listen to its song. "It sounds like butter in a frying pan," they say. They have coined a nickname for the men in the wireless crew, which, as near as possible in English, is "sparkers" or "the spark men."

HOW TO OPERATE AUDION ON 110 VOLTS D. C.

By Norman A. Woodcock.

(De Forest Radio Telephone and Telegraph Co.)

In a recent article in the ELECTRICAL EXPERIMENTER, by R. F. Yates, the question was asked as to why the use of a high potential battery could not be dispensed with in the plate circuit of an Audion. Whilst at the present stage of development, a high potential is absolutely necessary between the plate and filament, there is no longer any reason why batteries should be used for this purpose.

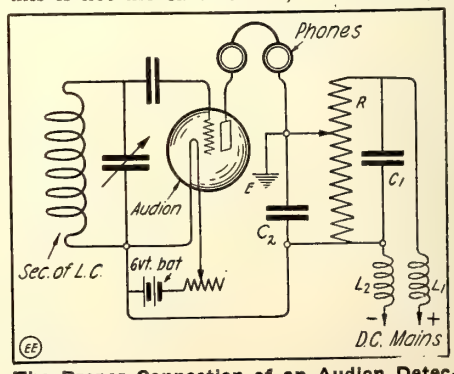
Thanks to a recent invention due to Dr. Lee de Forest, a means has been developed whereby the ordinary 110 volt, D. C. supply can be utilized instead of the expensive and cumbersome flashlight batteries generally employed.

The circuit shown in the accompanying diagram is simple, and could readily be made up by any amateur experimenter possessing a little ingenuity. To avoid mistakes, the entire Audion hook-up is shown. This is standard, with the exception that the high voltage battery in the plate circuit is replaced by the arrangement now to be described.

The ordinary 110 volt D. C. mains are connected thru a pair of choke coils L_1L_2, to the terminals of a condenser C_1. These choke coils may be composed of fine insulated wire wound upon iron cores, whilst the condenser may be of 1 or 2 m.f. capacity.

R represents a high resistance potentiometer having a sliding contact as indicated. The resistance should range from about 5000 to 25,000 ohms. A grafite rod will serve the purpose admirably.

The remaining condenser C_2 may be of 1 m.f. capacity, whilst the circuit may be grounded as shown at E or not, as found advisable by experiment. Suitable condensers may be purchased from any electrical supply house, as they are in common use in telephone practise. When the circuit is properly adjusted, there should be practically no noise heard in the telephones. If this is not the case at first, a few trial adjustments will usually give the desired result.



The Proper Connection of an Audion Detector to a Direct Current Lighting Circuit, to Elliminate the "B" Battery. The Latest Audion Sets Operate In This Way.

It should be hardly necessary to add that the above arrangement *will not work* on Alternating Current.

THE CONSTRUCTOR



The Uncrowning of the Gimcrack King

By THOMAS REED

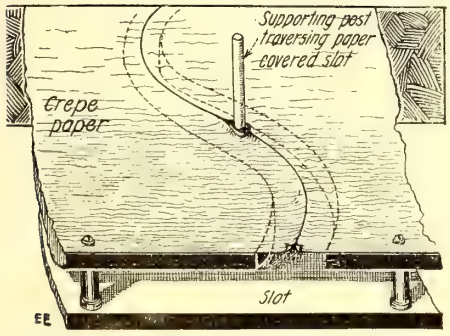
DID you ever have a large, fat fortune come and stare you in the face, hold out its hand in the most enticing way, and then suddenly turn its back on you and beat it? I did. It came about thru my advertising novelty, the "Sailing Boat."

In my early days, the only advertising novelty was to advertise at all. If you were going to all the trouble of running a store to sell thread and buttons and hoop-skirts, the public surely ought to reciprocate by giving you their trade. They had to, anyway, if yours was the only place in town. You didn't need to tell them where to go; and to tease them into buying when they didn't really need to would have been wicked.

Advertising was resorted to only as a simple home remedy for an attack of competition. Suppose some mercantile pirate, without regard for God or man, opened up a store next door to yours, with a line of buttons that the women—the crazy things!—liked better than the ones the drummer stung you on three years ago, and commenced swiping your trade. Well, when you'd become sufficiently scared, and your wife was going strong on how she'd always told you so but you wouldn't listen to her and what was going to become of the happy home now, you sought the village editor and paid him seventy-five cents for an advertisement in his paper, something like this:

H. GREEN
Dry Goods.
14 Main Street

No pictures of women in the corset-stage of plumage—mercy sakes!—or offers to sell goods for less than they cost you—what were you in business for, anyway? No, merely a dignified reminder that the public was—no doubt inadvertently—straying from the only legitimate joint in which to garb itself in proper garbage. What an expense!



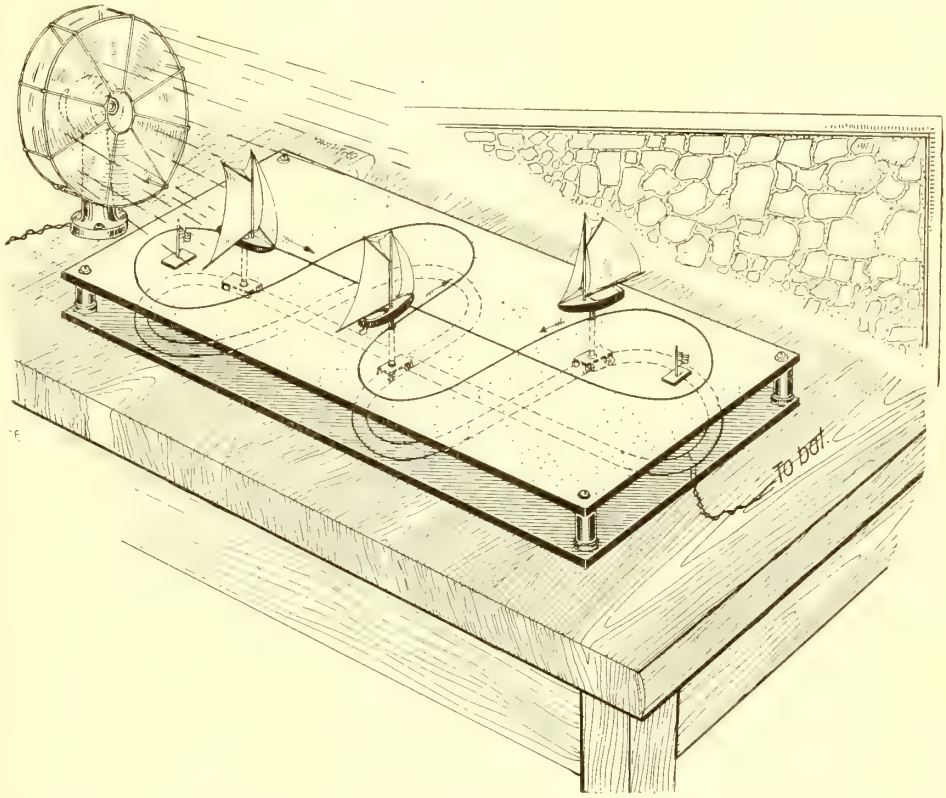
Detail of Crepe Paper "Water" and Method of Covering Slot So That Post Supporting Boat Would Not Leave Slot Open.

Seventy-five cents just for that, when you knew the editor used the same type over again for something else, so it didn't cost him anything. However, it had to be done; and now you hoped to goodness your trouble with that competitor was at an end. Such was advertising before it began to be spelled with a large, bold face capital "A."

I remember well when the capital "A" first came within my ken. Uncle George had been to New York, and one evening he dropt in and told us about it. Things had got to an awful pass there, he said. Quantities of stores kept the very same articles, and the only way to get any trade at all, or even keep what you had, was to *advertise*. Some people did it every little while. It was a terrible expense, and ate into your profits like anything.

Well, he told of the various things they did to catch people's attention, and I was dozing off because it was kind of warm in the sitting-room, when I sat up with a start, for he was talking about certain motion-novelties, animated "figgers" in the windows, that folks stopt to look at. Any silly contraption would draw a crowd, he said; tho he couldn't see the use of it, because most everybody just looked and past along, and never even went into the store at all. Personally, he wouldn't waste his time looking at such "gimcracks."

There was one exception, tho, on which he had bestowed a moment. It was in the window of a restaurant, and consisted of a miniature of that restaurant itself, just as perfect as could be, with a file of lear



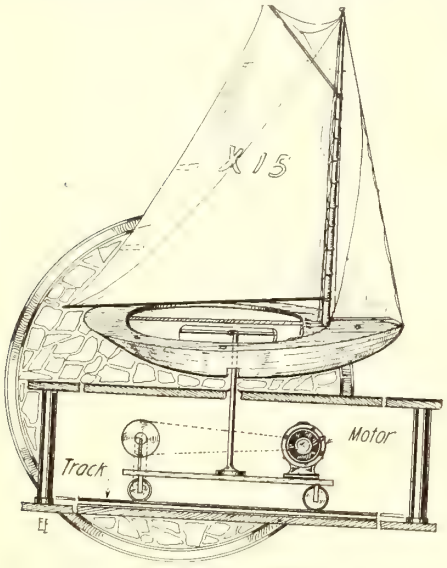
Here's the Boss "Gim-crack"—It Almost Coined Money. The Breeze From the Electric Fan Caused the Sail-boat to Swing Over Realistically As It Rounded the Curves. The Boat Was Propelled on a Miniature Electric Railway Car.

people going in one door, and a file of fat ones coming out another door. "As much as to say they'd eaten a lot inside the place—explained Uncle George for fear we'd miss the point—"see what I mean?"

If this novelty was the only one Uncle George had favored with his attention, he sure made up for it with his neglect of the others; for he watched its operation so long that he digested his last meal and got hungry again; and this restaurant being so near him, the impulse struck him to be a wild-eyed sport and go in there and dine. The funny thing about it was, he found the dinner first-rate, and cheaper than at his hotel, so he took all the rest of his meals there while he stayed in town. He strongly recommended the place to Father the next time he should go to New York, and gave him a card that he'd asked the proprietor for on purpose, so Father could find it. "But gosh," said Uncle George, "you'd never know the place was any good to look at it—no pies or cake in the window, nothing at all but that fool toy—perfectly useless, and it must have cost a lot, too." According

to him, those New Yorkers didn't know any better than to throw their money away.

They say it takes the new generation to get the fresh viewpoint; and I got it, tho,



Side View of Sail-boat Mounted on Miniature Electric Railway Car. The Car Motor Obtains "Juice" from the Two Insulated Rails, the Axles Being Insulated Also.

of course, I didn't mention it aloud because in those days there was no great demand for younger generations' fresh viewpoints, or freshness of any kind. In spite of Uncle George's disdain, it struck me that if a gimcrack was persuasive enough to wean a man like him from the table of the trusty Broadway Central, sell him a long line of "eats," and send him home a booster, such contrivances must have the merchandising world absolutely by the tail.

Instantly a vast prospect opened to me, of success and wealth in this direction, for gimcracks were decidedly in my line. The only trouble with those which I was always making and imagining was that, tho undoubtedly interesting, they were not of the slightest use. But here was a way to turn the interest into use; and I pictured an endless series of brilliant mechanical devices emanating from my brain like the fat people from Uncle George's restaurant, faring forth to earn me royalties and make me famous as the "Gimcrack King." There was practically nothing to it; in fact, I wisht the thing had been a little more difficult, because some historian in later times, reading of my meteoric rise, might get wise to the fact that it had been nothing but play to me, and so belittle my achievement.

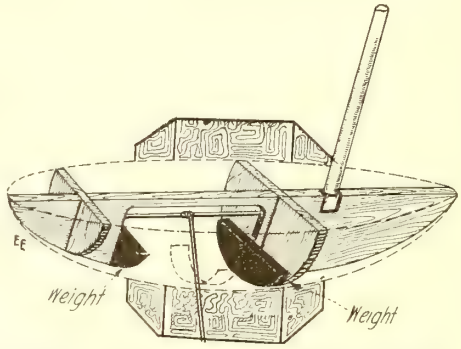
The next day, I was at work on Gimcrack No. 1. I realized I should have to begin in rather a small way, strictly on my private resources. I was averse to borrowing money from Father for the promotion of new enterprises, and he shared my aversion; I may even say that since the clock episode his share was the larger. So, out of the many ideas already in stock, I chose the "Sailing Boat," as the least expensive.

The accompanying illustrations show the principle. The boat, of the lightest possible construction, was mounted on a small truck, rolling on a track, and driven by a toy electric motor "geared down" to produce the slow and stately motion of a floating craft. A slender steel post elevated the boat itself above a wooden flooring, concealing the tracks and motor-truck, and covered with blue crepe paper to represent the sea; the paper being continued over the edges of the narrow crack thru which the post ran, meeting at the middle and parting and reuniting on the passage of the post, so that the surface appeared unbroken.

The boat, balanced lengthwise on pivots and weighted at the bottom, heeled over with a natural slant to *starboard* and *port* as she "beat to windward" against the breeze from a concealed electric fan. Rounding the weather buoy, she would straighten out and go off "down the wind" to the other end of the ocean floor, when she would luff majestically round the leeward buoy and recommence her tacking.

Elaborating the idea, certain sections of the tracks were insulated and provided with small resistance-coils, so that the boat varied in speed, as tho the wind lulled and freshened. I thought of introducing later a second boat, which should follow the first, sometimes appearing almost to overtake it, but always losing headway at the critical moment—a bid for the sympathy of the large "also-ran" element of the populace; but a single boat was all I was able to finance at the start.

When this rinktum was in operation, the family were invited to a private view. Being obliged to impersonate the electric fan myself, my lung-power gale produced an unusually "wild night on the coast," the good ship Mary Ann careening till she almost (theoretically) capsized while making hardly any progress, then going at a rapid pace without her sails filling at all. This inconsistency being duly explained, the family admired the invention mildly, but toward its wealth-producing function they were cool. Hadn't I heard what Uncle



Phantom View of Sail-boat Showing Disposition of Lead Balance Weights Inside Hull. These Keep the Boat on a Level Keel Normally.

George said? New Yorkers might waste their money on such things, tho even they must learn wisdom pretty soon; certainly no New Englander would think of mutilating his hard-earned profits in that way. I'd find out, they guest. Thus they put the gloom on me, as families always do.

An inventor is never a good promoter; and I was so far from an exception to the rule that I amounted to what you might call a *retro-moter,* or one whose scheme, instead of going forward to profit, goes backward to a point where he's lucky if he can let go of it before it tows him into the Bankruptcy Court; but I didn't know that then. Regarding the demand for the boat as a certainty, I gave careful consideration to the amount of royalty. $50.00 a week occurred to me as a convenient round number. It was worth that, of course; but it would probably be better along the first, until the business was establisht, to charge much less, say $25.00 or even $10.00 tho it would have to be understood that this was a temporary rate for introductory purposes only.

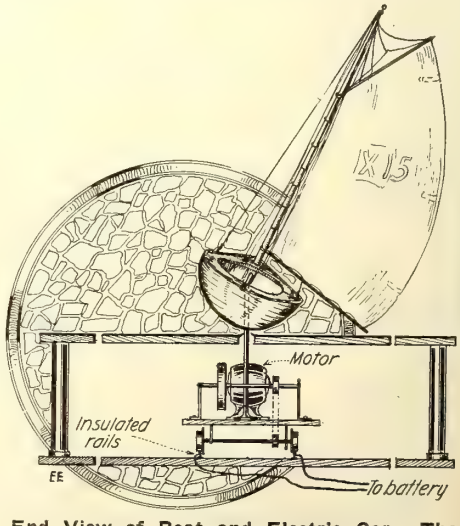
From even the introductory $10.00 rate, I evolved some highly satisfactory figures. The Sailing Boat had cost me, all told, $2.03, so that practically five new ones could be built from each week's profits. At the end of the second week, therefore, my income would be $60.00; at the end of the third week, $360.00; fourth week, $2,220.00; fifth week, $13,320.00; and sixth week, $79,920.00. I stopt there because the supper-bell rang. It seemed like a lot of money. Perhaps, to be perfectly safe, one had better call it an even $70,000.00; there might be setbacks, of course. Anyhow, when the weekly receipts reached some such figure, it would be safe to divert part of the profits from development, and perhaps purchase one or two articles of luxury.

Now please don't interrupt me while I tell of the disastrous beginning (which was also the end) of my campaign to introduce the Sailing Boat, because I'm much older now and very, very much wiser, and I anticipate your suggestion that instead of tackling the most successful merchant in town, I should have approached the struggling fellow who felt the need of something to stimulate trade. Sure, sure; I know. But as the amounts of money already involved were so large, I felt that the lessee's credit was the first consideration; so, as intimated, I opened negotiations with Zebediah Crowell, whose dry-goods and notion store was the thriftiest thing within the purlieus—Zebediah, while the tightest wad in town, being apparently best equipt to stand the strain of my royalties.

Altho my anticipations of profit were somewhat too intoxicating for a no-license town such as mine, I needed them all to offset the parental scepticism; for father said that no money ever got away from Crowell's grip without suffering internal injuries in the process. So my state of mind might be described as firmness, rather than optimism, as I entered his imposing store, lugging my large package with difficulty, blusht when asked what it was I wisht to purchase, and stammered my desire for a personal interview with the proprietor.

I had nerved myself to the spectacle of Zebediah enthroned in a spacious and luxuriously-fitted private office, and only hoped it would contain a table on which I could make my demonstration with proper effect. Mr. Crowell at that particular moment, however, was said to be in the basement; and bumping with my parcel down a flight of very steep and dark stairs, I came upon the great man engaged in one of the intricacies of trade.

He was seated in the dim light of the only window, before a box of tangled strings,



End View of Boat and Electric Car. The Motor Drives a Counter-shaft So As to Reduce the Speed of the Wheels.

patiently undoing the knots and snarls, sorting the strings into sizes, and tying each

(*Continued on page* 578.)

REMOVING RUST ELECTRICALLY.

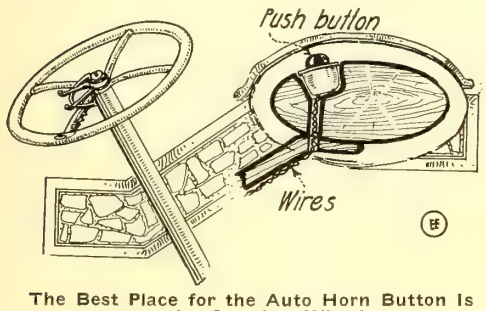
What we call rust on iron or steel is merely a coating formed by the combining of the iron with oxygen, which coating is apt to form in the presence of moisture. Since the obnoxious color of the rust is due to the oxygen in the moisture, any method which will decompose the rust so as to set the oxygen free will leave the bright metal. Now it is well known that when two terminals of an electrical circuit are dipt in water, hydrogen is set free at one of the terminals and oxygen at the other; therefore, what we need to do is to have the rusty metal form the cathode at which the oxygen is given off. Pure water is a poor conductor of electricity, hence one-tenth of its volume of ordinary sulfuric acid should be slowly poured into the water. Adding the acid heats the water and this should be allowed to cool before inserting the terminals, which would consist of the rusty pieces as cathodes and a piece of lead or lead pipe as the anode.

Contributed by PETER J. M. CLUTE.

A CONVENIENT LOCATION FOR AUTO HORN BUTTONS.

Usually when one is driving a car, the horn has to be sounded just when both hands are needed most on the steering wheel, or for some other purpose. The electric horn buttons are located quite desirably on a large number of the new cars; however, there are many older cars, on which it is desirable to install an electric horn, as many people enjoy the charm of a second horn in addition to the one already on their car. In either case the location of the horn button is almost sure to raise a question. A most convenient location for this horn button can be made by boring a half-inch hole in the rim of the steering wheel, as in Fig. 2. In this hole put a small push button, which can be obtained at (any Willys-Overland service station) most electrical supply stores. If the push button is placed a little toward the inside of the rim, the danger of touching it accidentally, will be eliminated. The wires may be run on the under side of a spoke, and down the steering post in the usual way.

As the horn is used mostly at crossings and before rounding curves, the button will always be under the hand which is the least needed for steering at the time, if placed at the lowest point, as shown. For example, if you wish to make a turn at your right, you will naturally pull toward you with your right hand; this will bring the push button a little toward the left, bringing it under the free hand, which will not have to be removed from the wheel to reach the horn button.



The Best Place for the Auto Horn Button Is on the Steering Wheel.

Contributed by
H. CORCELL STUART.

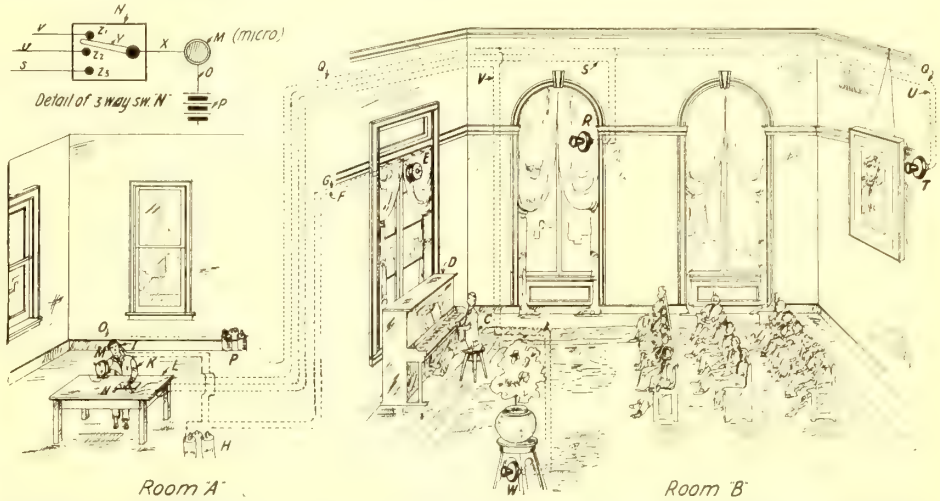
Due to the advent of the war, we are particularly desirous of obtaining snappy manuscripts describing original and practical "Electrical Experiments."

The Mysterious Voice

A Clever Electrical Illusion

By C. A. OLDROYD

THE effect of this electrical illusion is as follows: The performer sits at a piano and plays a tune which has been selected by one in the audience. After he has been playing for a few moments a voice is suddenly heard which sings the very same tune. The voice seems to come from behind the stage, but after a few bars of the song the voice seems to come from a far corner of the room—perhaps from the ceiling.



The Amateur Electrician Will Find This "Stunt" Very Effective. By Means of Sensitive Microphones and Loud-speaking Telephones the Audience Is Induced to Believe That a Real "Mind-reading" Seance Is Taking Place.

While the audience is looking in that direction, trying to discover the mysterious singer, the voice suddenly changes and seems to come now from a third place—the midst of the audience—only to change back again to one of the former points in a jiffy. The explanation of this "stunt" is given below.

Referring to the diagram, we have two rooms, A and B, about twenty yards apart. The performer C, and piano D and the audience are in room, B. A sensitive microphone, E, is concealed behind some curtain or other decorations and two wires, F and G, lead from E to a telephone I in the room A. This telephone is provided with a head band, worn by an assistant, K. A battery H, consisting of a few dry cells is connected in series with the microphone and telephone. The assistant K, sits in front of a table L, to which is secured a sensitive microphone, M, in a convenient position. One binding post of this microphone is connected to a wire O, a battery P, and finally, by means of the wire Q, to loud-speaking telephone receivers, R, T and W.

The other binding post of the microphone M, is connected by a wire X and a three-way switch, N. This switch consists of a wooden base upon which are mounted a lever, Y, and three contacts Z_1, Z_2 and Z_3. Z_1 is connected by a wire V to the loud-speaking 'phone W; Z_2 by U to T and Z_3 by wire S to R.

It is now clear that the assistant can, at will, by means of the three-way switch, N, connect any of the loud-speaking 'phones T, R, or W, to the microphone, M.

The operation of the illustration is carried out as follows:

The performer C, in room B, is asked by a member of the audience to play a certain tune. The assistant K, in room A, hears the music of this tune in his 'phone I. He sings into the microphone, M, and puts the lever Y, of the three-way switch N, into the position Z_1. The current will then pass over the wire V into the loud-talker, W, which is concealed behind let us say a jardinière. After a few moments the assistant changes the position of the switch, N, to say Z_2, and the voice will then be heard coming from the 'phone T, which may be concealed in the midst of the audience or behind a picture.

If the lever Y is changed to position Z_3 the voice will be heard in the loud-talker R, and so on. The placing of the 'phones must be left to the experimenter, but very good places are: in flower-pots, under tables and behind pictures. In every case, care must be taken that the opening of the 'phone horn is not obstructed. With a little care this can be easily provided for, as by having a number of artificial rose bushes or other flowers arranged in two rows and the lane between them leading in a direction down which the audience cannot see.

A NOBLE USE FOR AMATEUR RADIO TRANSMITTERS.

I have thought of a plan to utilize every amateur sending set in the country and help in the saving of life and the success of the war. Simply, it is this:—Let every amateur take his sending set and fix it up to work at the ordinary commercial wave length, and put the outfit, which should be worked off dry cells, in a 5 gallon coal oil tin, securely fastened. The whole is then soldered up absolutely air-tight. The key should be on the outside in a little compartment, with a glass cover, also air tight. The sending terminal may also be in this space. The aerial, about No. 20 copper wire (a single strand) is attached to a folding box kite, the wire being wound on a reel mounted on bearings attached to the set, which is crated or rather protected with wood to withstand knocking about. Now one of these sets with simple instructions and a copy of the code is to be placed in every life boat on the merchant ships leaving American ports. This would avoid some of the dreadful stories of hardship, starvation and death, which reach our ears every now and then.

Contributed by WILLIAM H. GRAY
Lake Buntzen, B. C., Canada.

An Electrically Played Mandolin

By McCLURE ALBRIGHT

WELL, Bugs, it's time to think about those long winter evenings, so clear out your think-tank and light up your jimmy pipe. This is a real job, fellow experimenters, and a task that will keep you interested right up to the time you are ready to throw in the motor switch and listen to the automatically played mandolin. The ideas here outlined are also applicable to a guitar with some modifications.

All of the details are not given as most experimenters like to have the pleasure of working out the general arrangement and style of the outfit themselves. The assembly scheme involves a sufficiently large base-board upon which the mandolin will fit, together with various *fret* and *pick* control magnets, as well as the pick-rotating motor.

Referring to Fig. 1, we have a general layout of the fret (finger) and pick control electro-magnets, also the circuit connections to pick driving motor and finger control board. A perforated paper roll is drawn thru the latter, each perforation permitting a contact finger to make contact with the copper plate as shown in detail in Figs. 3 & 1. This part of the work presents a fine chance to learn something about music, if you are not already proficient in that classic.

The wiring can be easily traced out. When an *open* string is to be played, the current passes right thru to the desired pick-magnet only; when any other note is to be played the current passes thru the *fret* (finger) control magnet first and then to the pick magnet. All four strings can be played simultaneously if desired. As an example of the pick and fret magnet action, consider that contact 31 is closed; this causes the pick (constantly rotated by the motor) over the open "E" string to function, giving the note of "E-natural." If contact 32 was closed instead, then the fret (finger position) magnet corresponding to "F-natural" would be actuated, (see detail of this mechanism in Fig. 4); the current passing on thru pick actuating magnet "E," this sounding the note of "F-natural," et cetera. There are 40 fret control magnets, which may be old bell magnets.

Fig. 2 shows the simple manner of arranging the pick rotating motor and gears. The four pick shafts could also be driven by friction wheels and would make less noise. The constantly spinning picks are raised away from or lowered into contact with the strings by virtue of the pivoted suspension shaft Y, and the pick control arms X, X, X, X, attached to four electro-magnets as indicated in Fig. 3-A. The arms X, are normally held above the strings by spiral springs as shown. By means of the stop screw X1, the movement of the pick arm X, may be controlled so as to get the best sound. It must not strike the string too heavily; neither must it sound the string too lightly. A little experiment will soon clear up this point, when the whole arrangement is lined up for final adjustment. The pick control magnet may be a large bell-magnet coil or telegraph sounder magnet. If the builder desires to make his own magnets (four required) they can be built from a wrought iron core ½" in diameter by 2½" long. Fiber spool ends are fastened on the core, these having a diameter of 1⅝". The bobbin is wound full of No. 26 single cotton covered magnet wire, if 6 volt battery current is to be used.

The small motor which drives the pick shafts can be a 6 volt battery type, giving say 1/40 horse-power. The "Little Hustler" motor is too small; those selling at $3.00 to $4.00 are about the right size. It can be either shunt or series wound. One main

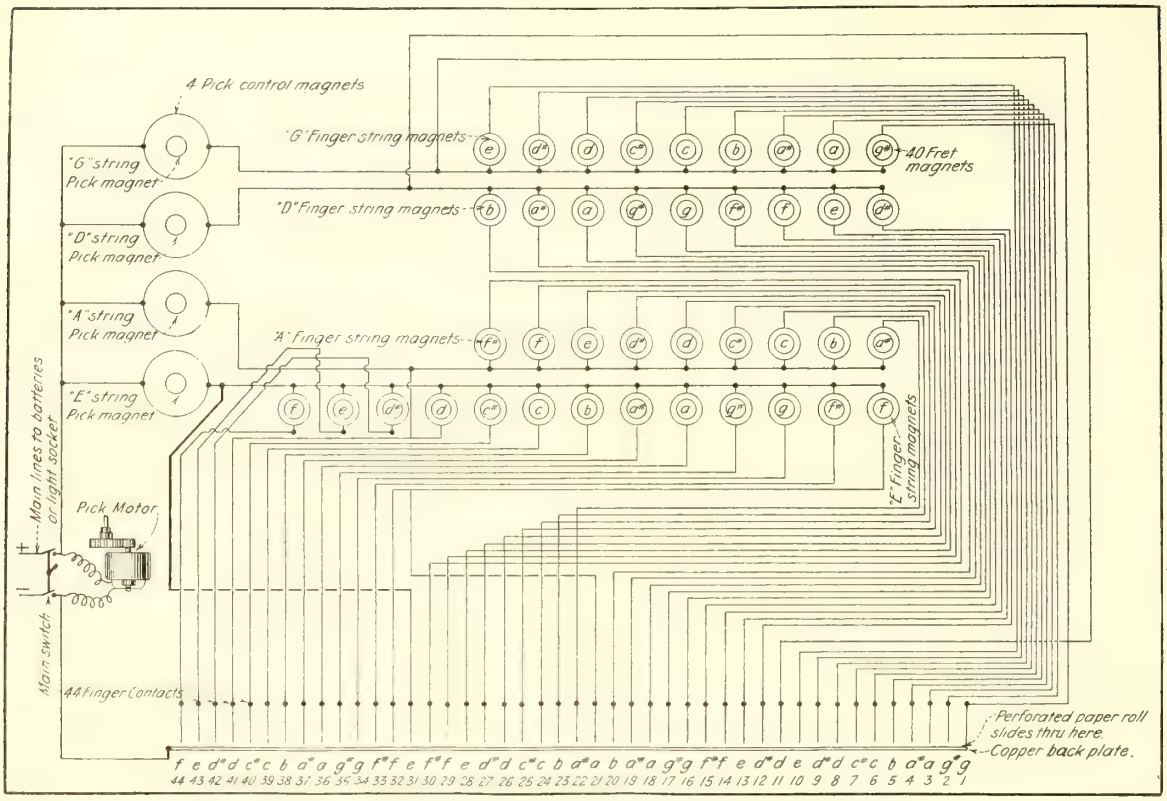
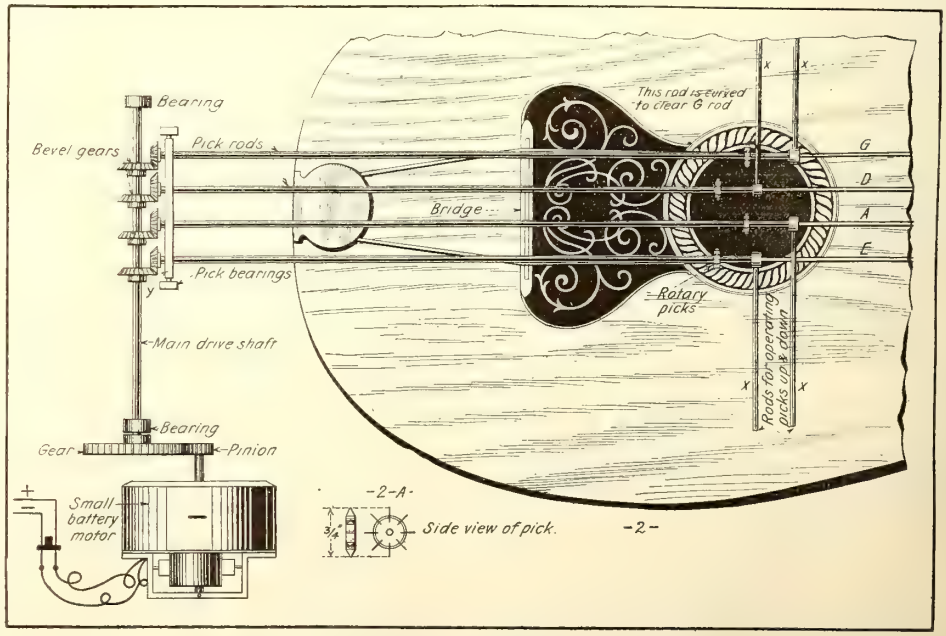


Fig. 1.—General Plan of Circuits, Pick Magnets, Pick Rotating Motor and Switch-board Used in Electrically Played Mandolin. The Same Idea as Here Described Is Also Applicable to a Guitar With a Little Ingenuity. The Details Are Quite Simple.



Figs. 2 and 2-A.—A Detailed View of the Motor Drive for the Rotary "Picks," With Reduction Gears and Also the Rods for Raising and Lowering the "Picks" Themselves.

switch controls the motor and magnet circuits as becomes evident.

The wiring to the fret magnets, etc., may consist of ordinary bell or fixture wire. It should be fanned out neatly at the terminals and shellacked or tied in place, the same as telephone wires on switchboards.

It will pay to cultivate some musical friends if you are not thoroly familiar with notes, and chords. With a little ingenuity a paper roll perforator can be devised, having a keyboard corresponding to the contact switch-board layout in Fig. 1.

ELECTRIC ARCS UNDER PRESSURE.

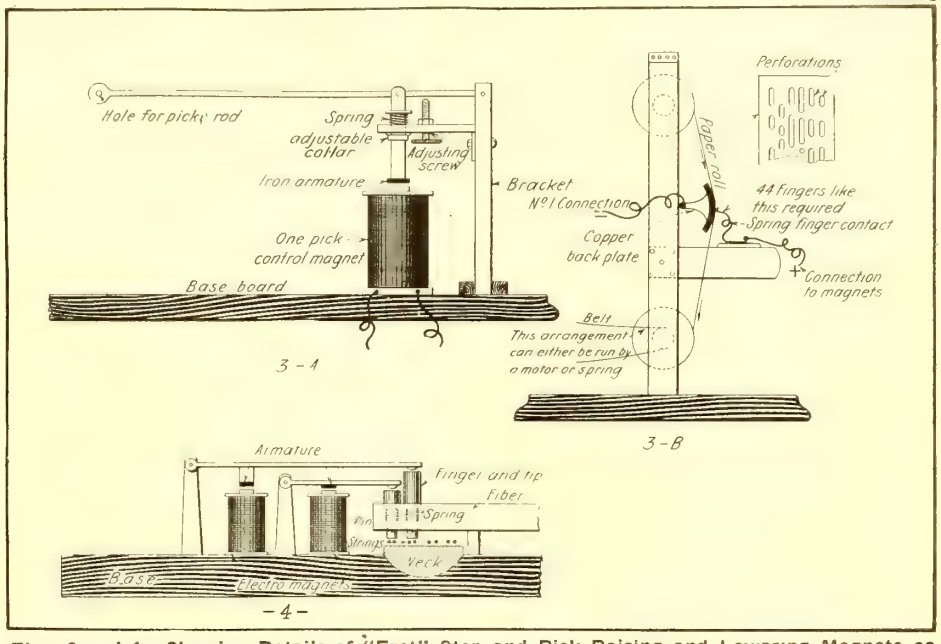
Recent improvements in searchlights have taken the form of various methods of cooling the electrode with a view to obtaining greater local concentration of the light, either by a spray of alcohol or, as in the Sperry searchlight, by a blast of air.

Another line of development being investigated in Germany has been the use of arcs under high atmospheric pressure. Lummer was reported to have obtained promising results shortly after the outbreak of war, and it was thought possible that a considerable improvement in the efficiency of arc lamps and projectors might be secured in this way. According to some experiments described by Mathiesen in the *Elektrotechnische Zeitschrift,* this anticipation is not being realized. Pressures varying from a vacuum up to 5 atmospheres compression were utilized, both with inclined and vertical carbons. In the former case a marked gain in efficiency was secured, but the arc was found to become very unstable for pressures exceeding one atmosphere. On the other hand, with vertical carbons more stable conditions are realized, but the gain in efficiency seems to be very moderate.

A TRACKLESS ELECTRIC CAR.

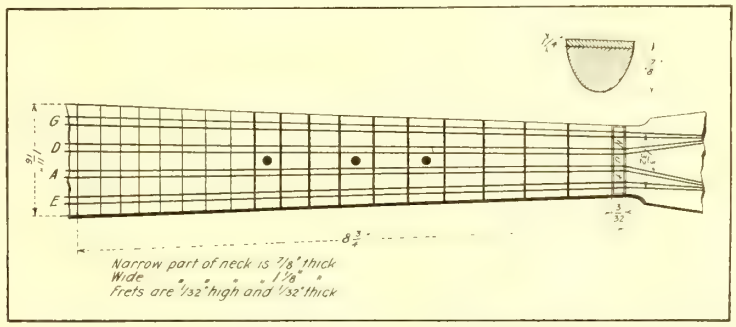
The accompanying illustration shows a very interesting trackless electro-mechanical car or engine, which is operated by current supplied thru the ordinary lamp socket and a step-down transformer. The feed wires drop down from above to the special central pedestal. Thus, there are no wires to interfere with the electrically driven vehicle spinning round and round in a circle on the floor.

The toy may be set to rotate in any size circle, the length of the flexible electric cord being adjustable by means of a small ratchet drum inside the body of the car. This drum has a small handle projecting on the outside of the cab, and by means of the ratchet wheel, the drum remains in whatever position it is turned to.

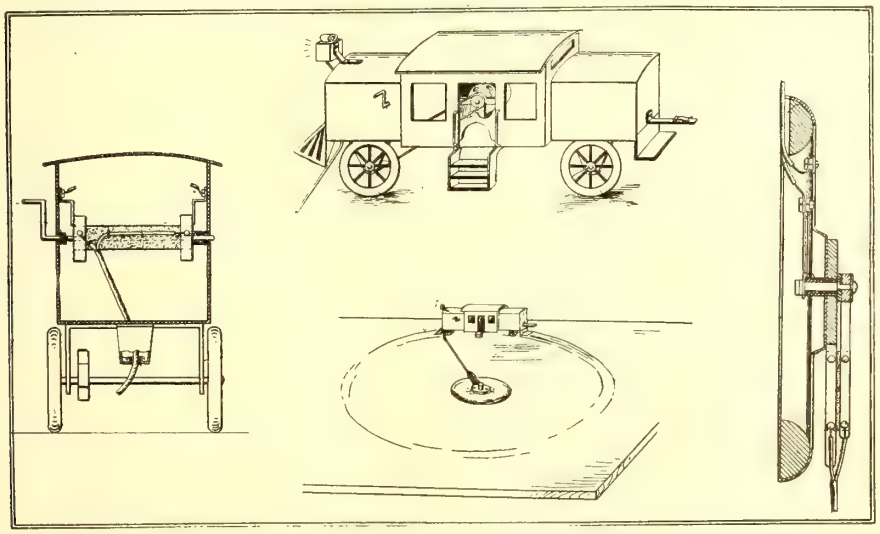


Figs. 3 and 4.—Showing Details of "Fret" Stop and Pick Raising and Lowering Magnets as Well as End View of Switch-board and Sample of Perforated Paper Roll Which Opens and Closes the Circuits.

The two-conductor cable connecting the car with the central pedestal receives its current thru two metal brushes making contact with two oppositely charged rings on the pedestal. A patent on this ingenious toy has been awarded to Walter E. Thayer of Brooklyn, N. Y.



Detail of Mandolin Neck Used by Author in Building Electrically Played Instrument.



A Clever Electric Toy In the Form of a Miniature Engine, Which Runs In a Circle and Without Tracks. Current Is Supplied to the Motor from a Central Pedestal.

A MYSTERIOUS PICTURE.

If you are invited to a party and want to amuse the good people, the following trick will keep them guessing for weeks:

Procure a portrait of a member of the party in question, but without his knowledge, of course. Have an enlargement made of the picture, which after being fixt must be thoroly washed. Place it in a solution of mercuric chloride (be careful: poison!) until the image has absolutely disappeared. Wash well again and let dry.

Now you are ready for the party. Fasten your enlargement on an easel such as painters use. From the distance it will appear as a blank sheet of paper. Only very close examination would disclose the fact that the sheet is prepared.

Tell your audience that you have suddenly developed an artistic talent and that you are going to give some proof of your maestria, right now.

Produce your painters brush and a container apparently containing black ink. This liquid is prepared beforehand in the following manner: Fill a glass full of water (about 12 to 15 ounces, to which add two drams of ammonia, take a little India ink and stir it in this mixture so as to make the liquid look black. Be careful not to add too much India ink, so that when brushed on the paper, it will not leave any marks.

Have the members of the party now sit or stand—as required by your portrait—some distance from the easel, and begin to proceed to bring out the picture, by applying the ammonia mixture with your brush. Much to the astonishment of the audience a fine picture appears in a few seconds.

Contributed by

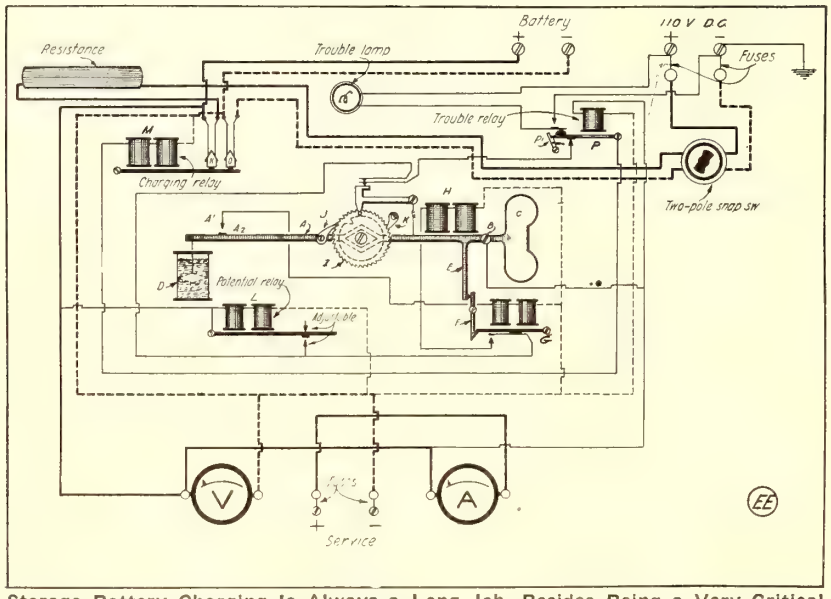
LEONARD VINCHINO.

Due to the advent of the war, we are particularly desirous of obtaining manuscripts describing original and practical "Electrical Experiments." We shall continue to publish Radio articles, but what we need is snappy "Electrical" articles. Be on guard for the enemy—Repetition!

An Automatic Storage Battery Charger

By LEWIS SCRIVEN

AUTOMATIC storage battery charging switchboards are becoming more the general practise wherever this type of battery is used. Its use is significant, and as its name implies automatically keeps the battery in its proper condition at all times,



Storage Battery Charging Is Always a Long Job, Besides Being a Very Critical One. To Charge Them with the Minimum of Trouble and Care, Use Should Be Made of an Automatic Switch-Board Such as That Illustrated.

something which the ordinary person often forgets. The general description which follows will clearly show how such a board operates.

Referring to the diagram: A is a balance bar 15 to 20 inches long, pivoted at B, having a contact point at A 2 to meet A 1; and C a counter weight. D is an oil cup in which a plunger (shown sectionally) is allowed to move freely from side to side; but not loose and is suspended from a light rod from the bar A. By having the rod A, a trifle heavy to counter-balance C, it is allowed to fall slowly by the buoyancy of the oil. Part E is solidly fastened to A, and serves to push F, so as to release armature (which it holds) when A is at its lowest point.

G is a relay having an armature with a contact which catches on the hook of F, when A is up its full height. H is the magnet used to lift A.

I is a cog wheel having a rim about ¼-inch wide with a notch in it as shown by dotted line, and on this rim rests a rod which is used to close contacts. J is a ratchet pawl pivoted on A, which turns this cog wheel on the upward motion, and K a stop-ratchet, so wheel cannot turn backwards.

L is a potential relay, which when the voltage falls, allows its armature to drop, making contact with the point under it, which must be adjustable. The point above, altho not a contact point, must also be adjustable. By having the armature a certain distance from the magnet core it is allowed to drop at the battery's *run-down voltage*. While down it should be such a distance from the core that it will pick up at the *normal voltage*.

M is a charging relay having brass plugs N and O, to close contact springs directly above each.

P is a trouble relay having a contact on its armature which breaks when it is up, but closes other contacts to light a lamp. The armature when up, is retained by catch P 1. (The charging source is presumed to be 110 volts direct current.)

Referring to the electrical wiring the operation is as follows:—Suppose the battery is fully charged; relay L armature will be up. All contacts on the cog-wheel will be open, relay M armature down, and relay P armature down. Since A will have fallen to its lowest point, relay G armature will be down, making contact.

The voltage falls. Immediately the relay L falls, closing two of the contacts on the cog-wheel, energizing coils H, lifting A so that A 1 and A 2 meet. This energizes the coils of relay G, breaking the energy in relay H, and A having nothing to hold it up, begins to slowly drop. Meanwhile ratchet pawl J has turned the cog-wheel enough to close all contacts on it, which energizes relay M, sending the charging current thru the battery; the intervals of time between the contacts at A 1 and A 2 should be about one or two minutes. The arm A will now work up and down until the contacts are again opened by the notch in the cog-wheel. As the diagram here shows it, the bar A is in the act of falling but has not yet released the armature of relay G.

Relay M should not take more than ¼ ampere.
Relay P should not take more than 1/25 ampere.
Relay G should not take more than ¼ ampere.
Relay L should not take more than 1/25 ampere.
Magnet H should not take more than ⅛ ampere.

The trouble relay P is a necessity. Its armature is heavily adjusted so that it takes, say about fifty volts to lift it. Should the battery become disconnected while charging, the high voltage will immediately lift the armature, being held by catch P 1, opening cog-wheel contacts which cuts off relay M, and lights lamp to indicate trouble. This prevents high voltage passing over the battery wires. Attention is also called to the fact that the negative charging source is grounded. Should the negative service wire become grounded, no harm will be done. Should positive service wire become grounded (causing a short-circuit) its fuse will blow. Otherwise, if the positive charging source had been grounded and negative service become grounded, the battery would discharge thru the resistance.

This board can be made to operate on any size battery, by winding the coils to suit, altho 24 volt batteries seem to be standard for low-tension work.

The resistance could also be a bank of lamps, its resistance depending upon the charging rate of the battery. (Eight hours is the standard rate for charging lead plate cells.)

These boards are used in some of the finest buildings and while only one type is here described, any number of batteries can be controlled by one board by a few minor changes and extra relays to care for the different sets.

HOW TO PHOTOGRAPH LIGHTNING.

Don't use films, but use low speed thickly coated plates. The camera should be firmly posted on a window sill, and focused for infinity. Of course the shutter should be open. Watch the storm and as soon as lightning occurs close the shutter again.

It requires quite a lot of experiments to get a good forked flash. Some time a good picture may be spoiled by sheet lightning occurring just a few seconds after the exposure.

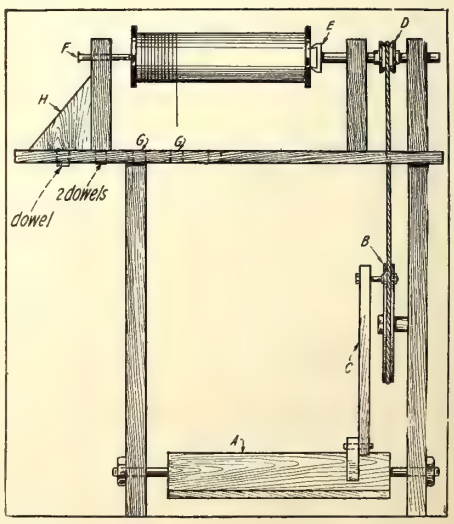
Quick handling is necessary for good results. Develop plates fully, using a contrast-giving developer.

Contributed by JOS. MINDER.

COIL WINDING MACHINE FOR AMATEURS.

The accompanying illustration shows a view of an efficient coil winding machine. It should be made to any convenient size. The treadle (A) is connected to a large pulley wheel (B) by a rod (C) as shown. This runs a smaller wheel (D) which is fastened to an axle by a set-screw. A set of pins (E) are also fastened to the inside end of the axle. At the other side a pivot is made of a long wood screw. The upright which holds the pivot is made movable and may be put in different holes (G) according to the coil to be wound. (H) is a brace for the movable upright. With the aid of this machine one may wind a coil very rapidly.

Contributed by THEODORE LAUER.

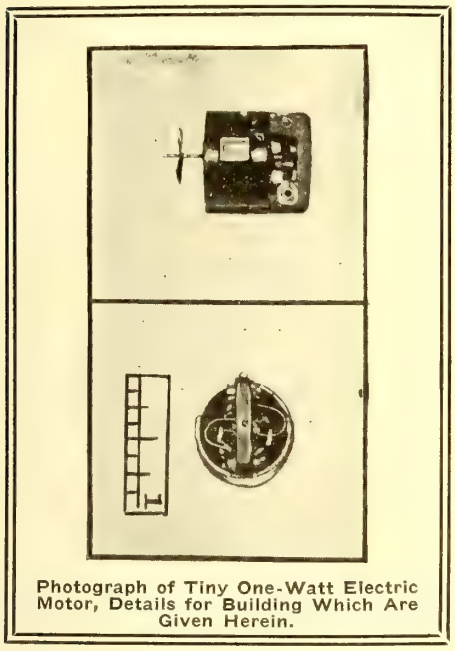


A Practical Winding Lathe for the Amateur Electrician. The Rear Pedestal Is Movable and Is Secured in Various Positions by Means of Dowels.

How to Build A One-Watt Motor

By W. J. HOWELL

FROM time to time publications contain pictures of small electric motors and a short description of how many "fly-power" the motor is able to deliver. Most of the articles state that said motor is very small in size and that jewelers' tools were used to make it, but all these failed to convince me that fine tools were needed and if the



Photograph of Tiny One-Watt Electric Motor, Details for Building Which Are Given Herein.

list given below is studied it will be seen that the tools that were used are those that every experimenter has or ought to have in his work-shop. The list is as follows; shears, drills and drill holder, small vise, three cornered file with one-eighth inch sides and a half inch flat file, small fret saw using fine saw blades, pair of tweezers and a needle holder, which is a small bar with a hole in the end for holding a needle which can be used for prying in small spaces, pair of pliers, with pointed tips and a small soldering iron made from a piece of brass, half inch by one quarter round, and mounted on a piece of iron wire stuck into a wooden handle.

The motor itself is not the smallest thing in captivity but is just about small enough to be easy to make and handle and there is no danger in showing it to other people and fearing that they will *lose it under their finger nail.* I am of the opinion that it is possible to make one even smaller just thru my experience in overcoming construction details with this one, but that is something that can be tried by those who will and have the time to work at the task, for task it is—altho patience is half the battle and believe me, one needs it in large quantities besides a fair ability to handle tools.

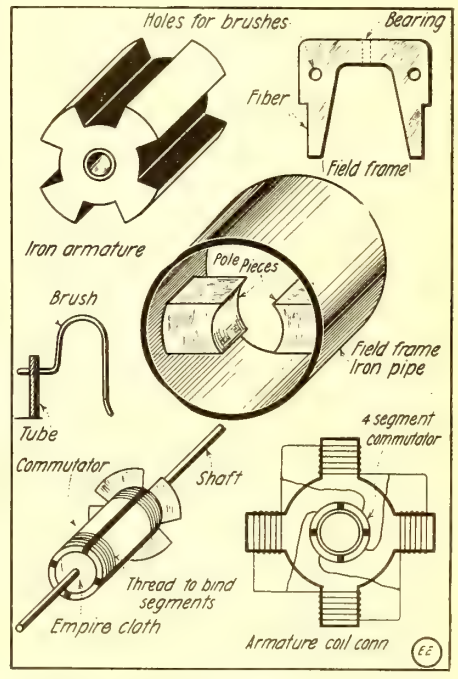
The shaft is made of a piece of iron wire about the size of a number 22 copper wire and is one and one-eighth inches over all. The next thing to build is the commutator; this is made of brass tube one-quarter inch long, altho the actual bearing surface is about two-thirds of this length. The tube should just be large enough to pass over the shaft and still leave room for some insulating material such as one layer of Empire cloth. The tube I used is a trifle over one-sixteenth inch in diameter with very thin walls. Before cutting off the piece for the commutator, saw it with two cuts into four parts or segments, making the cuts about one quarter inch long. Clean the inside surface of the tube and free it from all burrs left by the saw and force it over the shaft, not forgetting to put on the Empire cloth to insulate it from the shaft. Tie the four free ends of the tube down by a thread wound several times around it, about an eighth of an inch from the end, and bend these ends up so that the armature wires can be soldered to them. Then saw off the rest of the tube and tie those four ends down. This construction gives a commutator that is round and each segment is insulated from the shaft and from each other.

The armature is made of five iron washers, three-eighths inch diameter, and as the holes in the washers are too large for the shaft the difference can be taken up by putting on several layers of Empire cloth and the washers forced on until they are about an eighth of an inch from the four bent ends of the commutator. Divide the end washer into eight parts and make a saw cut at each mark until the saw reaches a point midway between the outside and in-side diameters of the washers. This is done to all five at the same time by holding in a vise. When finished, file away four alternate pieces of iron and this will leave four poles, around which the armature coils (of which there are four) will be wound. Be careful to remove all rough places and then put on a shellac coating over the washers thick enough to act as an insulator, because there will not be very much room for any paper insulation of any kind. Wind each coil when the shellac is dry, with 36 silk covered copper wire, taking care on the first layers not to cut thru the shellac. When finished, the four poles will have four coils which take up most of the room in the slots between them, and the ends of the coils are connected to the starting ones of the next coil; that is, the beginning of one coil is connected to the ending of the adjacent coil and the beginning of that coil to the ending of the next coil, and so on, until the entire four coils are connected in series. It is of course understood that all the coils are wound in the same direction, so that by following the above system of connection, they will be hooked up in the proper manner. Now turn the commutator so that the bent up tips come midway between the iron poles and solder the wires to the tips. This is best done by putting a little flux on the tip and pass the two wires which are twisted together, over the tip and hold the surplus wire down the other side of the armature with the fore-finger, heating the small soldering iron in a Bunsen flame with the other hand, which when hot enough and properly tinned will pick up a drop of solder and held to the tip, thereby securing the wire to it. The surplus wire is of course cut off.

It is best while winding the four coils to test for grounds to the washers and then unwinding and rewinding carefully so as not to cut thru the shellac. With care the armature should be in the class that gives no trouble. Paper could be put on for insulation but it requires a lot of extra time and shellac is alright, if handled properly.

Next in line comes the field-frame work and this is made of an iron pipe three quarters inch diameter and one-half inch long. It is about one thirty-second of an inch in thickness. At one point drill a hole about three-sixteenths inch in diameter and carry the hole straight thru the other side, care being taken that it divides the pipe into equal parts or halves. These holes are then filed square so that two pieces of iron about one-quarter inch square and three-sixteenths inch in length can be driven in the holes. Now cut a brass strip one-eighth inch wide and a little longer than the diameter of the frame and solder it parallel to the pole pieces, across one end of the tube. This is to be one bearing and a little solder can be put on the pole-pieces, to make sure that they stay in place, but before the brass strip is put on solder the pole-pieces and then file them concave so that the armature has a little clearance space between them to turn.

Place the drill holder with a number 60 drill in the chuck, in the vise and hold the brass strip up and drill thru the middle. This gives a hole of just about the right size for the shaft. Remove drill from chuck and put your three-sixteenths inch drill in its place. Bend a piece of card-board so that a square form is made, slightly larger than the square iron pole-pieces and slip this over the drill, with possibly a piece of friction tape over the drill to take up the difference and force over the card-board two pieces of the same material with square holes cut in them. Space these about one-eighth inch apart and you have a winding form to wind the field coils, which are about one-half inch diameter and made of No. 36 single silk-covered copper wire. When wound take care in removing the same from the form and by leaving a little wire at the end this wire can be past thru the hole in the coil a few times thereby securing the turns in place. Two pole-pieces of course means two coils, but before placing them on the iron pole-pieces, the inside of the frame should be insulated with a strip of Empire cloth with two



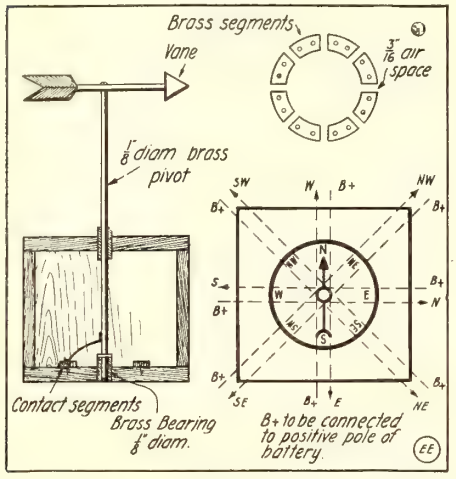
Details for Building a One-Watt Electric Motor.

square holes cut in it in order to allow it to pass over the poles. The poles themselves have a small piece of paper wound on them as insulation, held in place with shellac.

(*Continued on page* 573)

USING COMPASS AS WIND-DIRECTION INDICATOR.

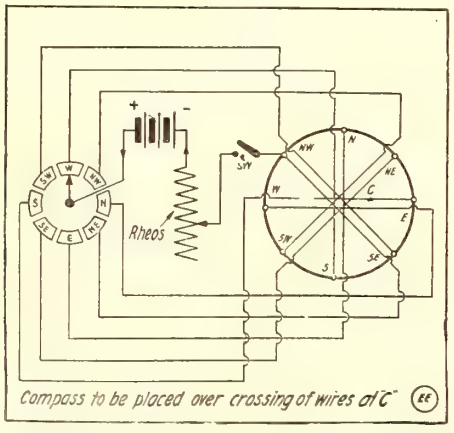
The underlying principle involved in the following apparatus is that a compass needle is deflected when brought near a current-carrying conductor. To make it



The Electrical Experimenter Will Find This "Compass Type" Wind-Direction Indicator Both Useful and Instructive.

more clear to those unfamiliar with the laws relating thereto, we shall take a specific case as an example: When a compass is placed over a wire in which the current is flowing South, the pole of the compass will be deflected toward the West; the amount of deflection varying according to the current strength. The greatest possible deflection is due West, or at *right angles* to the North-South wire. So if we provide sufficient current, the needle will point directly West. If the current flow were to be changed from Northward to Southward, the needle would point East. Thus, it can be seen that, by arranging connections with an outside weather vane, which creates a separate circuit for each of the eight principal geographical directions, and applying the principles as stated above, we may use the compass for indicating the direction of the wind.

The construction of the special weather vane and its operation are shown quite clearly in the drawings. The arrow, made from a shingle or other comparatively thin wood, is mounted at its balancing point upon a ⅛" diameter round brass rod. This rod or pivot turns freely in the brass bear-



Circuits Used for Electric Wind-Direction Indicator Built from a Magnetic Compass.

ings of equal inside diameter and is supported by the collar (soldered to it) which rests upon the lower bearing. From ⅛" brass sheeting are cut the segments, with which the spring brush makes contact. These should be screwed to upper surface of the bottom of the box at proper distances from each other, and around the bearing as a center. One-half inch wood serves for the box, which should be varnished and the cracks of which should be filled with paraffin to keep out rain, which would soon short-circuit and corrode the segments. Connections are made to each of the segments and the lower bearing.

Current-carrying wires which cause the deflection of the compass needle are placed in grooves cut in a small wooden block; two wires in each groove. These grooves may be cut in a mitre-box most easily. The wires should be about No. 18-20 B. & S. gage. If smaller, heating will result. The grooves are filled with wax or paraffin, which is then smoothed to level of block with sandpaper. During the operation the compass is placed directly over the cross of the wires shown at "C" in diagram.

Much care will have to be used in wiring the square block with the weather vane. However, if the drawings are followed closely, no trouble should occur. The rheostat is unnecessary, but with it the current is better regulated. The number of batteries will vary since compasses in each case will differ, as also will the distance from vane to inside block. Note that the battery is connected with the bearing from positive pole.

Contributed by J. L. TAYLOR, JR.

(*Ed. Note: While this is a very good experiment theoretically, the drain on the battery would prove excessive for continuous readings, unless gravity cells were used. However, for periodical readings the scheme is practical for use with dry or storage cells, utilizing a switch to close the battery circuit when making the readings.*)

A MYSTIC SHOW WINDOW ATTRACTION.

A novel device to attract the attention of passers-by to your display of goods is presented in the "inexhaustible drinking glass," which seemingly is suspended in mid-air without any visible means of support, emitting large quantities of water, apparently coming from nowhere.

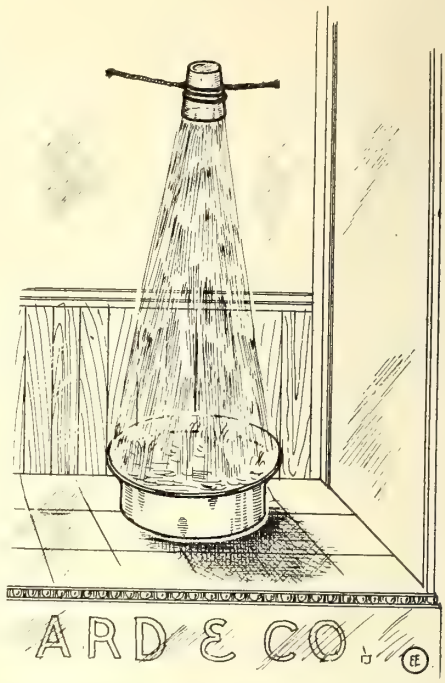
The illusion is set up as follows: Procure a tin-wash-basin and cut a quarter-inch hole in the center of bottom for the supply tube and a hole near the edge for a ¾" drain pipe. Drill corresponding holes in floor of show window. The drain pipe can be made of tin, soldered in place and extending up into the basin to within about ¾" from the top. The lower end leads thru the floor of window, where it connects with a rubber hose which carries off the waste water.

For the supply you will need a glass tube with an internal diameter of from ⅛" to 3/16" and long enough to extend from a few inches beneath the show window up into the basin to the same height as the pipe. When the tube is in place, apply a liberal amount of soft putty on the under side of the basin around the tube.

Place the basin in position in window, permitting the drain and supply tubes to extend thru their respective holes in the flooring. Adjust the glass tube in a perfectly vertical position and press down tightly, squeezing the putty in place to prevent leaks.

As city water pressure varies greatly, due to other consumers turning their faucets on and off when drawing water, the glass will not always remain at the same height, rising and descending with a jerky motion. To overcome this take a gallon can of any kind (an old varnish can will do), connect it to the city supply pipe and solder a small tube in the side, to which connect the glass tube with a small rubber hose. The illustration will explain this.

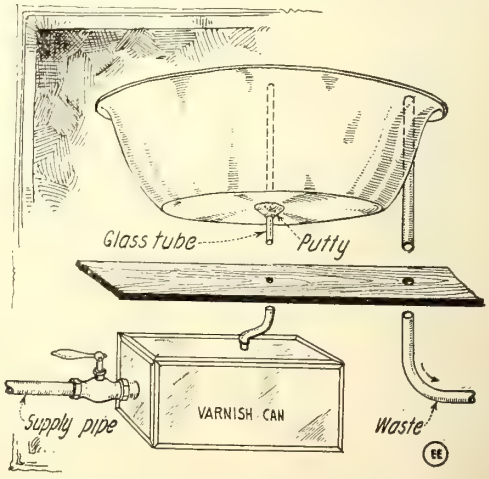
Invert a light weight, thin shell, drinking



The Mystic Electric Tumbler That Floats on a Stream of Water. Details for Building This Interesting Amusement and Show-Window Attraction Are Given in the Accompanying Article.

glass over the glass tube in the basin, and turn on the water slowly at first. The glass will rise in the air, resting on the stream of water. Its height can be varied with the stop cock. The water falling from the glass obscures the supply stream, and on striking the water in the basin it causes a wavy surface, thereby hiding the glass tube, its effect making the spectators wonder what is holding the glass up and where the water is coming from. A coil of wire slipt over the glass, with the two wire ends sticking out as illustrated, makes the device look "electrical." This serves merely to mystify the onlookers still more.

Contributed by GEO. NIEDERHOFF.



Details of Basin and Water Nozzle Used in Making the Mystic Tumbler.

WRITE ARTICLES!!!

Now is the time to write up that favorite "stunt." Make it brief—a hundred words or so will tell the story. Send a clear sketch, or better, a photograph of the rinktum. Address the Editor.

HOW TO MAKE IT

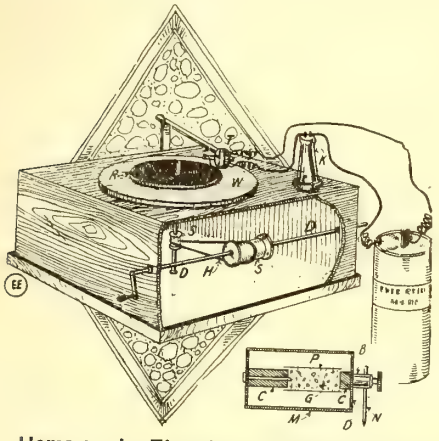


This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00 SECOND PRIZE, $2.00 THIRD PRIZE, $1.00

AN ELECTRIC PHONOGRAPH REPRODUCER.

First a small box about 7"x10" is procured, then a round disc 6" in diameter is cut out (W). A ¼" dowel is fitted into center of the disc; on the same dowel a spool is fitted, a short piece of the dowel being left protruding thru the disc to put the record on. Next another dowel is fitted with a spool and crank, these two dowels and all attached are placed as shown in diagram. A transmitter is made from a round wooden box about 2" in diameter, a round carbon (C) is fastened to the bottom, a carbon of the same size is fastened to a thin tin diafram and on the same bolt a long binding post (B) is fastened, around the two carbons a piece of paper is wound; in between the carbons are carbon granules (G). A connection is taken from the diafram, and the bottom carbon. This transmitter is pivoted on an arm as shown. The needle (N) runs in the groove of the



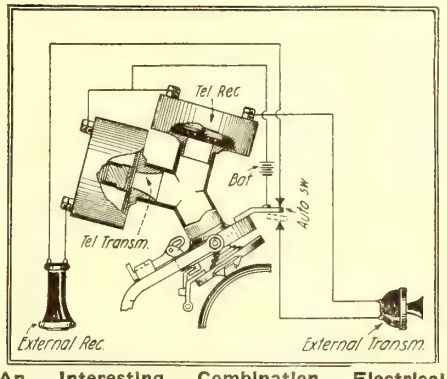
A Home-made Electrical Phonograph With Hand-drive Attachment of Simple Construction. This idea Is An Excellent One for Experimentation.

record (R). A rubber band (H) is placed in position as shown, then when the crank is turned the wooden disc with the record turns around and the needle runs on the record. The wires from the transmitter are connected to a telephone receiver (K) and battery of two to three dry cells.

Contributed by HERMAN SLOBIN.

ELECTRICAL RECORDING AND REPRODUCING ATTACHMENT FOR PHONOGRAPHS.

A simple and particularly efficient design for an auxiliary electric recording and reproducing mechanism for attachment to phonographs is shown in the accompanying illustration, and this idea has been patented by Newman H. Holland. The usual recording and reproducing stylii are carried on a reversible platen or head, so that one or the other will be brought into contact with the phonograph record in the usual manner. Instead of connecting a horn to the acoustic chamber above the stylii and diafram, this chamber is foreshortened and splits up into two distinct or branch chambers, in one of which there is placed a micro-phone member and in the other a telephone receiver.

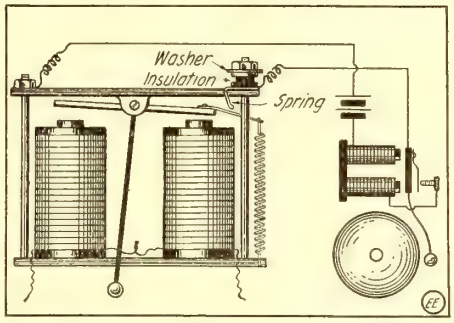


An Interesting Combination Electrical Recorder and Reproducer for Use on Phonographs.

The microphone member on the phonograph is connected with a common battery as indicated, and also with a switch attached to the traveling phonograph carriage, so that when the phonograph is talking the speech is picked up by the attached microphone and sent out over a line of any desired length to the telephone receiver. In a similar manner the phonograph can be utilized for recording speech from a distance, by means of the external microphone, which is connected thru the common battery to the telephone receiver mounted in the second branch of the acoustic chamber on the phonograph carriage. This idea is often very useful in experimental and laboratory work.

TELEPHONE RINGING ATTACHMENT.

I herewith submit a novel idea to the "HOW TO MAKE IT" department. With this telephone bell attachment, a second



To Ring An Extension Bell From Any Telephone Ringer, Simply Attach An Insulated Contact Spring to the Frame as Shown.

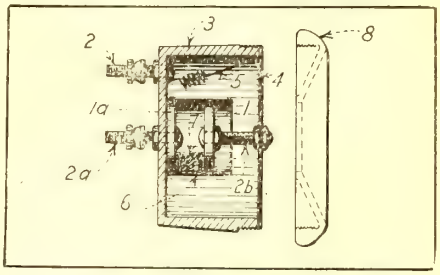
bell can be made to ring in any part of the house. A small piece of spring brass is bent so that it will hit the armature of the telephone bell when it comes up. With a few insulating washers, it can be attached to the frame very easily, as there is a bolt that extends thru the upper part of the frame. The nut is removed, and the spring slipt on. The door bell has a wire connected from the contact point to the spring, so that its interrupter will not work. Two batteries are sufficient to run it. It will ring every time the 'phone does.

Contributed by EARL MEISSNER.

CARBON GRAIN TRANSMITTER MADE FROM RECEIVER SHELL.

A simple yet efficient microphone may be constructed from the "junk" found around any experimenter's workshop.

Referring to the drawing: (1) and (1a) are disks sawed from an old round battery carbon. A 3/16" hole is drilled in the center of each. (2), (2a) and (2b) are battery binding posts. Binding post (2) is inserted thru a 3/16" hole in the back of the receiver shell (3) and connected to the diafram (4) by means of a small coiled wire (5). Carbon disk (1) is secured to the diafram (4) by means of battery binding post preferably a No. 6-32 rod (2b). (6) is a paper tube fitted over carbon disk (1a) and glued or shellacked so as to hold it firmly. Carbon disks (1) must be smoothed on its edge so as to allow it to vibrate, as the voice waves impinge against the diafram. (7) are carbon grains (scraped from an ordinary piece of carbon) placed in the paper tube (6) between carbon disks (1) and (1a). (8) is the receiver cap. Best results are obtained by using polished carbon grains which can



The Experimenter Will Find This Improvised Carbon Microphone Very Serviceable, Especially If Polished Carbon Grains Are Used In It.

be purchased from any electrical supply house.

Contributed by GEO. H. GORDON.

HOME MADE GAS LAMP FOR THE DESK.

Many experimenters have undoubtedly wanted a desk lamp, but have never looked around the workshop for odd pieces of apparatus with which to make one.



A Quickly Made Desk Lamp Constructed from a Ring Stand, a Bunsen Burner, Goose Neck, Mantle and Globe.

The photo given here illustrates a method of making a desk lamp from the following pieces:

1 ring stand; 1 Bunsen burner, with the part removed as shown in photo, 1 regular goose-neck fixture, with mantle and globe; 1 burrette or test tube clamp.

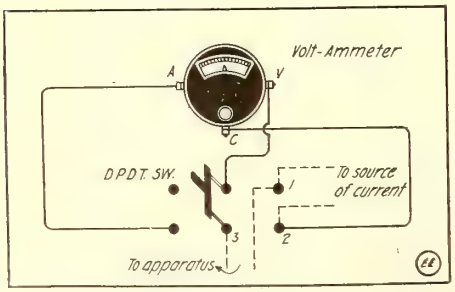
Assemble the apparatus as shown in the photo and you have a very satisfactory study table or desk lamp at insignificant cost.

Contributed by
ALBERT W. WILSDON.

VOLT-AMMETER SWITCHING SCHEME.

Probably many of the readers of this journal have desired to use a Volt-ammeter for measuring both the voltage and amperage without changing the wiring, but have been required to use two instruments, as this problem requires usually several switches and complicated wiring.

I have had this trouble, but have worked out a system of wiring which requires only one switch. The diagram is self-explanatory, and it will only be necessary to state that C is the common, A the amperage and V the voltage post of the meter. Post 1 is connected to both the source and apparatus; either 2 or 3 may be connected to the source, the other to the apparatus.



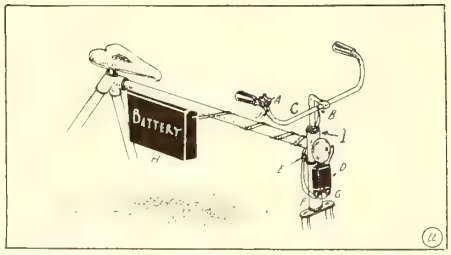
By Simply Throwing the Switch Shown to Either Right or Left, "Amperes" or "Volts" May Be Read On the Combination Volt-Ammeter.

Contributed by JOHN D. FORNEY.

ELECTRIC BELL FOR A BICYCLE.

The drawing shows a very simple electric bell for use on a bicycle which will make people jump, thinking it is an ambulance or an "electric." All that is necessary to make it is—an old door bell, a battery box, (like the one used with a bicycle electric light) some No. 12 insulated wire, a clamp, and an automobile push button (horn). It's very simple in construction. Direction:—Drill a hole in the under side of the handlebar at B, and one on the upper side at J; run the two wires thru and connect to push button A, clamp bell D to frame I, with clamp E, but be sure that it is well insulated or else the bell will ring continuously. Then attach battery box H, and run wires to G and F, also the push button and the bell is ready to work. I have been using the bell described for years, and as you can see at a glance, it is bound to be perfectly satisfactory. By using a two-point switch you can put a light on front and rear, wiring it to the same battery, as the bell consumes very little current. The bell may be placed on a motorcycle and use a storage battery, providing the bell is heavy wound.

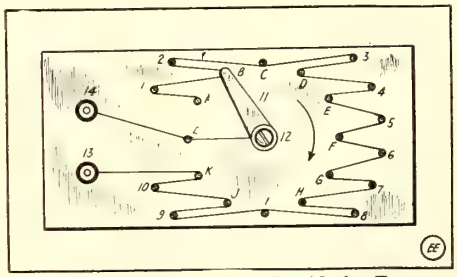
Contributed by
CLARENCE SOMERS.



Every Bicycle Owner Wants an Electric Bell Now. Here's the Way to Rig It Up.

A HANDY RHEOSTAT FOR LAMPS AND MOTORS.

Herewith is a diagram of a simple and quickly constructed rheostat. All the figures from 1 to 11, and all the letters from A to L, represent points of the rheostat, which are made by driving tacks so that they are about ⅛" high (from base). At 13 and 14 are two binding posts made from battery bolts; 11 is the movable contact arm. The base is 3" x 5". The tacks are driven in the form of two circles; the first circle has a diameter of 1" and the other circle has a diameter of two inches. There are 12 tacks on the inner circle and 10 tacks and 2 binding posts on the outer circle. All tacks are placed equal distances from each other in circles. Now connect A to 1 to B to 2 to C to 3 to D to 4, and so on around to 10 to K. The wire used is taken from an old telephone induction coil. Then connect 13 and K with a piece of bell wire and also 14 to L to 12 with same size wire. Arm 11 can be made from a piece of brass and 12 is a brass screw and two nuts from the carbon of a dry cell battery. The arm rotates to right to increase current (from 1 to 11), and decreases by rotating to left; to decrease current (from 11 to 1). This rheostat can be used for governing the speed of small motor, dimming battery lamps, etc.

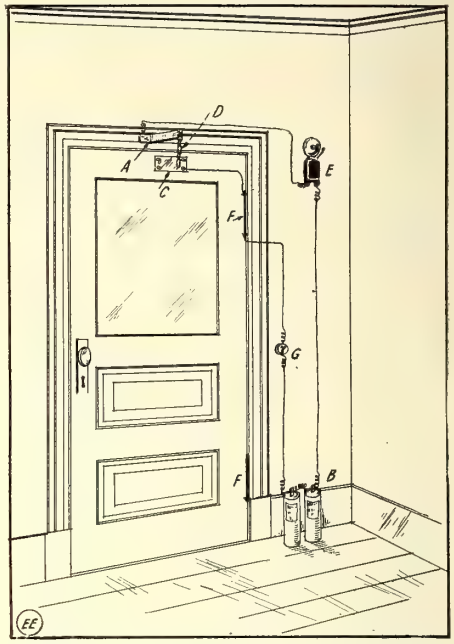


A Battery Rheostat Can Be Made From a Few Feet of Iron or Other Wire Looped Around Several Tacks as Here Illustrated.

Contributed by JOHN WELLS.

A SIMPLE ELECTRIC DOOR ALARM.

A simple door alarm can be made with very little cost, by first taking a piece of sheet copper 4 by 5 inches and cutting a piece 4 by 1 in. off for the arm as shown in sketch. Then fasten a piece of chain at the end of the arm long enough so that when door is opened, it will touch the lower plate 4 by 4 inches mounted on door as shown. This closes the circuit which rings the bell. The wire running from the door contact plate should be soldered to one of the hinges (F) and another wire should be soldered right on the same hinge, and run down to the switch (G), and from there to batteries (B).

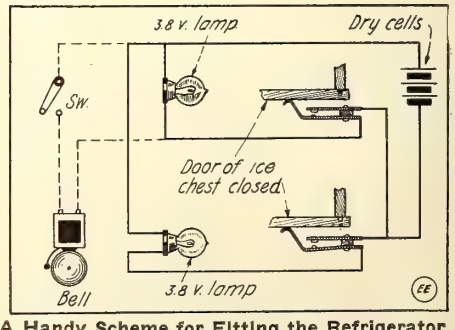


Here's a Cheap, Yet Efficient Electric Door Alarm Switch Made From a Piece of Metal Chain and a Brass Contact Plate.

Contributed by A. GRUETZMACHER.

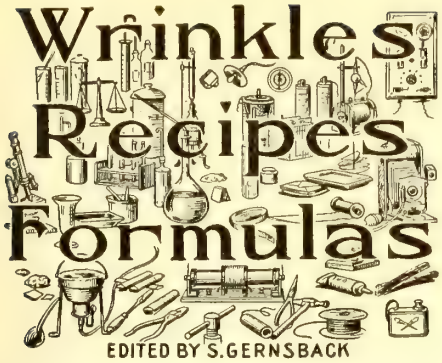
LIGHTING THE ICE CHEST.

As my refrigerator was out on my porch I found that the device described was very convenient for me, and by having it outside I thought a wire attached to the same circuit and brought inside to an alarm bell, would prove an excellent burglar alarm and it has worked to perfection. By having a refrigerator so lighted, one can go out to it and see what to get without the aid of any other light.



A Handy Scheme for Fitting the Refrigerator With Electric Light and Also a Burglar Alarm.

Contributed by G. B. McCARTNEY.



EDITED BY S. GERNSBACK

Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

EXPERIMENTER'S APHORISMS.

In the following, we wish to give to the Experimenter some hints as to the use of the different ingredients and how to work them:

(1) Always bear in mind that exact working of a formula requires ACCURACY, CLEANLINESS, PATIENCE, and SKILL.

(2) Know what you are about, before you start to experiment.

(3) "THE HISTORY OF FAILURES IS THE HISTORY OF SUCCESS" goes an old adage, and it applies well to the experimenter.

(4) Many times impure, wrong or deteriorated raw materials, spell FAILURE instead of SUCCESS.

(5) A great many of the chemicals and ingredients required, cannot be obtained from drug stores; buy them at a reputable supply house.

(6) BEFORE CONDEMNING A FORMULA, be sure the fault does not lie with the manner of handling it, or the purity of the ingredients.

(7) Be sure to mix the materials comprising a certain formula in the proper sequence.

(8) When starting to prepare a mixture, especially one containing liquids, ask yourself: "IS THE SPECIFIC GRAVITY CORRECT, AS INDICATED BY A HYDROMETER? IS THE TEMPERATURE RIGHT? IS THE QUANTITY OR WEIGHT RIGHT?

(9) Acids and water, when mixed, should be manipulated in the proper manner, i. e., THE ACID SHOULD BE POURED INTO THE WATER, and not vice versa, as the solution is liable to be forcibly ejected from the containing vessel and into the mixer's face.

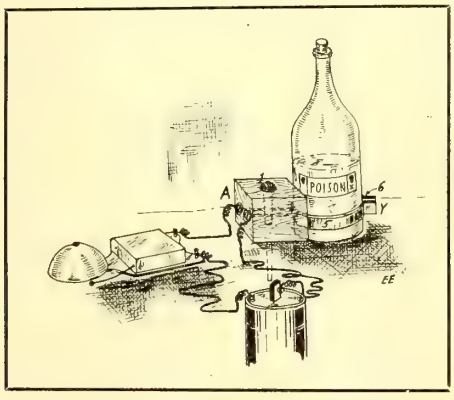
(10 For any kind of SYSTEMATIC WORK, a floating THERMOMETER and HYDROMETER, as well as measuring glasses and scales, should always be provided, as GUESSWORK is EXPENSIVE, and SOMETIMES FATAL.

(11) Put labels on ALL bottles, boxes and packages with FULL INSCRIPTION as to their contents, it will avoid troubles and mistakes.

(12) Remember that a beginner cannot expect to make articles AT FIRST, which will compare with regular manufactured products.

ELECTRIC WARNING FOR POISON BOTTLES.

This instrument is used in two ways as follows: The clamps 5 and 6 in illustration



When the Poison Bottle Is Removed From the Contact Strips, They Spring Together, Closing an Alarm Bell Circuit.

serve to fasten bottle to avoid its falling from shelf, and also to notify an ignorant person of the presence of poison. Proceed to first construct upright, A, 2" high, 1½" wide, and ½" thick. Fasten block to shelf by screw 1. At any height put in binding posts on block, as shown in figure. Construct clamps 5 and 6 out of old clock springs heated, bent in above design and retempered. These should be constructed according to the circumference of bottle, leaving ¼" between X and Y.

Connect spring arms at posts and connect posts to batteries and warning bell as indicated in figures. When at night, anyone removes the bottle the springs come together and thus make contact accordingly. The bell rings as warning of poison.

Contributed by JOHN WEINZIL, JR.

CHEMICAL GROWTHS RESEMBLE FOLIAGE.

The following item may prove of interest to your chemical readers and those who dabble in chemistry just for the novelty of such experiments as this:

A 10% solution of sodium silicate (water glass) is put into a glass or beaker, and crystals of any or all of the following salts are dropt in; copper sulfate, ferrous sulfate, nickel sulfate, cobalt nitrat. Many other salts will give similar results but the various sulfates appear to be the best.

Shortly after the crystals are placed in the solution, they will begin to grow in fantastic shapes, each of the salts giving a different growth of different color. These growths look so much like undersea foliage that they have often been called "Submarine Gardens."

The rate of growth depends on the strength of the silicate solution as the crystals are due to a formation of the silicate of the salt used. A solution of the strength mentioned above allows the crystals to grow in a more even manner at a rate which can be watched. The growths, however, will not keep unless the solution is very weak, and then they grow too slowly.

Contributed by JEROME S. MARCUS.

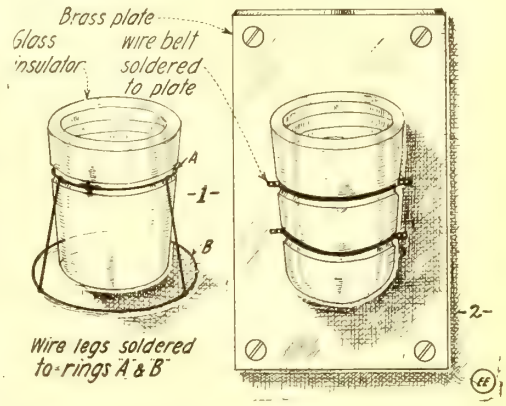
RELATIVE ELECTRICAL CONDUCTIVITY OF DIFFERENT METALS AND ALLOYS.

Metals	Relative Conductivity
Pure silver	100.
Pure copper	100.
Refined and crystallized copper	99.9
Telegraphic silicious bronze	98.
Alloy of copper and silver (50%)	86.65
Pure gold	78.
Silicide of copper, 4% Si	75.
Silicide of copper, 12% Si	54.7
Pure aluminum	54.2
Tin with 12% of sodium	46.9
Telephonic silicious bronze	35.
Copper with 10% of lead	30.
Pure zinc	29.9
Telephonic phosphor-bronze	29.
Silicious brass, 25% zinc	26.4
Brass with 35% zinc	21.59
Phosphor-tin	17.7
Alloy of gold and silver (50%)	16.12
Swedish iron	16.4
Pure Banca Tin	15.5
Antimonial copper	12.7
Aluminum bronze (10%)	12.6
Siemens steel	12.
Pure platinum	10.6
Copper with 10% of nickel	10.6
Cadmium Amalgam (15%)	10.2
Dronier mercurial bronze	10.14
Arsenical copper (10%)	9.1
Pure lead	8.88
Bronze with 20% of tin	8.4
Pure nickel	7.89
Phosphor-bronze, 10% tin	6.5
Phosphor copper, 9% phos	4.9
Antimony	3.88

TWO USES FOR GLASS INSULATORS.

The accompanying drawings show two methods of how glass telephone insulators and some stiff wire can be so constructed and utilized as useful receptables for matches, drills, screws, acids, et cetera, in any experimenter's laboratory. Figs. 1 and 2 show plainly how the wire is bent and soldered.

Contributed by JOHN M. MUNSONS.



Handy Receptacles for Matches, Screws, Etc., Made From Wire and Glass or Porcelain Insulators.

A FORTUNE-TELLING EXPERIMENT

Procure a cylindrical carton about 2½ inches in diameter and at least a foot in length. Place in the bottom of this carton a small bottle, preferably an ink bottle, containing some pieces of iron sulfide (Fe_2S_3) covered with either hydrochloric or sulfuric acid. The cork of this bottle should have a hole about ⅛ inch in diameter drilled thru it to allow the escape of the generated hydrogen sulfide gas. About an inch or so above this bottle (or generator) a round piece of perforated cardboard is held in place by resting on four common pins, the latter being placed at the ends of two diameters which are perpendicular to each other. These pins are thrust thru the wall of the carton so that they protrude on the inside; thereby forming a basis of support for the perforated cardboard. The holes in the latter should be about ⅛ inch in diameter. Take a pad of ordinary unruled paper and write various fortunes on each sheet with a solution of lead acetate, commonly known as sugar of lead. The solution being colorless, the pad paper will appear to have no writing on it.

In telling the fortunes of your friends, have one of them sign his or her name on the top of a sheet of this pad. Tear this sheet off. Have another friend place his or her name on another sheet of the pad. After having three or four signed sheets, roll them up, place them in the carton, and quickly cover. Keep your friends interested by quoting some magic patter, and after placing the carton to the four winds and going thru some magic motions, remove the cover and take out the roll of paper. Immediately cover the carton. Then distribute the sheets of paper to those whom the signatures designate. Behold! Your friends will receive the same signed sheets of paper covered with black writing which upon reading will tell their fortunes.

The chemistry involved in this experiment is the formation of the black precipitate of lead sulfide by the generated hydrogen sulfide (H_2S) coming in contact with the lead acetate $Pb(C_2H_3O_2)_2$ on the paper.

$$Pb(C_2H_3O_2)_2 + H_2S = PbS + 2HC_2H_3O_2$$

Contributed by
FRANK BECHTOLD, JR.

Experimental Chemistry

By ALBERT W. WILSDON

Nineteenth Lesson

LAWS OF CHEMISTRY

THERE are certain laws of chemistry which the reader should study and memorize, previous to taking up Electrolytic chemistry. There are two FUNDAMENTAL LAWS, namely, the *"Law of Conservation of Matter"* and the *"Law of Definite Weight."* The Law of Conservation of matter states that *the weight of the sum of all the products in an experiment is exactly equal to the weight of the sum of all the factors.* The

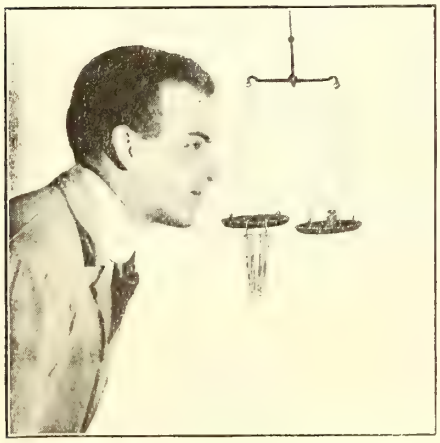


Fig. 93.—Illustrating the Law of Conservation of Matter with Two Balanced Test Tubes, Containing Two Different Solutions.

factors are the substances used to make an experiment; the products are the substances obtained.

Thus, Hydrochloric acid is the product of the combination of the two factors hydrogen and chlorin, expression of which reaction is as follows:

$$\underset{\text{(factors)}}{H + Cl} = \underset{\text{(product)}}{HCl}$$

By this law is meant that chemical experiments can neither create or destroy matter. We may form new substances, separate elements from compounds, make compounds from elements, change solids to liquids or invisible gases, and gases to liquids or solids. We cannot create or destroy matter, therefore, matter is indestructible and uncreatable, as physics teaches us that energy is. *Amount of matter is always determined by weight, not by volume.*

Properly understood, every equation, as well as every experiment, illustrates this law. If we were to take any chemical equation and count the number of atoms of any given element, on the right of the equality sign (the products), we will find that it is the same as the number on the left (the factors). The compounds are changed, but the atoms are the unchangeable things, as Dalton declared them to be when he named them *atoms,* which in Greek means "uncutable."

Let us now take an equation and count the number of atoms on each side of the equation:

$$\underset{\text{(factors)}}{Zn + 2HCl} = \underset{\text{(products)}}{ZnCl_2 + H_2}$$

Here we find that we have for factors, 1 atom of Zinc, which reacts with Hydrochloric acid, composed of 2 atoms of hydrogen, and 2 atoms of chlorin. For products from the above factors we have (a) 1 molecule of Zinc Chlorid, composed of 1 atom of Zinc, and 2 atoms of chlorin, and (b) 2 atoms of hydrogen.

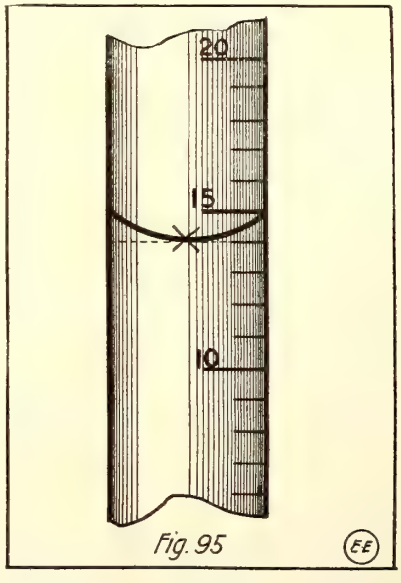
Let us now count the number of atoms for each element and compound, and see if they are balanced in accordance with this law. On the left hand (the factors) we have 1 atom of zinc, which is also shown on the right hand as a product contained in the molecule of zinc chlorid. As another factor we have 2 atoms of hydrogen in the 2 molecules of Hydrochloric acid ($2 \times H = 2H$), as a product we have 2 atoms of hydrogen liberated. As another factor we have 2 atoms of chlorin within the 2 molecules of hydrochloric acid, which is also seen as a product combined in the Zinc Chlorid. Thus the equation is properly balanced.

Law of Definite Weight (also called the Law of Fixt Proportions).—*Any given chemical compound always contains the same elements, and in the same ratio by weight.*

There are two parts to this law. One is that a given compound is always made up of the same elements. Hydrochloric acid is always composed of hydrogen and chlorin, as its ultimate constituents; never anything else. The other part of this law is that these elements always have the same ratio by weight. Thus in hydrochloric acid, that ratio is 1 of hydrogen to 35 of chlorin—1 : 35. The ratio does not vary; it is the same as yesterday and always has been the same; it always will be. The experiments which prove the first part of the law prove the second part also. Any chemical experiment, in fact, illustrates it.

The practical application of this law is that if you take too much of one of the factors in making an experiment, only a part of the reaction will take place, and the excess will be left behind unacted upon; in some cases a different substance from that wanted may form.

In large chemical industries it is almost



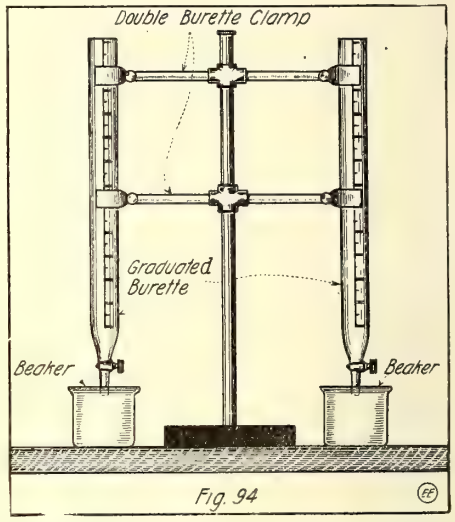
This Illustrates How Readings Are Correctly Taken from the "Bottom" of the Meniscus in a Tube Containing a Fluid.

as necessary to know the right proportion for mixing substances as to know what to put together. Suppose we wish to prepare some ferrous sulfid (FeS) from its elements; in what proportion should we mix the latter? The equation which stands for the reaction must first be written: Fe+S=FeS. Next the atomic and molecular weight must be affixt:

$$\begin{array}{ccccc} Fe & + & S & = & FeS \\ 56 & + & 32 & = & 88 \end{array}$$

Atomic Weights Molecular Weight

This means that when iron and sulfur unite to form ferrous sulfid, 56 parts by weight of iron always unite with 32 parts of sulfur



Illustrating the Law of Fixt Weight, Experiment No. 109, by the Aid of a Double Burette.

(or some multiple or submultiple of these numbers) to form 88 parts of ferrous sulfid. We should then mix the elements in the proportion of 56 grams of iron to 32 grams of sulfur, or 7 to 4. 56 to 32 forms a ratio which may be divided by the common factor 8. Let us suppose we have 10 grams of iron, how much sulfur will combine with it?

The work should be arranged as follows, placing x under the required or unknown substance (this being Sulfur in this case), and 10 under the known or given substance (Iron in this case).

$$\begin{array}{ccccc} Fe & + & S & = & FeS \\ 56 & + & 32 & = & 88 \\ 10 & & x & & \end{array}$$

Evidently there is the same ratio between 56 of iron (Fe) and 32 of Sulfur (S) as between 10 of Fe and x of S. This gives the following proportion:

$$\begin{array}{ccccccc} 56 & : & 32 & :: & 10 & : & x \\ & & 56\,x & = & 320 & & \\ & & x & = & 5.7 & & \end{array}$$

Proportion being an equality of ratios, we have: 56 : 32 :: 10 : x. Or we may write it

$$\frac{56}{32} = \frac{10}{x} \quad \text{or} \quad \frac{56}{10} = \frac{32}{x}$$

All give the same result. Thus 5.7 grams of sulfur are needed to combine with 10 grams of Iron.

Again, we wish to know how much ferrous sulfid will be made? Arrange and solve as follows:

$$\begin{array}{ccccc} Fe & + & S & = & FeS \\ 56 & + & 32 & = & 88 \\ 10 & & y & & \end{array}$$

$56 : 10 :: 88 : y$

$56y = 880$

$y = 15.7$

15.7 grams of FeS

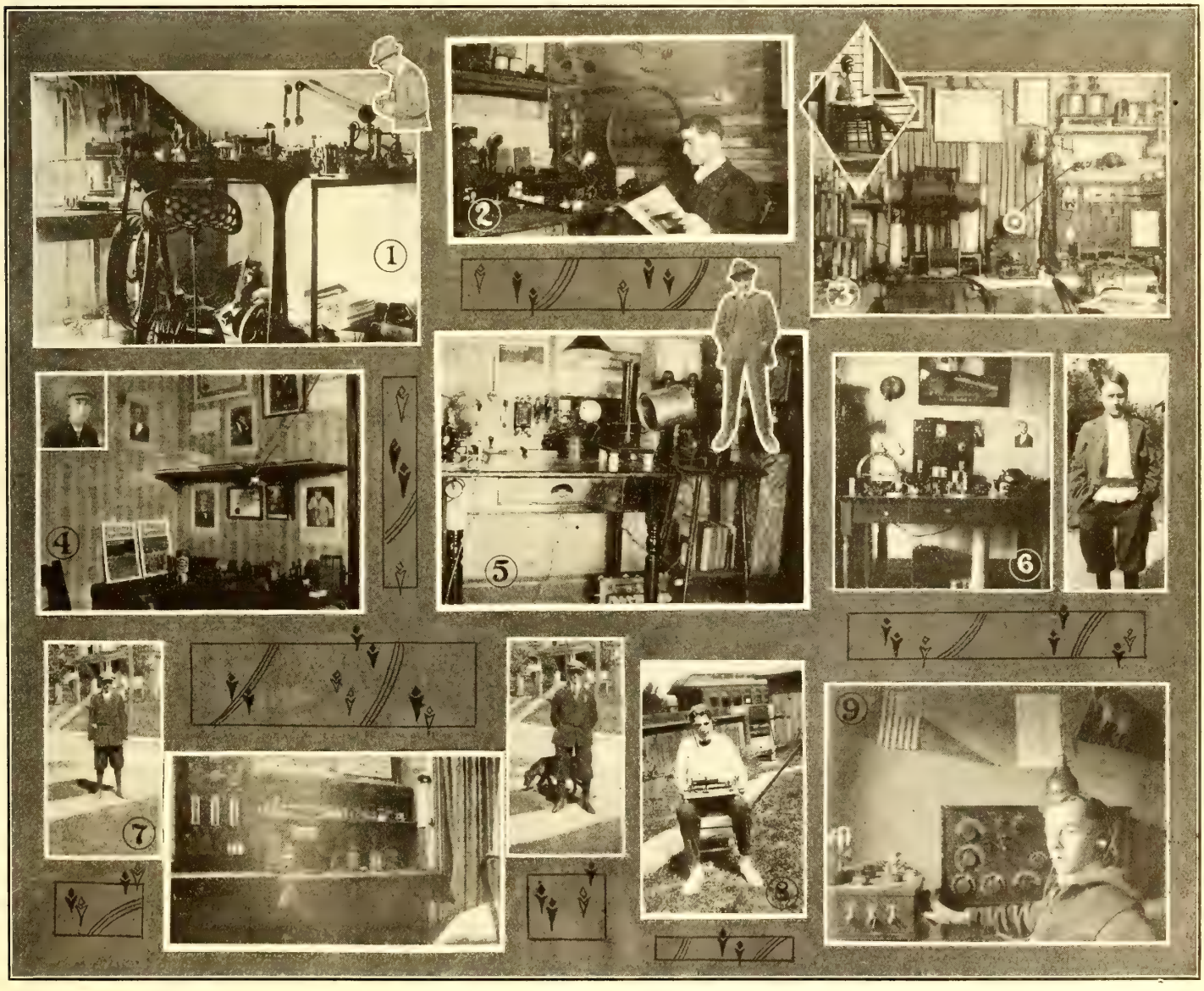
(*Continued on page* 559)

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

Those "Electrical Laboratory" Photos!!!

Well, "Radio-bugs," it seems that you are at last awakening to the fact that your Uncle Samuel has really gone to war, and that such being the case, the "Radio Labs.," of more peaceful times have actually slipt into oblivion, for the time being. 'Tis a mark of distinction to be the owner of a "good" electrical laboratory in these times. Don't go about the reorganization of your "Lab." with a half hearted spirit. On the contrary, let your motto be, "I will study and observe so that I can be of service to my country when the time comes!" You radio enthusiasts should open up your minds to the vast possibilities of "experimental electricity." If you possess a laboratory you, young man, may discover the "germ" of a far-reaching electrical idea which would be of inestimable value to Uncle Sam. And you will be rewarded, never fear. Fortune—Fame—Honor—all these come to the genius who, by patient experiment and study evolves a "new idea" that works. We hope to hear from every owner of an "Electrical Lab.," with a photograph of his *favorite corner,* as well as a likeness of the owner. And come to think of it—don't the "Girls" experiment? Address the Editor "With the Amateur's Prize Contest."



A GROUP OF REPRESENTATIVE AMERICAN AMATEUR LABORATORIES.

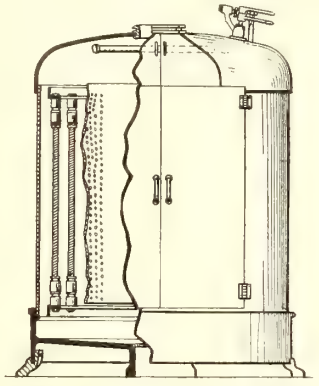
Electrical Laboratories of, 1—L. W. Hagerman, Racine, Wis. (Prize Winner); 2—Burnie Lazette, Monroe, Mich.; 3—J. N. Edwards, Bluefield, W. Va.; 4—Clarence F. Kramer, Lebanon, Ind.; 5—Osmond S. Ryer, Pasadena, Cal.; 6—Robert W. Field, Owensboro, Ky.; 7—Thos. D. Churchill and S. Goldhamer, Toronto, Can. Radio Stations of, 8—Jack Herzog, Lafayette, Ind.; 9—Kirk E. Smith, West Springfield, Mass.

LATEST PATENTS

Electric Bath-Cabinet

(No. 1,241,234; issued to Honora C. Marrinan.)

This combination electric heating and hot water bath is suitably

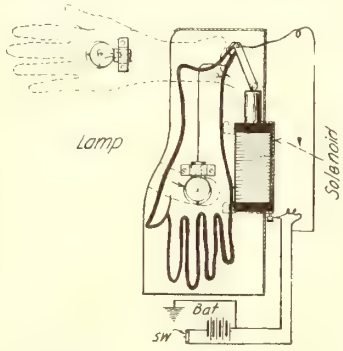


designed so that the proper degrees of heat can be produced from a series of electric heating coils, placed around the interior of the bath cabinet. The heat reaches the bathing chamber occupied by the person using it, in the most efficacious manner possible. One of the principal features of this bath cabinet lies in the interlocking electric switch and hot-water valve levers. The hot-water valve and electric switch control is so arranged that the turning on of said switch or valve prevents the turning of the other.

Electric Automobile-Signal

(No. 1,238,430; issued to G. H. Nierman.)

A semaphore type of electric automobile signal intended for at-

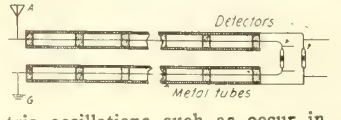


tachment on mud-guard of such vehicles and controllable from the driver's seat. The hand or other figure can be moved to a horizontal position, as shown in the illustration, by means of a magnetic solenoid, which is connected with the car storage battery or to a separate battery, as conditions may dictate. The movable hand forming the signal is fitted with a small incandescent lamp for night signaling, and the lamp may be cut out during the day. The solenoid core is connected to the movable signal arm by a flexible link motion as shown.

Intensifier of Radio Oscillations

(No. 1,235,650; issued to David W. Brown.)

An extremely simple form of intensifier for high frequency elec-

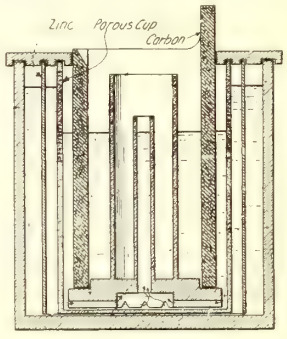


tric oscillations such as occur in wireless receiving circuits, and involving simply the use of two metal tubes, or their equivalent, thru which the aerial and ground lead wires pass to the detector. These envelops or tubes also become themselves highly electrically excited when oscillations from the aerial travel along the lead wires within them, and may be connected to other detectors having their own local circuits and translating instruments, such as telephone receivers, etc., as here indicated. Thus, it is possible with this arrangement to use two detectors and recorders.

Galvanic Battery

(No. 1,240,885; issued to Richard Schuster.)

This galvanic cell employs two electrolytes, is said to be odorless, and especially adapted for charging storage batteries. Its novel feature resides in the provision of a container or standpipe with over-flow ascending pipe, arranged centrally of, and in communication with the

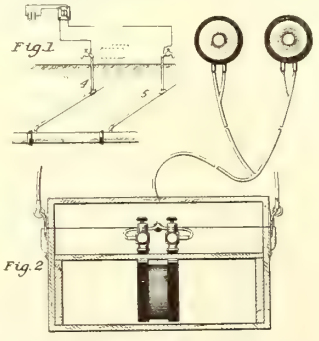


cathode cell, for the purpose of receiving the products of decomposition given off by the cathode electrolyte. The battery consists of an outer jar, a porous cup containing the cathode electrolyte, a carbon member, and in the annular space between the jar and porous cup, the anode electrolyte and the annular zinc member. All of these parts being nested in a well-known manner. The cathode electrolyte consists of a solution of bichromat of soda, water and sulfuric acid. The anode electrolyte comprises a caustic potash solution mixed with water. The upper part of the porous cup is made impervious to the electrolyte. The cell gives 2.7 volt and it is also reversible in action.

Electrical Detector for Underground Pipes

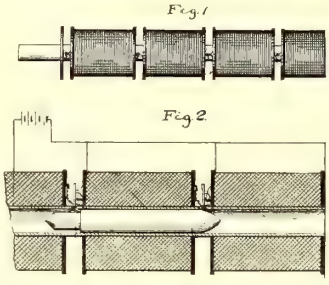
(No. 1,241,963; issued to Edward H. Grove.)

It is first necessary to connect a source of interrupted current to two



different taps on the pipe line, as shown in the diagram. This detector comprises a small magnet coil connected to a pair of sensitive telephone receivers, which are held to the ear. The operator proceeds to hold the detecting instrument by its supporting strap just above the ground as in Fig. 1, in a position at an angle to the pipes 4 and 5. While so holding the exploring coil, and walking about, the operator proceeds to swing the instrument in the direction of its length. When swinging the coil, the operator may move along naturally. When he is directly over the sought pipe, the sound in the telephone receivers will be as loud at one limit of the swing as at the other.

Electric Gun



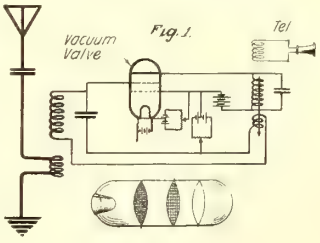
(No. 1,241,333; issued to Levi M. Bowman.)

Another patent on electric guns, and having for its principal novelty the particular automatic switch arrangement shown, whereby the movement of the projectile along the barrel successively trips the switch connecting in circuit the coil just ahead of the projectile. Thus it becomes evident how each succeeding magnet coil will act on the projectile progressively, so that by the time it reaches the end of the barrel, it will have acquired a high velocity.

Valve Receiver for Radio Signals

(No. 1,238,869; issued to George M. Wright.)

Receiver for radio signals, com-

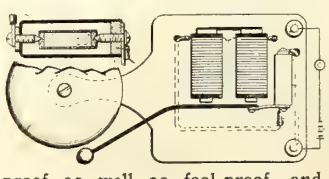


prising an evacuated vessel containing a heated filament, two grids and an anode. The inventor states that he is thus able to limit the strength of the current in the anode circuit, with the result that the sounds caused by atmospherics in the telephone will be considerably reduced, and will thus be prevented from over-powering the sounds caused by the signals which it is desired to detect.

Vibrator for Electric Bells

(No. 1,242,038; issued to W. E. R. Rademaker.)

This patent covers a unique design of vibrating interrupter for electric bells, which is of such a type that it can be made dust-

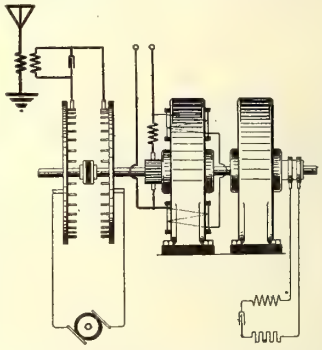


proof as well as fool-proof, and the usual contact screw is done away with. The interrupter member of this bell comprises a movable electrode of carbon or metal, delicately mounted within a small tubular chamber secured to the bell frame. When the circuit is closed thru the bell and interrupter, the electro-magnets are excited to their full maximum and the resulting vibration due to the armature striking the magnets, jars the interrupter electrode, thus opening the circuit momentarily.

Radio Frequency Oscillation Generator

(No. 1,240,206; issued to Raymond A. Heising.)

This radio-frequency oscillation generator is unique in that no spark gap is utilized. The high frequency oscillatory circuit is charged by a rapidly rotating commutator from a high-voltage direct-current generator, at those times during the cycle at which the difference of the voltage be-

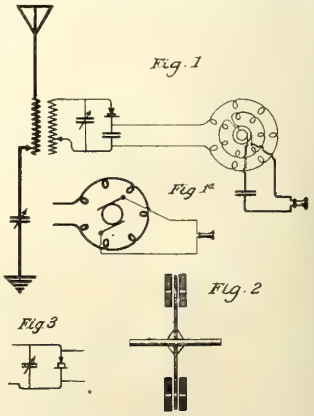


tween the generator terminals and that across the oscillation circuit is small. This invention covers special means for obtaining a constant speed in the commutator-driving device; this device comprising an alternating current generator, rigidly connected to the shaft with a D. C. motor connected to an external D. C. source of energy.

Radio Receiving Apparatus

(No. 1,241,565; issued to Harry Shoemaker.)

This undamped wave receptor patent employs a small alternating current generator, having a speed adapted to produce alternations of a frequency best adapted to operate a telephone diafram, say 900 cycles, and the windings of the machine are so connected that rectified energy in the detector circuit will pass thru its field,



while the current from its armature will pass thru the telephone. The telephone will then be subjected to a sinusoidal electromotive-force which will be substantially proportional to the current flowing thru the fields. This in turn will be proportional to the receiving energy or the number of wave trains received per second.

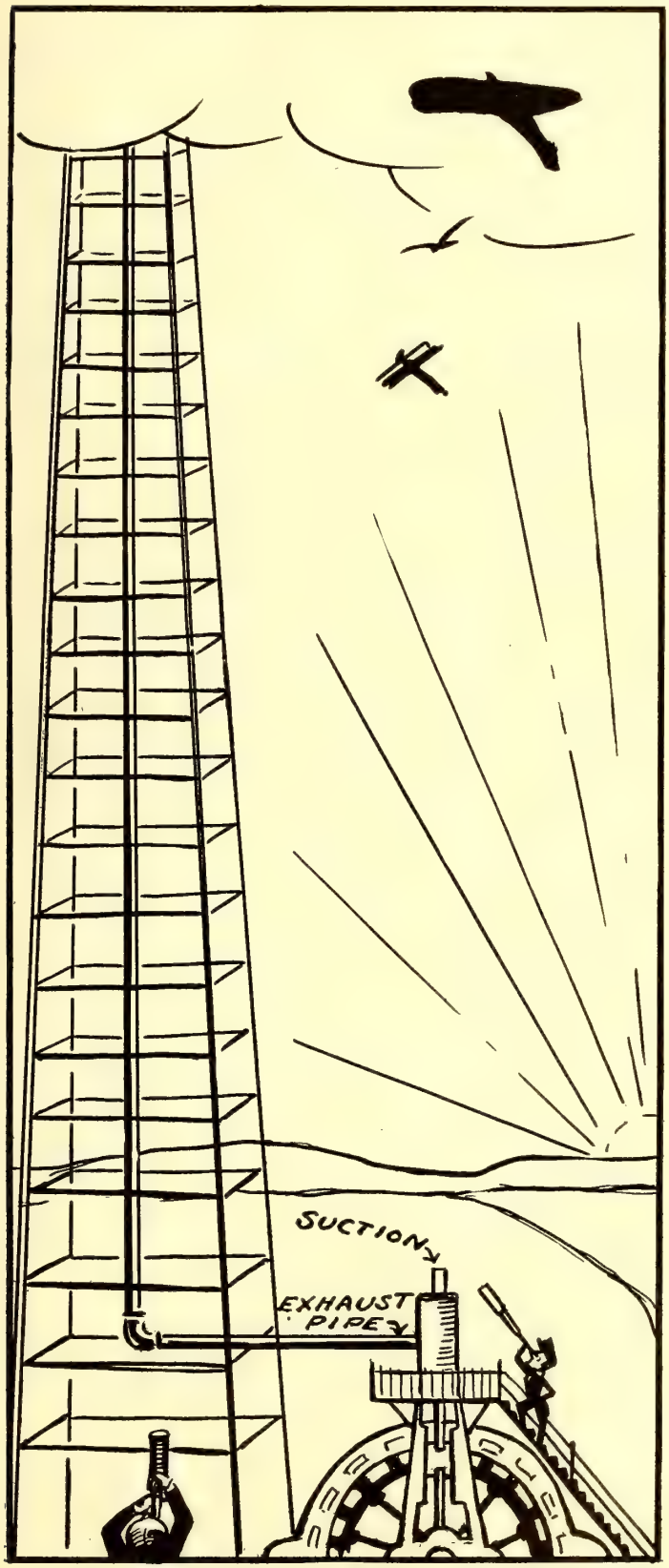
COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c EACH.

Phoney Patents

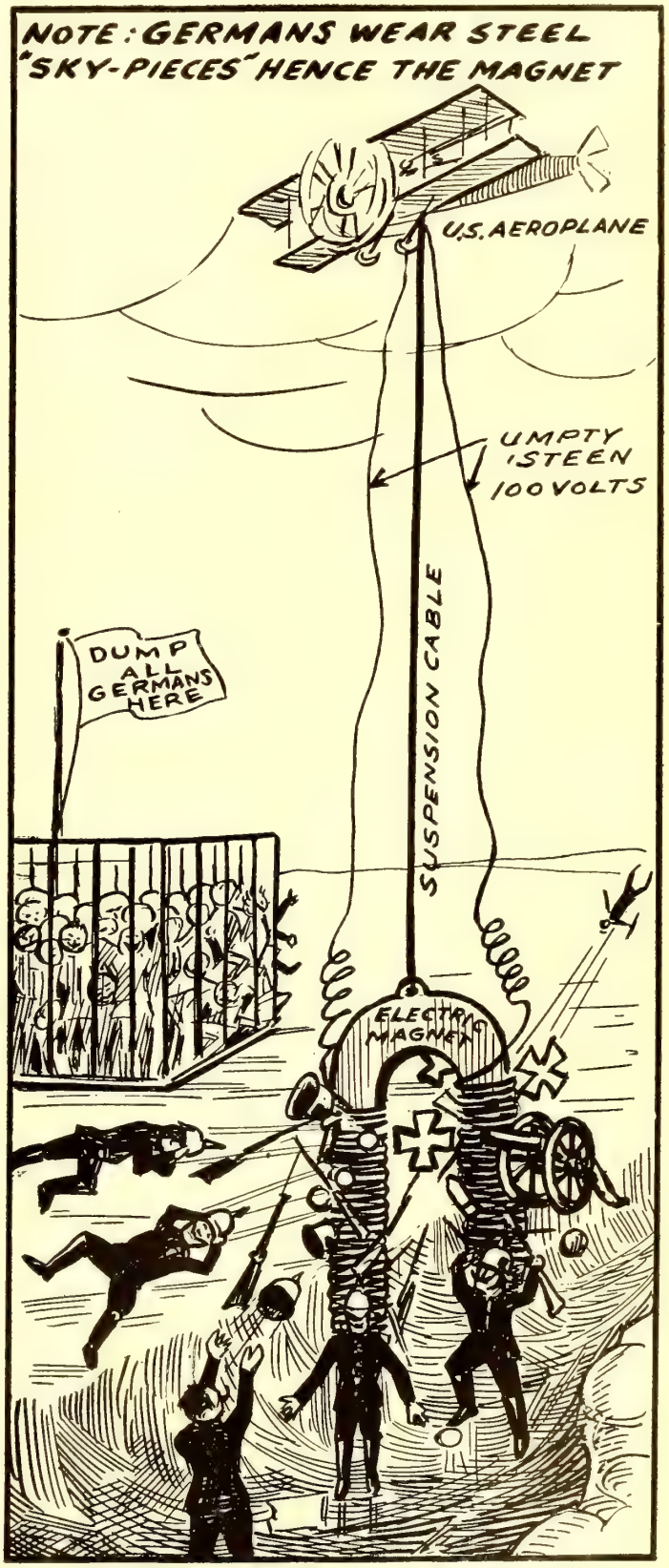
Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for the entire universe.

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PHONEY PATENT OFFIZZ



PERPETUAL MOTION ENGINE. This Engine Runs on Air Instead of Steam. The Engine Takes In Air At 14.7 Lb. Pressure At Suction Pipe and Exhausts the Same 40 Miles Above the Earth Into a "Vacuum," Or the Highly Rarefied Upper Atmospheric Strata. It Costs Nothing to Run. Inventor, Evert Pool, Hobart, Okla.



Prize Winner.—HUN-CATCHER.—Why Not Equip Those 20,000 Yankee Aeroplanes With Powerful Electric Magnets? The Magnets Attract the Steel "Sky-pieces," the Attached Huns, Guns, Gas Tanks and All. Dump 'em in Convenient Cages and Let Billy Bryan Talk the Kaiser Out of 'Em. Inventor, Joseph Wachtman, West Fairview, Pa.

QUESTION BOX

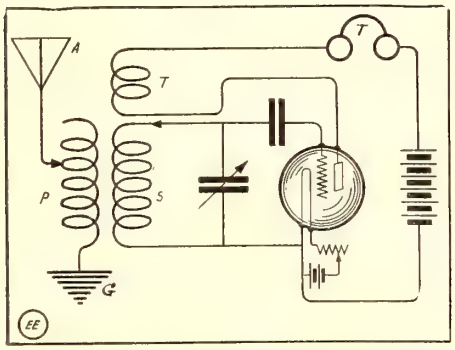
This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. **Only three questions can be submitted to be answered.**
2. **Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.**
3. **Sketches, diagrams, etc., must be on separate sheets. Questions address to this department cannot be answered by mail free of charge.**
4. **If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.**

AUDION TICKLER COIL.

(861.) John Andrews, Philadelphia, Pa., asks:

Q. 1. What does the term *tickler* coil mean?



Hook-up for Audion with Inductively Coupled "Tickler" Coil at "T."

A. 1. There have been a large number of experimenters asking the same question. The term tickler coil refers to a coil which couples electromagnetically the wing and grid circuits of an Audion, so as to make it oscillate. A standard circuit in which a tickler coil is employed is shown in the accompanying drawing. The coil "T" is the tickler coil which is coupled to the secondary; it reacts on the grid circuit thru the stopping condenser.

GASOLINE ENGINE QUERY.

(861-A.) Wilbur Brown, Ontario, Canada, wishes to know:

Q. 1. Does a two H. P. gasoline engine of the marine type use any more gasoline than a gasoline engine of the hit and miss type of the same H. P. such as used for farm use.

A. 1. It is impossible for us to tell you whether the marine type engine draws more gasoline than the other type as the amount of gasoline depends upon several factors, namely: load, leak of compression, due to poor valve speed, type of carburetor and the general characteristics of the engine.

Q. 2. Would a ¼ in. spark coil work any better or carry any farther in a ground telegraph system than a buzzer.

A. 2. A ¼ inch spark coil would work better than a buzzer for a ground telegraph system.

Q. 3. How many glass plates 3½ x 3½ will be required for a condenser to be used on an Oudin coil 3 inches in diameter and consisting of about 500 turns of No. 35 double cotton covered wire.

A. 3. Twenty-five plates will be required.

AUDION PHENOMENA.

(862.) John Pils, Chicago, Ill., inquires:

Q. 1. What is the exact action that takes place in an Audion when used as a rectifier of radio frequency currents, or amplifier of audio frequency currents?

A. 1. It would be impossible for us to give you an exact explanation of the phenomena that take place in an Audion in this column. The general operating characteristics of this device depends upon the relation which exists between the potential on grid and the current in the plate or wing circuit with respect to the filament. A very thoro treatise of the operating characteristics of the Audion has been publisht in the August, 1916, issue of this magazine. It is worth 35 cents a copy.

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As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 *to* 150 *words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.*

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, *233 Fulton Street, New York City.*

CONDENSER QUERY.

(863.) Andrew Hall, Pittsburgh, Pa., asks:

Q. 1. Between what points on a condenser scale does the capacity vary as a linear equation?

A. 1. Between 10° and 160°.

Q. 2. Is it possible to make a condenser with a zero capacity at zero scale?

A. 2. No, as it is impossible to shield or to reduce sufficiently the electrostatic field produced by the edges of the plates when the movable plates are set zero degrees on the scale.

Q. 3. How is the Seibt condenser built?

A. 3. The Seibt variable condenser is made out of one solid aluminum casting and the plates, both movable and stationary, are machined out from the same. With this process of manufacture the variable condenser is made very accurate and the space between plates is reduced very considerably, thus increasing the capacity of the condenser. The capacity of this type of condenser is much higher than that of a built-up condenser of the same size.

PROPERTIES OF RUBIDIUM.

(864.) Frederick Handel, Brooklyn, N. Y., writes the "Question Box":

Q. 1. What are the properties of rubidium metal?

A. 1. The specific gravity of the metal is 1.52. It melts at 38.5° centigrade; while at 10° it is as soft as wax. It is a lustrous silver white metal, with a tinge of yellow, oxidizes rapidly in the air, developing much heat and soon igniting. Volatile as a blue vapor below a red heat. The metal does not keep well under petroleum, but is best preserved in an atmosphere of hydrogen. Next to caesium it is the most electro-positive of all metals.

Q. 2. Does lead acetat precipitate from neutral or acetic acid solutions?

A. 2. Yes, the product of the reaction is a yellow lead chromat and the equation shows the reaction between lead acetat and sodium chromat.

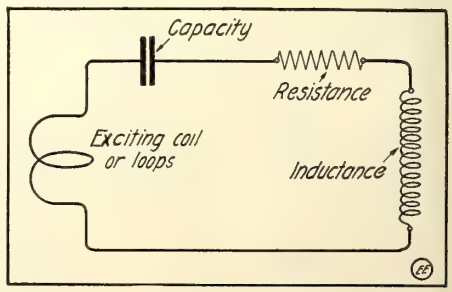
$$Pb\ (C_2H_3O_2) + Na_2\ Cr\ O_4 = Pb\ Cr\ O_4 + 2(Na\ C_2\ H_3\ O_2)$$

PHANTOM ANTENNA.

(865.) Paul Heffle, Detroit, Mich., inquires:

Q. 1. Is it possible to operate a telegraph system by the use of a buzzer, water pipe and gas pipe as current lines?

A. 1. Yes. We advise you to refer to page 318 of the September, 1917, issue of this magazine.



Circuit of a "Phantom" Antenna, Used in Testing Radio Transmitters in the Laboratory.

Q. 2. What are *phantom antennae* and how are they made up?

A. 2. A phantom antenna is an artificial antenna which is used in laboratories in-

stead of a real antenna, but which has the same electrical unit values as that of a real antenna. Thus a real antenna has resistance, capacity and inductance.

You can build one of these phantom antennae by connecting in series a suitable resistance, capacity and inductance coil and the diagram here gives the hook-up of such an antenna. The Government however forbids its use during the duration of the war.

TRANSIENT ELECTRIC PHENOMENA.

(866.) A. Wolf, St. Paul, Minn., asks:

Q. 1. What are transient currents?

A. 1. According to the definition given by Dr. Louis Cohen in his elaborate book on alternating currents, the following holds true: "If the electrical conditions of a circuit are disturbed in any way, as for instance by change of the electrical constants of the circuit, or a change in the electromotive force acting on the circuit, a readjustment of the current and potential in the circuit will necessarily follow. The permanent state, however, is not reached instantaneously; it requires an appreciable time interval before the electrical equilibrium is again establisht. The electrical phenomena which occur in the time interval before the permanent state is reached again have been properly designated *Transient Electric Phenomena.*"

PERMANENT MAGNET AND AUDION CIRCUIT.

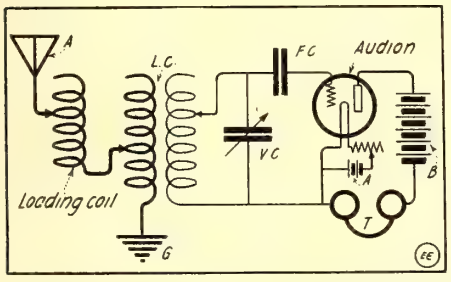
(867.) E. Davis, of Edgewood, R. I., wishes to know:

Q. 1. How can a permanent magnet be used in an Audion circuit to increase the sensitiveness of the device?

A. 1. There is only one possible place wherein a permanent magnet can be utilized in an Audion circuit to advantage, and that is by placing the poles of the magnet near the Audion tube, in which case the sensitiveness of the device is increased manifold, the action of which is due to the concentration of the ionic stream which is discharged by the hot cathode filament. In this case the amplification and rectification of the instrument is considerably increased.

3,000-MILE RECEIVING OUTFIT.

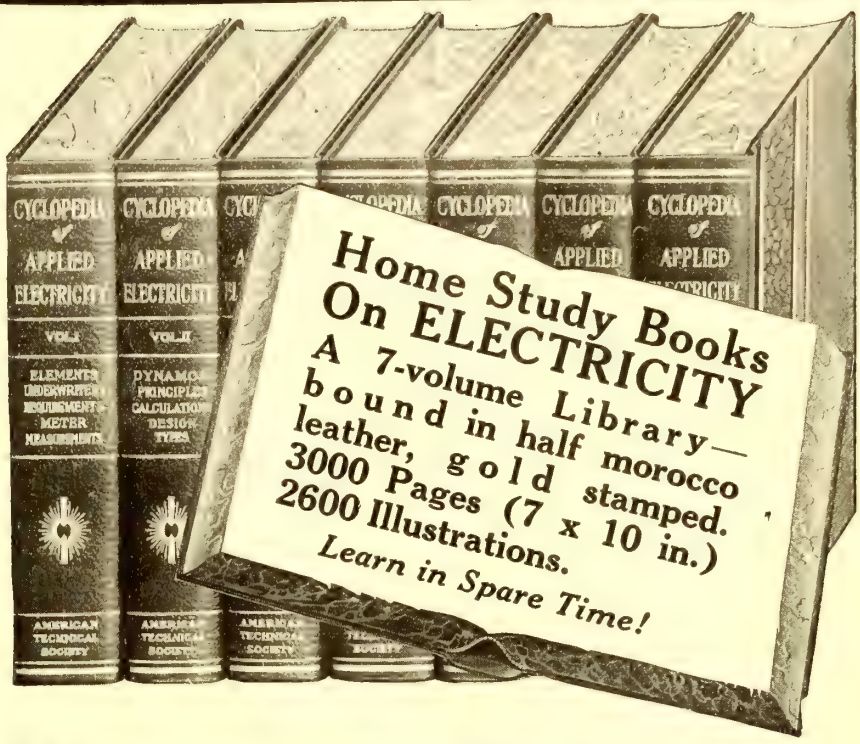
(868.) T. A. Snyder, of Chicago. Ill., asks:



Hook-Up for Audion Receiving Set for Radio-Telegraphy.

Q. 1. In order that I may receive from a distance of 3,000 miles, what wireless instruments are required for an efficient set?

A. 1. The following instruments will be required in order to be able to receive 3,000 miles. A very sensitive detector, such as the Audion, with its accessories, including a high tension or "B" battery; a filament battery; a pair of high resistance (preferably 3,000 ohms) 'phones; a "grid" condenser of .00015 mfd; a .001 mfd., variable air dielectric condenser. A loose coupler of the switch-contact type, and a loading coil.



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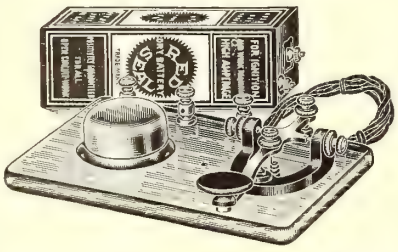
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MescoTelegraphPractice Set

For Learning Telegraph Codes

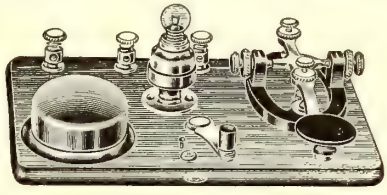


The Practice Set comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal Dry Battery, and four feet of green silk covered flexible cord.

The key and buzzer are mounted on a highly finished wood base, and three nickel plated binding posts are so connected that the set may be used for five different purposes.

List No. Price
342. Telegraph Practice Set, with Battery and Cord.....$2.70

MESCO Combination Practice Set for learning the Morse and Continental Visual and Audible Codes



This outfit is the only reliable instrument which will enable students to become proficient operators in the U. S. Naval Service, because it is equipped with a buzzer and miniature lamp enabling the user to master both the visual and audible signals quickly.

List No. 52—Practice Set with Red Seal Battery and Cord, $3.38

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Q. 2. How would you connect them?

A. 2. Wiring diagram is given herewith.

Q. 3. Do you know of any firm who sells blue-prints—giving full information as to how wireless instruments can be made?

A. 3. We would suggest that you procure the two books—one entitled "How to Make Wireless Receiving Apparatus" and the other "How to Make Wireless Transmitting Apparatus," which can be obtained from our Book Department at 25 cents each.

SOLID ELECTROLYTE.

(869.) Stanley Dewsnap of Springfield, Mass., wishes to know:

Q. 1. Can you give me the formula for making the solid electrolyte now in use in small portable storage cells in connection with pyrometers of the optical type?

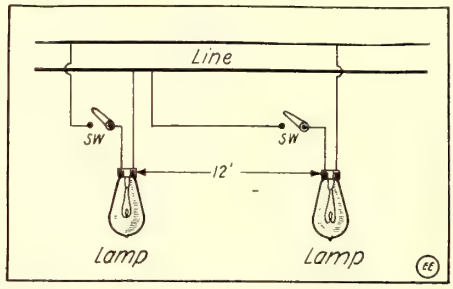
A. 1. The type of storage battery you speak of, and which is used in the pyrometer, is a dry storage battery of the portable type. It can be readily made by immersing the regular storage battery plates in some glass wool which is thoroly saturated with the regular sulfuric acid solution of the proper density. This mixture for making a storage battery of the dry form, has been utilized abroad with great success.

Q. 2. Does the use of such an electrolyte require any different type of plate?

A. 2. The use of this electrolyte does not necessitate a different type of storage battery plate.

RECTIFIERS.

(870.) William Lewis, Rosedale, Kansas City, Kan., writes:



How Two Lamps Can Be Controlled By Single-Pole Snap Switches From Two Different Locations.

Q. 1. Please show in a diagram how I can control two electric lamps (12 ft. apart) by one pole (one circuit) snap switches, one switch upstairs, and one switch downstairs.

A. 1. We give herewith wiring diagram of the scheme in question.

Q. 2. How many rectifier jars are needed to change 110 volts 5 amp. A.C. into 55 volts D.C.?

A. 2. You require four standard type rectifiers in order to obtain the current you desire.

PHOSPHORESCENT PAINT.

(871.) Edw. L. Wagner, of Sandpoint, Idaho, asks:

Q. 1. What is the composition (electrolyte and depolarizer) of the "Radio" or "Tungsten" flashlight battery?

A. 1. The chemical composition of the depolarizer as used in these flashlight batteries is the commercial form of manganese dioxid. The electrolyte is composed usually of a mixture of zinc chloride and sal ammoniac in water. This is used in these batteries the same as the regular dry cells.

Q. 2. How to prepare phosphorescent paint from calcium sulfid?

A. 2. The phosphorescent paint used today is made by thoroly mixing some phosphorescent calcium sulfid with linseed oil.

(*Continued on page* 557)

WANTED! RECRUITS FOR "GAS AND FLAME" REGIMENT.

(*This statement is authorized by Major Atkisson of the Thirtieth Engineers*).

THE ELECTRICAL EXPERIMENTER has been called upon by the commanding officer of the Thirtieth Engineers to help in mobilizing the personnel of a "Gas and Flame" Service Regiment. This regiment is being recruited now from men volunteering for the service, and will be ready to go "over there" by Thanksgiving.

This is a regiment for skilled, practical men, who will be called upon at once to demonstrate their worth and skill.

Enlistment in the "Gas and Flame" Regiment offers opportunity to skilled men, to be used and recognized as men skilled in their trade.

This opportunity should appeal to men who have previously felt that they were most needed at home, because of their special training and experience.

The regiment will be required in the field of operation to supervise the American offensive in "Gas and Flame" service, and will be called upon to instruct men all along the front in this most important work. Consequently these men, all volunteers, will be in the thick of the greatest activities.

The Thirtieth "Engineers" is the pioneer regiment in the "Gas and Flame" service. Men who enlist now will be leaders in the Spring offensive.

Your Opportunity—This organization will require a large proportion of men able to assume responsibility, and to act upon their own initiative and individual judgment. There will be opportunities to advance to the higher non-commissioned grades. There will be opportunities for commissions.

The "Gas and Flame" service offers a real chance for red-blooded Americans to get in where their efforts will give definite results. In addition to needing any men who are looking for just this opportunity to help put across the important service, specialists are needed as outlined below.

Who Can Qualify—Chemists (analytical, research and manufacturing). Chemical workers, powdermen, men experienced in gas manufacture, machinists, automobile repair men, men able to operate and repair gas or steam engines, pipe fitters, electricians, designers, interpreters, carpenters, blacksmiths, plumbers, boiler-makers and chauffeurs.

Men with long experience in their trade are especially desired to fill the Master Engineer grades.

All men enlisted in the Thirtieth must have good muscular development and be capable of undergoing active service at the front.

Men are wanted who know how to take care of themselves, who are active, energetic, and have a strong determination to carry out any mission to which they may be detailed.

Loyal American citizens with the above qualifications between 18 and 40 years of age, who have not actually been called by a local board in the draft, are eligible for enlistment.

Officers Are Specialists—Colonel A. A. Fries, Engineers, N. A., is to be the commanding officer of the Thirtieth Engineers. He is a regular officer of the corps of engineers, with many years' experience in military and civil engineering. Colonel Fries is now in France and is "Chief of the Gas Service."

Major E. J. Atkisson, Corps of Engineers, is organizing the first battalion of the Thirtieth Engineers at Camp American University, D. C. He is a graduate of West Point and of Cornell University.

(*Continued on page* 558)

QUESTION BOX.

(*Continued from page* 556)

The proportions between these two chemicals is dependent upon the amount of light desired to be emitted by the phosphorescent mixture.

SYNCHRONOUS GAP.

(872.) Robert D. Stewart of Cambridge, Wis., asks the following questions:

Q. 1. What should be the number of cycles delivered by a rotary converter of ½ K. W. to convert 110 volts D. C. to 80 volts A. C., best suited to wireless purposes?

A. 1. We should advise that 500 cycles should be the most efficient frequency for such a rotary converter to be used in radio work.

Q. 2. How can the number of cycles of a rotary converter of such a type be increased to twice the number?

A. 2. The frequency can be doubled in a rotary converter by doubling the speed of the armature.

Q. 3. Which would be the most efficient to use, a synchronous spark gap, or a rotary spark gap, with such a rotary converter?

A. 3. A synchronous spark gap is the most efficient form of spark discharger for use in radio work, and if a rotary disc with projecting electrodes is mounted on the shaft of a rotary converter, a synchronous spark is thus obtained.

MULTI-LAYER COIL.

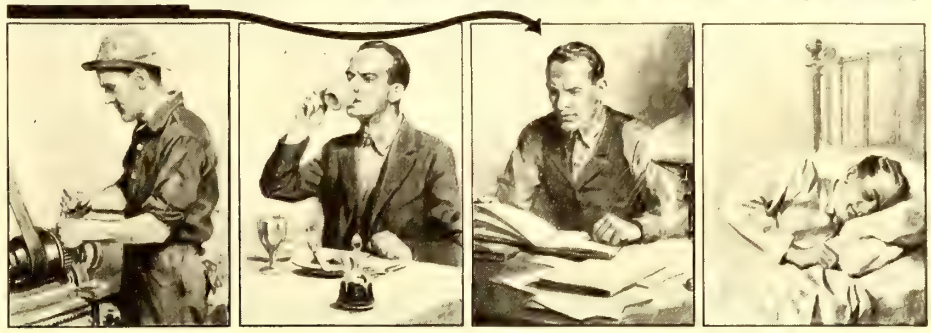
(873.) Mr. B. A. Browne of Washington, D. C., writes:

Q. 1. I understand from the article "Calculation and Measurement of Inductance" on page 320 of the September issue of the ELECTRICAL EXPERIMENTER, that the multilayer coil as described in figures 2, 3 and 4, may be used in lieu of a loose coupler. If I am correct, will you please say how the wave length is varied. The description does not seem to provide for any taps as in loose coupler construction. This coil is described as "very satisfactory for tuning long waves." Will you please give the approximate minimum and maximum wave lengths that could be received with a coil of this design, constructed as indicated on page 321, column 1.

A. 1. The amount of inductance of multilayer coils is varied in the same way as in other types; that is, by taking from each layer a contact lead which naturally controls the number of turns in the coil; thus controlling the wave length or the circuit in which the coil is connected. You can have as many contact leads or "taps" from a multilayer coil as you wish. However, it should be carefully noted that the insulation between the connection and its adjacent layer should be very thoroly arranged; thus avoiding any short-circuits. The maximum and minimum wave length received with such coils is entirely dependent upon the other constants entering into the oscillatory circuit, viz., the antenna inductance and antenna capacity, and the capacity used across the oscillatory circuit. It is essential that these factors be known beforehand, before we can give the maximum or minimum wave lengths that can be had with this type of coil. However, you can obtain wave lengths ranging from 100 to 10,000 meters with this coil, providing the proper capacities are used in the circuit.

Q. 2. I understand from reading the ELECTRICAL EXPERIMENTER that a "tickler coil" is merely a contrivance to rapidly make and break a wireless circuit. If I am cor-

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☐ Gas Engineer	☐ Stenographer and Typist
☐ CIVIL ENGINEER	☐ Cert. Public Accountant
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☐ MINE FOREMAN OR ENGINEER	☐ Commercial Law
☐ Metallurgist or Prospector	☐ Traffic Management
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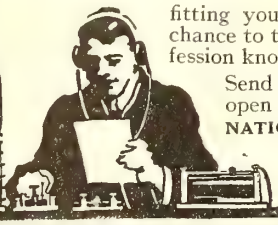
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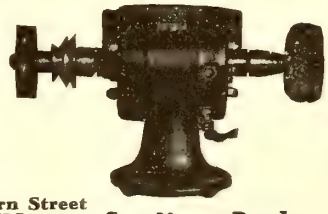
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rect in this, will you tell me how this operation enables the reception of undamped waves with detectors that will not otherwise render such waves audible?

A. 2. The exact function of the tickler coil is given in Query No. 861, and is that a direct magnetic coupling between the wing and grid circuit of the Electron relay or Audion tube is obtained, which functions serve as the means of transferring the plate current to the wing circuit, which grid current is strengthened by the addition of a charge on the grid; thus increasing the amplifying or regenerative effect of the tube. The only means by which oscillating conditions can be had is by coupling both of these circuits and the tickler coil together. In other words, energy transferred and retransferred from both of these circuits, and the rapidity of this transformation of energy is so high, that an oscillatory current of high frequency is obtained, which must occur in the "beat" reception of undamped waves.

WOMAN WINS WIRELESS TEST.

It fell to a young woman to make the highest average at a government examination for wireless operators. She made the highest of anybody—man or woman—in Baltimore city.

Immediately after the declaration of war with Germany ten pretty girls decided to take up wireless telegraphy in order that they might be able to take the places of the boys called to serve their country at the front. They all now have a government license, and one of them received the highest average made.

WANTED! RECRUITS FOR "GAS AND FLAME" REGIMENT.

(*Continued from page* 556)

All officers have been carefully selected from the Regular Army and from civil life, with a view to their special fitness for this particular service. They are experienced chemical, gas and military engineers.

How to Enlist—Go to the nearest recruiting station or U. S. District Engineering Office, state fully and clearly your qualifications and that you wish to be enlisted in the Thirtieth Regiment of Engineers (Gas and Flame).

The officer in charge will examine you physically and pass upon your qualifications

If accepted, you will be enlisted and immediately sent to headquarters of the Thirtieth Regiment of Engineers at Camp American University, D. C.

All men must first enlist as privates, the rate of pay being $33.00 per month and expenses. Men with the necessary experience may be assigned to special duties and given non-commissioned rank at rates of pay ranging from $40.20 to $96.00 per month and expenses. The latter include, for both privates and non-commissioned officers, food, clothing, medical attendance and transportation. Those who enlist will be eligible immediately for promotion, according to their ability and as openings occur. Men who enlist now will have excellent opportunities for promotion as the service expands.

Everybody Can Help—

1. If not qualified for enlistment, get at least one man to volunteer. You can be an immense help in this way, even if you yourself are not in a position to serve.

2. Get this announcement printed in your local newspapers. *This is exceedingly important.*

3. Manufacturers, see that a few men of your organization respond to this call.

4. Use this page as a poster in your office, or ask us for reprints.

EXPERIMENTAL CHEMISTRY.

(*Continued from page* 550)

Again, suppose we want to know how much oxygen will combine with a piece of charcoal weighing 7 grams? Also how much Carbon dioxid (CO_2) will form? Arrange and solve as follows:

$$\begin{array}{rcl} C + 2O & = & CO_2 \\ 12 + 2x16 & = & 12 + 2x16 \\ 12 + 32 & = & 44 \\ 7 \quad x & & y \end{array}$$

$$12 : 7 :: 32 : x \qquad 12 : 7 :: 44 : y$$
$$12x = 224 \qquad 12y = 308$$
$$x = 18.66 \qquad y = 25.66$$

Thus 18.66 grams of Oxygen are required and 25.66 grams of Carbon dioxid (CO_2) are formed.

Always have the final weight numbers (as 12, 14, 32, 44 as above) on the same horizontal line; and be sure your equation balances; then it is only necessary to use such numbers as the equation calls for. Results must be given in decimals to one or two places—not in common fractions.

Suppose we want to obtain 2 liters of Oxygen. How many grams of Potassium Chlorat ($KClO_3$) must we employ, if a liter of oxygen weighs 1.43 grams? This question may be solved as follows:

$$\begin{array}{rcl} KClO_3 & = & KCl + 3O \\ 39 + 35 + 48 & = & 39 + 45 + 3x16 \\ 122 & & 74 \quad 48 \\ x & & \end{array}$$

Weight of O required,
1.43 g. x 2 = 2.86 g.

$$122 : x :: 48 : 2.86$$
$$48x = 248.92$$
$$x = 5.18$$

In working out problems according to the preceding models, observe the following order:

1. Write and balance up the equation.
2. Affix the weights to such of the substances as are called for.
3. Put in the proper places under the given weights, the weights to be used, placing x, y, or z for the wanted substances.
4. Make a proportion, using the substances involved.
5. Place the product of the means equal to that of the extremes.
6. Find the value of x, y, or z.

EXPERIMENT NO. 108. Illustrating the Law of Conservation of Matter. (Quantitative.)

Have 2 test tubes and wind a fine copper wire around the neck of each, leaving a loop to hang them from one arm of a hornpan or other balance. Arrange the balance so that it can be easily adjusted; then pour into one tube 5 cc. of a solution of lead nitrat ($Pb(NO_3)_2$), and into the other an equal volume of sodium chlorid solution (common salt), the exact amount is not essential in either case. Be sure there is no liquid on the outside of the tubes. Fasten the tubes to the bottom of one beam of the scales (See Fig. 93) and weigh the tubes and their contents, or counterbalance them, noting the weight.

Now carefully detach the tubes, pour the contents of one into the other without spilling, note the effect produced, and then hang them again on the beam. In case there is not equilibrium, try the work over again with more care.

Here we have two factors to begin with, *i. e.*, a solution of lead nitrat and a solution of salt. These will be found to have a certain weight, when weighed or counterbalanced upon the scales. These are then mixed and a chemical change is effected.

$$\underset{\text{(factors)}}{Pb(NO_3)_2 + 2NaCl} = \underset{\text{(products)}}{PbCl_2 + 2NaNO_3}$$

Count the atoms in each substance, and see if they are balanced on each side of the equation. When the small $_2$ is placed after the brackets, as in lead nitrat, it means that both the elements within them must be multiplied by two. When a 2 is placed before a substance, as in sodium chlorid, it means that all the elements following it (not beyond a plus or equality sign) must be multiplied by two.

TABLE.

INTERNATIONAL ATOMIC WEIGHTS

The following is a complete list of the 81 elements, with symbols and atomic weights, in which O = 16, H = 1.008.

ELEMENT.	SYMBOL.	ATOMIC WEIGHT.
Aluminum	Al	27.1
Antimony	Sb	120.2
Argon	A	39.9
Arsenic	As	74.96
Barium	Ba	137.37
Berylium	Be	9.1
Bismuth	Bi	208.0
Boron	B	11.0
Bromin	Br	79.92
Cadmium	Cd	112.40
Caesium	Cs	132.81
Calcium	Ca	40.09
Carbon	C	12.00
Cerium	Ce	140.25
Chlorin	Cl	35.46
Chromium	Cr	52.0
Cobalt	Co	58.97
Columbium	Cb	93.5
Copper	Cu	63.57
Dyprosium	Dy	162.5
Erbium	Er	167.4
Europium	Eu	152.0
Fluorine	F	19.0
Gadolinum	Gd	157.3
Gallium	Ga	69.9
Germanium	Ge	72.5
Gold	Au	197.2
Helium	He	4.0
Hydrogen	H	1.008
Indium	In	114.8
Iodin	I	126.92
Iridium	Ir	193.1
Iron	Fe	55.85
Krypton	Kr	83.0
Lanthanum	La	139.0
Lead	Pb	207.10
Lithium	Li	7.00
Lutecium	Lu	174.0
Magnesium	Mg	24.32
Manganese	Mn	54.93
Mercury	Hg	200.0
Molybdenum	Mo	96.0
Neodymium	Nd	144.3
Neon	Ne	20.0
Nickel	Ni	58.68
Nitrogen	N	14.01
Osmium	Os	190.9
Oxygen	O	16.00
Palladium	Pd	106.7
Phosphorus	P	31.0
Platinum	Pt	195.2
Potassium	K	39.10
Praseodymium	Pr	140.6
Radium	Ra	226.4
Rhodium	Rh	102.9
Rubidium	Rb	85.45
Ruthenium	Ru	101.7
Samarium	Sa	150.4
Scandium	Sc	44.1
Selenium	Se	79.2
Silicon	Si	28.3
Silver	Ag	107.88
Sodium	Na	23.00
Strontium	Sr	87.62
Sulfur	S	32.07
Tantalum	Ta	181.0
Tellurium	Te	127.5
Terbium	Tb	159.2
Thallium	Tl	204.0
Thorium	Th	232.42
Thulium	Tm	168.5
Tin	Sn	119.0
Titanium	Ti	48.1
Tungsten	W	184.0
Uranium	U	238.5
Vanadium	V	51.0
Xenon	Xe	130.7
Ytterbium (Neoytterbium)	Yb	172.0
Yttrium	Yt	89.0
Zinc	Zn	65.37
Zirconium	Zr.	90.6

EXPERIMENT NO. 109. Illustrating the Law of Fixt Weight. (Quantitative.)

Have 2 graduated burettes arranged as in Fig. 94. Have one of these nearly filled with very dilute Hydrochloric acid (HCl) (C. P. acid with about 10 times its volume of water). Into the other pour approximately the same volume of sodium hydroxid solution (NaOH). This solution can be made by dissolving 5 grams of Caustic soda

(*Continued on page* 571)

DOES YOUR **STOMACH BALK?**



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DOES YOUR HEART MURMUR, SKIP AND FLUTTER?

Do you know that your heart is also menaced by a deranged stomach? If, instead of properly digesting your food, it is allowed to remain in the stomach to sour and ferment, the gases thus generated by the decomposition will swell your abdominal region unnaturally, interfering with all the organs, and bringing the pressure thus caused principally against the heart. It is this condition that is responsible for many of the fatal, so-called cases of Heart Failure.

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If your stomach is in good condition you can digest anything, and then your natural appetite will call for the food your body needs. The Stomach is a muscular organ and its perfect functioning depends upon maintaining a normal muscular activity. This is where

YOU NEED MY HELP!

This is where my study of anatomy and the internal organs becomes so valuable. I have devised methods which bring about such an internal muscular development so that the functioning can be controlled, thus giving you full control of your health.

It is not what you eat, but what you are able to digest that gives you the vitality to do things. Stop pampering your stomach. It is the STRONGFORT Methods that you need, based on the true principles of Nature's laws of health and body building.

I AM A BUILDER OF MEN

YOUR whole body can be rebuilt, I will show you how to help Nature and replace the old worn, decaying cell life and rebuild it with new vital tissue. No matter what your weakness may be, whether it has been brought on by *indigestion, gassy stomach, nervousness,* or by *youthful indiscretions,* my natural methods will correct it. If you are SKINNY, run down, bilious, always tired and sleepy, have headaches, rupture, no "Pep," you need the STRONGFORT Methods. Every bodily ill gives way to the gentle, healing and building influences of my System. Mark the ailment that interests you most on the coupon below, and I will send you personal information that will help you.

It will cost you nothing to consult me—it may save your life. Send TODAY for my book, **"Intelligence in Physical and Health Culture."** It is a liberal education on the subject and will show you the way to perfect Health, Long Life, Success and Happiness. It is FREE. Send 6c in stamps to cover mailing expenses. Write NOW.

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..Constipation	..Despondency
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..Flat Chest	..Flat Feet
..Colds	..Increased Height
..Catarrh	..Muscular Development
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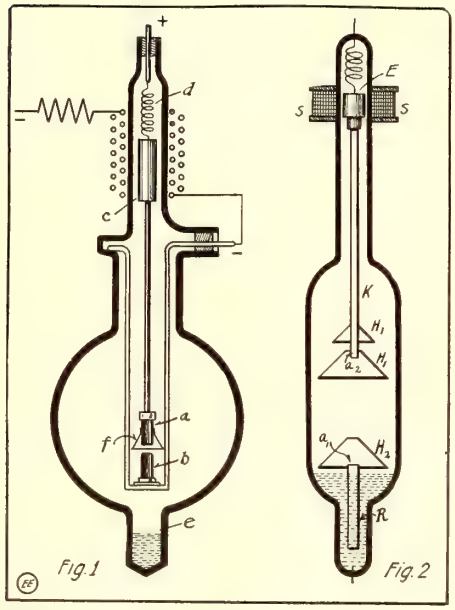
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A NEW NERNST VAPOR LAMP.

Prof. W. Nernst describes a vapor lamp in recent German patents which is somewhat similar to Darrah's lamp, and is a decided improvement from the point of view of efficiency.

According to the patent, the lamp includes a spherical bulb, as shown in Fig. 1, which contains the two carbons *a* and *b*. The upper electrode is connected to the iron core of a solenoid, *c*, which is suitably protected against the chemical effects of the vapor. The lower end of the spherical bulb ends in a short closed tubular connection, which contains the salt to be vaporized. The volatilization is effected by an external source of heat; for this purpose the series resistance, to which the lamp is connected, may be suitably used.

In a second patent Prof. Nernst describes a vapor lamp in which the main conducting medium is mercury vapor; a suitable salt is added in order to give a better color to the light. The principle of the lamp consists in adding a line spectrum to that of the mercury vapor; in this way a white light is produced. Mercury vapor, however, has the property of continually removing any foreign substances. It is, therefore, possible to introduce the coloring substance continuously, if such



A New Form of Vapor Lamp In Which a Salt or Mercury Is Vaporized by Electrical Heat.

substances are used as fuse at the temperature of the mercury vapor lamp. The substances thus continuously volatilize with the mercury, subsequently condensing and flowing back into the circuit in order to begin a fresh cycle of operations. In Fig. 2 this lamp is shown, consisting of a glass bulb containing the electrodes. The anode is of mercury, and the cathode consists of a small carbon, *K*, which is connected to the core of a solenoid. It is necessary to prevent the condensed drops of mercury and salt from reaching the arc, and therefore small conical pieces of glass are fused into the vessel, and surround the carbon. The falling drops then volatilize on the surface of the mercury. Another conical glass piece is placed above the mercury in order to lead the vapor to the arc. If a strong current passes, the mercury vapor rises rapidly from the arc, and this causes a sucking movement at the lower ends, which takes a sufficient quantity of the salt vapors with it. A specially suitable salt mixture for these lamps is said to consist of 70 per cent. zinc chlorid, 15 per cent. calcium chlorid, 5 per cent. thallium chlorid, 5 per cent. lithium chlorid and 5 per cent. caesium chlorid. A lamp of this kind without a series resistance gives a light of 3,000 hefner c.p. on 120 volts; it takes 4 amperes, and therefore has an efficiency of 0.16 watt per hefner candlepower, which is a considerable improvement on other electric lamps. The numbers of the German patents are 288,228 and 288,229.

MANY GENIUSES ARE NEVER REWARDED.

By Dr. Leonard Keene Hirshberg, A.B., M.A., M.D. (Johns Hopkins Univ.)

CONSIDERING the relatively poor salaries Uncle Sam pays in Washington, the Government certainly has made some splendid investments—not to say obtained bargains—in many of its employees.

Almost from the beginning of the Government it has been the general rule that a department employee who made an invention need not turn it over to the department with which he was associated. In the Department of Agriculture this is one of the established rules, and the War and the Navy Departments also have promulgated a similar regulation. But, despite all this, it is the unwritten law—which is more powerful than that on the statute books—that a Government employee shall not make money out of his inventions. The Government and the people at large, therefore, reap a valuable harvest of inventions each year which cost them nothing and add immeasurably to the public wealth and comfort.

One of these inventors is Dr. Marion Dorset, biochemist of the Bureau of Animal Industry. He is the man who first isolated the germ that is responsible for cholera in the hog. Then he invented a serum to combat it. Dr. Dorset protected his processes by patents and then turned them over to the public. But anyone who chooses is at liberty to manufacture and use this serum without paying a penny of tribute. It is an absolute anti-toxin. It is estimated that this discovery of Dr. Dorset's is saving the nation about $15,000,000 a year in the one branch of its food supply.

Dr. Dorset is also the inventor of a secret ink used by the Government in stamping meats that have been past upon by the Federal inspectors in the packing houses. Prior to Dr. Dorset's discovery the Government was paying a private firm $60,000 a year for metal tags for the same purpose. The ink is far more effective, for it puts the stamp into the meat itself. It cannot be transferred. Dr. Dorset receives a salary of $3,500 a year.

The problem of grain standardization used to be considered almost impossible of solution. But a year ago J. W. T. Duvel, one of the Government's experts, discovered that there was a variation in the weight of grain of from 5 to 25 per cent., due to the amount of moisture it contained. This was a very important matter, because grain grown in a damp country would have an advantage of about 20 per cent. over grain grown in a dry climate. Dr. Duvel's researches resulted in his inventing a moisture tester, by which the percentage of humidity in grain can be ascertained in a very few minutes. This invention is now in use in every grain elevator in America. Not a cent in royalties is paid to anyone for it.

The Government sends out about 70,000,000 packets of seed a year. It used to cost the Government $1.32 a thousand for the mechanical work of filling these packets with seed. J. E. W. Tracy, of the Bureau of Plant Industry, invented a device for the filling of these packets. This has reduced the cost of this work by about one-fourth and saves the Government a good many thousand dollars a year. It also saves the seedsmen a lot of money, for the machinery can be made and used by anyone without paying a penny for tribute.

Logan W. Page, director of the office of good roads in the Department of Agriculture, gave to the world not long ago an invention of a waterproof cement, which is of great structural value in the building of locks and dams. It has played an important part in the construction of the Panama Canal. It is so valuable to many large industries that its inventor could have sold it easily for a great sum of money. A cement is produced that will make an otherwise porous structure watertight. Floors covered with this cement are damp-proof.

"Dedicated to the Public" are the four words printed at the head of the patents issued three years ago to Major George Owen Squier, Chief Signal Officer of the Army Signal Corps. His invention is revolutionizing the existing system of telephone communications. He might have sold it for a vast sum, but he gave it to the world for nothing.

The value of many of the great inventions of the officers of the War and Navy Departments can be actually proved only when the nation comes in contact with some other power. One of the most important of these inventions that has been given outright to the United States is the disappearing gun carriage. This was invented by Generals Buffington and Crozier.

Major O. M. Lissak of the regular army is the inventor of a machine for the manufacture of cartridge clips. This machine has been in use in the Government arsenals for many years. It is estimated that it has saved the Government something like $40,000 a year. Major Lissak derived no benefit from his invention until about nine years ago, when a bill was introduced in Congress awarding him a lump sum of $25,000.

In the General Land Office there is a chief clerk named Frank Bond. He is a geographer and takes a deep interest in American exploration. Long ago he conceived the idea that a map that would show at a glance just what the early explorers had done would be of great interest and value. Nothing of the sort was in existence. Mr. Bond spent years in making this map, which is of great historical value. It became especially important when some changes were made in the official maps involving the boundaries of the territory included in the Louisiana purchase. Then it was found that Bond's original researches were far more authoritative and exact than any that had been made before. As an aid to the study of the development and exploration of the United States, Mr. Bond's map has been of so much value that it has been asked for by practically every school and library in the United States.

The forecasting of the rise and fall of the tides at thousands of different places is a very complicated and intricate process. It is one of the important parts of the work done by the Coast and Geodetic Survey. Nineteen different elements enter into each calculation. Figuring this out

with paper and pencil used to be a tremendous task. It required an expense for clerical labor that came to about $40,000 a year.

Thirty years ago William Farrell, an employee of the Coast and Geodetic Survey, devised a machine for this purpose. He turned this invention over to the Government, and it has been used ever since. He never has received any revenue from it. The machine automatically figures the time and degree of maximum and minimum tides at any moment of the day or night and at any place along the coast of the United States. It takes only one man to operate it.

In the Treasury Department at Washington there is an ingenious apparatus which mechanically enumerates paper money in a fraction of time required for counting by hand. It is the recent invention of a mechanical expert of that department, and, like all other devices, is free for public use. It is being extensively adopted by banks and business houses.

THE DETECTION OF SUBMARINES.

At the present time it is of the highest importance that those capable of assisting in the problem of detecting enemy submarines should know something of the difficulties that must be overcome and the conditions under which the submarines usually operate. In this connection the following memorandum, which has been publisht in the "Mining and Scientific Press," of San Francisco, by the American Committee of Engineers in London should be useful.

The Engineering Committee of the National Research Council issues the following data to guide those desirous of helping to circumvent the enemy's submarine campaign by means of invention and suggestion. Any communication on the subject should be addrest to Mr. W. F. Durand, vice-chairman of the Committee, at Washington, D. C.

Submarines operate singly or in groups, as may seem best suited to local or special conditions.

They are supposed, where circumstances favor, to lie on the bottom at rest and with listening devices attempt to detect the approach of vessels. On receipt of evidence that a vessel is approaching they rise to a level permitting observation with periscope, and then maneuver accordingly. When in water too deep to permit lying on bottom the submarine must maintain steerage way in order to hold its level of submergence. The minimum speed at which this can be done will range with circumstances from 2 to 4 knots. The maximum depth of submergence is about 200 ft. The usual depth of running is from 50 ft. to 100 ft.

They have been supposed to return to the home base at intervals of 30 to 35 days. The total radius of action will presumably range from 5,000 to 8,000 miles at a moderate cruising speed of 10 or 11 knots. The high speed emerged will range from 14 to 18 knots, or possibly more in latest designs. The maximum submerged speed is about 10 knots.

The time required from emergence to submergence will range from one to three or four minutes, according to circumstances. When submerged near the surface, the time required to raise the periscope, take a quick observation and lower it again, may range from 15 to 30 seconds. If desired, the submarine can follow an undulating path, rising and submerging alternately, at frequent intervals, at will. Or otherwise it may run fully submerged but near the surface, and take frequent observations thru the periscope. Modern submarines are provided

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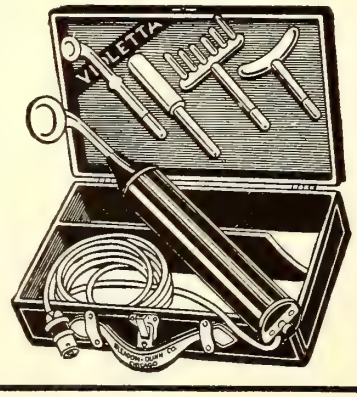
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with two or three periscopes. The loss or destruction of one, therefore, will not necessarily disable the boat.

Torpedoes fired from submarines are presumably aimed by changing the direction of the boat. This, however, is not assured in all cases. The torpedo, in order to run true, must travel at an immersion of about 10 ft. In smooth water it may be run at a shallower depth than in rough water.

Submarines may operate at night with less liability of detection, but with, of course, greater difficulty in picking up their target.

Submarines use the gyroscopic compass.

Sounds produced by the movement of a submarine thru the water, including those traceable to the propeller, to movements of the rudder, etc., should permit of detection by the use of the modern refined sound detecting devices.

The distance at which a protecting net, plate or shield or other means of exploding the torpedo before reaching the side of the ship must be located in order that such distance will render the effect of the torpedo harmless, will depend primarily upon (1) weight of explosive charge, (2) depth of torpedo when exploded, (3) strength of the ship's structure. With modern torpedoes and a depth of 10 ft. or 12 ft., and with the structure of modern merchant ships, distances of 20 ft. or 30 ft. would perhaps be required in order to give good assurance against injury. With rough water and possibly much less submergence at the time of explosion, reduced distances of 15 ft. or 20 ft. might prove sufficient. Experimental investigations on this subject show a very wide divergence among the results, and no precise rule can be given. It may be added, however, that naval constructors generally are satisfied that the distance at which protecting plates or shields would have to be placed in order to secure immunity is so great as to render their use of very doubtful practicability.

GOVERNMENT WANTS RADIO MEN.

Orders were received at the Topeka, Kansas, naval recruiting office recently authorizing the recruiting officer to enlist men and boys, who have completed the high school course or its equivalent, in the radio naval reserve corps.

There are 100 vacancies to be filled from this district. The men accepted for this service will be sent to one of the state universities on the eastern coast, where they will receive a four months' training in wireless telegraphy.

A number of the state universities in the east have offered their equipment in this department and have given the services of their instructors to the government for this purpose. Upon the completion of the four months' course the applicants will be assigned to duty on board a man-of-war. They will be honorably discharged from further duty upon the termination of hostilities.

RADIO PLANT FOR ANNAPOLIS

Annapolis will soon have a wireless station as powerful as that at Arlington.

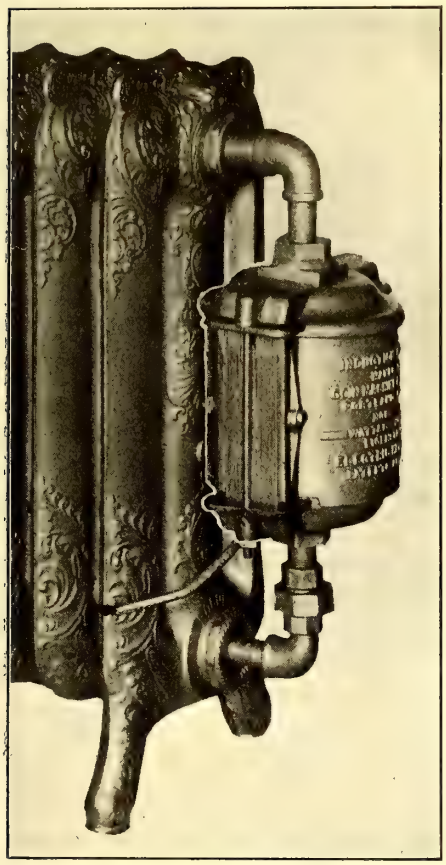
A high naval official admitted recently that the money for the erection of this monster radio station, approximating not less than $1,000,000, has already been set aside and that the work of installing the tower and its equipment will commence at once on the Naval Academy grounds.

AN "INDUCTION" ELECTRIC WATER HEATER.

The induction electric water heater here illustrated, is made in sizes from 750 watts to 500 K. W. In previous heaters of this type, the power factor has been so low as to make them of no commercial value. In this appliance, however, the power factor has been brought to between 75% and 80%.

The heater consists of a cast iron core thru which the fluid to be heated passes, laminated "U" shaped sections surrounding the ends of the core on two sides and a circulating primary coil thru which the exciting current passes, the whole being enclosed by a suitable casing.

The induced energy has been found by test to be wholly due to hysteresis and eddy currents in the solid cast iron core, which in turn heats the fluid of a circulating system into which the heater is introduced. In the resistance type of heater, there is always a chance that the



This Induction Electric Water Heater Is Intended for Use on Radiators, etc. It Involves the Use of a Coil Thru Which A. C. Passes, Which Causes a Water Heating Member to Become Heated by the Current Induced in It.

resistance will burn out. This generally happens sooner or later, and when it does the only thing to do is to get a new heater or heating element. The induction heater, on the other hand, is practically indestructible, the primary coil being of such large size wire that there is no danger of it burning out. Pure asbestos insulation is used thruout which cannot deteriorate with age or heat. The properties of cast iron are such that just before the metal becomes heated to the point of deformation, it loses its magnetic qualities, thus being automatically self-protecting. After cooling, the iron again crystallizes and has all of its former magnetic properties.

In recently investigated cases where the induction heater has replaced gas, it was found that at $4.00 per K.W. per month (4 mills per watt), it was about one-third less than gas at $1.00 per thousand feet.

The engineering principles involved in the construction of this heater do not limit its application to simply supplying hot water for household use, but it can, with very little change, be applied to hot water and steam heating. Where hot water or steam systems are already installed, it is only necessary to connect the heater in place of the boiler.

After a careful investigation, it is found that each kilowatt of capacity in induction electric heaters will supply 20 sq. ft. of hot water radiation. For low pressure steam heating one kilowatt will supply 12½ sq. ft. of radiation.

Further, the induction principle here involved applies itself efficiently to a melting pot for the Linotype and other type casting machines.

SOME DISCOVERIES NOT MADE BY TEUTONS.

During the last few months I have heard the Germans arraigned as blatant, boorish, barbaric, writes Townes R. Leigh in the *Cincinnati Enquirer*, yet in nearly every case the speakers suffixed to their invectives such an expression as: *"But when it comes to brains you will have to hand it to them; they have made science."*

Why hand it to them? What epoch-making invention or discovery is of German origin, except a stamp on which is inscribed "Made in Germany?" The steam engine has been called the greatest of all inventions. It broke the shackles from slaves; it mingled the marts of the world; it made neighbors of the antipodes. Newcomen, a native of Devonshire, England, obtained the patent for the first partially successful steam engine; Watt, a Scotchman, perfected it; Cuynet, Murdock and Trevithick brought forward the locomotive, not on German soil; Stephenson, an Englishman, was the first to apply the locomotive steam engines to railways for passenger traffic; France, England and America applied it to navigation.

The telegraph, which brings us the daily history of the world, was invented by an American, Professor Morse, who also suggested the Atlantic cable, which was subsequently laid by that American merchant-scientist, Cyrus W. Field, assisted in "mooring the new world alongside of the old" by Lord Kelvin, the prince of physicists, a British subject. Alexander Graham Bell, the inventor of the really practical telephone, was born in Scotland and grew to fame in America. A young Italian, Marconi, gave commercial wireless telegraphy to the world.

Cyrus McCormick, a native of West Virginia, produced the reaping machine which harvests the food of the world; Meikle, of England, brought forth the thrashing machine; thus was famine banished. Eli Whitney of Massachusetts parentage, invented the cotton gin; Hargraves, an Englishman, made the spinning jenny; Arkwright, also English, supplied its deficiency with his famous spinning frame; the Englishman Kay, introduced the fly shuttle in weaving; Brunel, who devised the knitting machine and Cartwright, inventor of the power loom, were British subjects. Thus was the world clothed.

Altho Germany is militaristic and worships at the shrine of Mars, what votive offering has she made to the God of war? It was not she who contributed gunpowder, smokeless powder, percussion cap, nitro-glycerin, guncotton, dynamite, tor-

(*Continued on page* 566)

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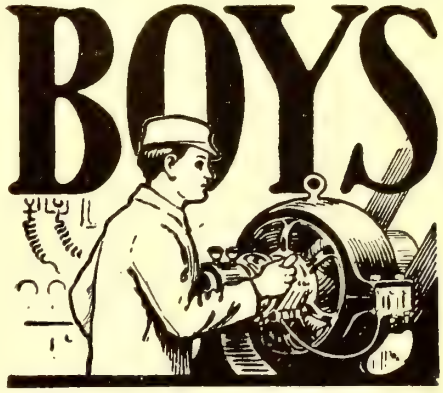




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TWO NOVEL ELECTRIC INSPECTION LAMPS.

The small automatic inspection lamp here shown in use has been brought out by a Boston inventor, for use especially by physicians and dentists. This lamp consists of an extremely small battery case and lamp holder to which is attached a wooden tongue depressor. When in use the pressure of the tongue on the depressor actuates the switch element, lighting the lamp; when removed from the mouth the depressor automatically opens the lamp circuit.



One of the Latest Electric Mouth Inspection Lamps Intended for Dentists and Physicians. It Carries a Tongue Depressor.

This lamp is equipt with 100 interchangeable wooden tongue depressors, and takes the regular pencil battery. By its use the physician has the free use of one hand, as it only requires one hand to hold the lamp and tongue depressor combined, and the construction allows it to be so held, that the hand does not obstruct the view of the throat.

The same inventor has perfected the small lamp and magnet shown in the accompanying illustration, and which is intended for use about automobiles and other machinery to pick up small metal parts that cannot be reached by the hand. The magnet end of this device is provided with a 110-volt, 4 candlepower bulb for illuminating the part inspected or the location where a piece of metal is to be picked up. The outfit is 18 inches long and provided with a suitable length of cord which can be attached to any lighting socket. The magnet part is detachable, so that the lamp can be used alone when such use is desirable.

WHY SOME KISSES THRILL!

An eminent psychopath has likened a kiss to the stroking of a cat, and says that the longer you kiss the same woman the less thrill you get in return.

Love is an electro-chemical action, and he who says the same effect that is derived from a kiss can be obtained from the stroking of a cat is a theorist, and is taking into consideration only the electro part of the action. It is likely that the learned psychopath is not a man from the great school of experience, or that he has never been fortunate enough to come in contact with the human magnet that did not repel him.

Compare two human beings, male and female, with two large storage batteries highly charged. The action to which the batteries are subjected wears them out as time goes on. They work harmoniously, and so it is with a man and a woman. So long as she is magnetic she draws the man to her, and the same thrill is there; but once she begins to repel, then the magnet ceases to perform its functions and the thrill is gone.

Who would be satisfied to stroke the back of a pretty cat to bring about the thrill they have experienced when brought in contact with the magnet that attracted them?

When the chemical elements in a man and a woman blend properly that is when they are mated; the kiss never loses its thrill.

Chicago Herald.

We showed the above clipping to our office boy, "Fips," and asked him for his opinion, he being self-admittedly well versed and experienced in all matters (and manners) of osculation.

After "Fips" had digested the clipping by means of two bottles of dyspepsia tablets, he scratched his tousled red head thoughtfully with his lower-most hind leg, and after partaking a fresh slice of "Raremint" chew-chew gum, he spake thusly:

"Everything being electrical in this world, why not the kiss? Does it not tingle like a galvanic current? Is there, as a rule, not a lot of juice behind it? Does it not require a good deal of pressure (voltage)? Does it not often result in a shock—when SHE "pastes" you one on your "lamps," in other words, when the fuse blows out?!

But from an academic standpoint the kiss really is a direct short-circuit of passion—neat definition that, what? I might add that the kiss also very often acts as a sort of electrical safety valve. Take two highly charged human animals, man+, woman—; if the potential was allowed to rise indefinitely either individual might blow up. Hence nature in its wisdom provided the kiss, which acting as a safety valve, neutralizes the + and — electricities, by allowing both currents to surge back and forward thru the valves, *i.e.,* lips. If one application does not bring down the potential to the safety level, why, dog-gone it, switch 'er on some more!!

The *Chicago Herald's* critic, however, picked out an unfortunate example when he compared man and woman to "large" storage batteries. Did not the poor simp know that storage batteries contain ACID? How can they—man and woman—be expected to "work harmoniously" when they are full of sulfuric acid?! My, my! How can a kiss survive a constant acid bath? No wonder the thrill becomes less and less! No wonder that sooner or later a "galvanic internal action" sets in, reducing the current strength to almost zero! And what about those internal short-circuits, present in all storage cells, particularly in human ones: selfishness, distrust, disloyalty, disinterestedness, dissatisfaction?

These not only completely discharge the storage battery, but make it often impossible to ever recharge the cells again, just as in a real storage battery. The plates have become thoroly sulfated by this time, covered with a thick coating. Result: the human animal by this time has become entirely and hopelessly callous. Hence, if a kiss is ever attempted in this state, no current can flow—consequently no thrill.

Moral: If you *must* kiss,—Stroke a cat!

MIND READING BY WIRELESS.

While traveling in Ohio last year, writes a commercial telegrapher, I attended a performance in a small town, where a mind reader was giving a wonderful exhibition of his powers. The mind reader, apparently an Oriental, for he wore a turban and spoke broken English, was able to name every object the audience chose to select for a test; he also named dates on coins, words, and read passages in books and newspapers; it was a marvelous exhibition.

The mind reader's assistant had a familiar look; he reminded me of a telegraph operator I had worked with in the West. When he came to where I was sitting I noticed he kept one hand in his side coat pocket. The assistant asked me to give the mind reader a test.

Pulling out my Union card, I asked him to name the organization of which I was a member. It was three minutes by my watch before the mind reader answered, "Brotherhood of Railroad Signalmen."

The assistant turned away from me as he held my card in such a way as to bring the side where his hand was in the coat pocket away from me.

Thirty years as a telegrapher has made my hearing wonderfully acute and I detected faint Morse signals. Then I realized in an instant why the mind reader's assistant kept his hand in his coat pocket. He had a wireless buzzer in there and was signaling the mind reader. The buzzer was muffled with cloth to kill the sound.

I also saw why the mind reader wore a turban and stood rigid in one position on a rug. The turban was to hide the receivers clamped on his ears and the rug to hide the antennae that ran under it and up behind his back to the receivers.

I changed my seat several times so as to be near the assistant; and every time I heard the same faint Morse signals. How the assistant glared at me every time I changed my seat! Finally I winked at him, and walked out of the theatre. He gave me a grateful look as I past out of the door.

WIRELESS AT THE FRONT.

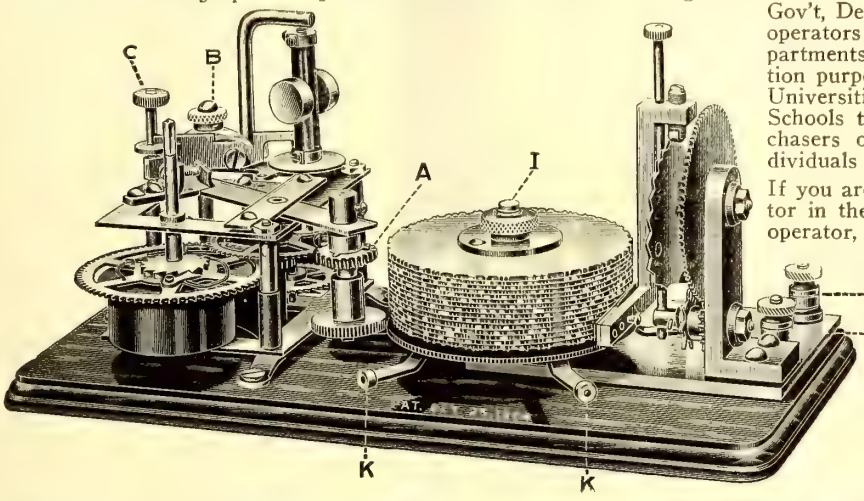
Altho very little has been permitted to pass the censors, it is understood that wireless is being employed to an unprecedented degree on the battle front in Italy. In the front line trenches the aerial wires are strung along a parapet just behind the barricade. In the support trenches the aerial wires are elevated a few feet above the ground, while far to the rear the aerial is generally elevated to about twenty feet by light bamboo poles. The sectional masts familiar to our Army pack sets and wagon sets are practically unknown in the war zone, for the reason that a modest aerial a few feet above the ground is sufficient for the short ranges which must be covered. Wireless telegraphy is a necessity in communication work, because of the difficulty of laying telephone and telegraph lines and then maintaining them across shell-sprayed terrain.

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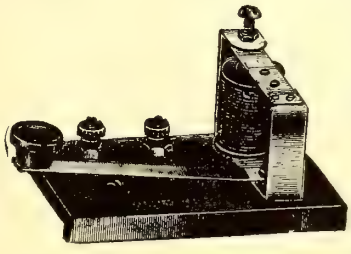
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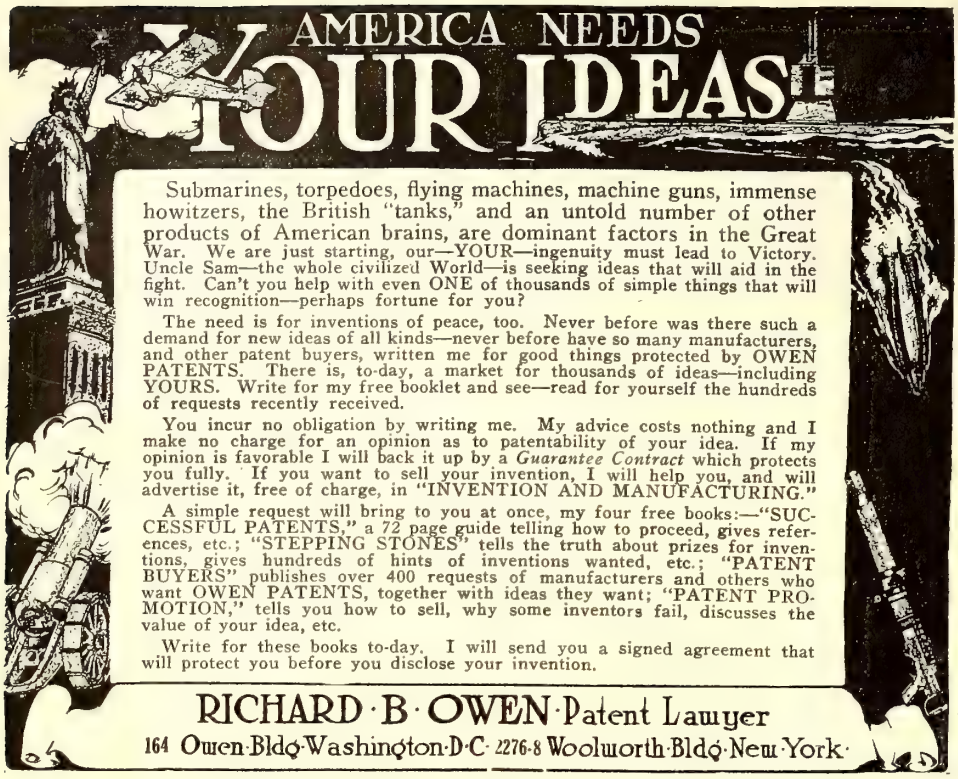
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Should advice be desired by mail a nominal Sketches and descriptions must be clear and ex ten on.

NECK-TIE.

(181.) Carleton A. Howiler, Akron, O., submits an illustration and description of a four-in-hand tie which does not need to be tied by hand. It contains a certain device whereby it is possible to put it in place very quickly thereby constituting a considerable saving of time.

A. The idea is quite good and as original as it is probably new. The point however is: how many men would wish to wear a tie of this kind? Still we do not wish to condemn the idea on account of this, as there are certainly a great many men who would gladly buy such a tie. We think patent protection can be had on this device, but as a precautionary measure, would advise our correspondent to get in touch with a patent attorney first.

ELECTRIC WIND SHIELD.

(182.) Norman J. Shoffer, Norwich, Conn., has devised a wind shield for automobiles which is heated in a certain manner by electrical means, the idea being to heat the wind shield in order to keep the glass warm thus melting the snow; it will also turn the rain into steam.

A. This is a very good idea, and seems to us rather practical if certain means could be incorporated in the device, which we shall be glad to give our correspondent if he desires them.

As sent in to us in its original form the device is not entirely "fool-proof."

ELECTRICAL MINE.

(183.) Paul Brooks, Milton, Pa., has submitted to us an idea of a wirelessly controlled land mine to be planted by troops and which mine is to be used only when the troops are forced to retreat. In that case the mines will be exploded under the enemy thereby impeding his progress. A clever tuning device has been included in this invention.

A. This is a good idea, and inasmuch as our correspondent also took care to safeguard the mine so that it could not be blown up accidently, we think that it might possibly be adopted by some of the warring nations. A device of this kind could be used as a trap by ordering the troops to make a feint retreat, thereby annihilating the advancing enemy's troops, after which the land could be occupied again by the original forces. We advise to have patent attorney look into the patent question, as we are not quite certain that this particular invention does not infringe with a similar one that came to our notice not long ago.

MAIL TIME SAVER.

(184.) Rudolph Goldstone, Connellsville, Pa., submits an idea of an electrical device to be incorporated in a rural mail box, the idea being that as soon as the letter is deposited, a bell will ring in the distant house thereby announcing that mail is in the box.

A. While this is not a new idea, and while a great many patents had been taken

ADVICE

H. GERNSBACK.

is of interest to inventors and particularly to Phases. Regular inquiries addrest to "Patent charge. Such inquiries are publisht here for the be of importance, we make it a rule not to as far as it is possible to do so.
charge of $1.00 is made for each question. plicit. Only one side of sheet should be writ-

out on similar devices, we think the one submitted to us has some possibilities, but before applying for a patent, we would advise our correspondent to have a search made in the patent office for patentability.

HEAT CONTROLLED FAN.

(185.) Francis Ziesse, Brooklyn, N. Y., has submitted to us description and illustration of a highly ingenious electric fan attachment, the idea being that by means of a certain adjustment the fan will start revolving as soon as the temperature reaches a certain point. In other words, on a very hot day when you are too busy to pay attention to the heat, the fan will not forget about it, but will start revolving on its own accord when the room becomes hot enough.

A. This certainly is a capital idea and while the device as submitted by our correspondent is good, it is perhaps not quite as practical as it might be. We think that if some of the features are modified, a commercial proposition can be readily obtained. We think a device of this kind is patentable.

OSCILLATION TRANSFORMER.

(186.) M. Kent Steddom, Oklahoma City, Okla., submits to us what he calls a "rotating oscillation transformer." The idea is that combining a rotary spark gap with an oscillation transformer in a certain manner.

A. This is certainly a very fine as well as clever idea and we heartily approve of it as it combines two instruments into one. The disposition as well as the arrangement is indeed very ingenious and we think there is no doubt but that good patent protection can be had upon a device of this kind. We have never come across anything quite the same, and our advice to our correspondent is to get in touch with a patent attorney at once.

SOCKET TRANSFORMER.

(187) J. B. Thompson of Paragould, Ark., submits a lamp socket transformer of minute design, which is supposed to be screwed into an ordinary lamp socket and can be used for running lamps, toys, etc.

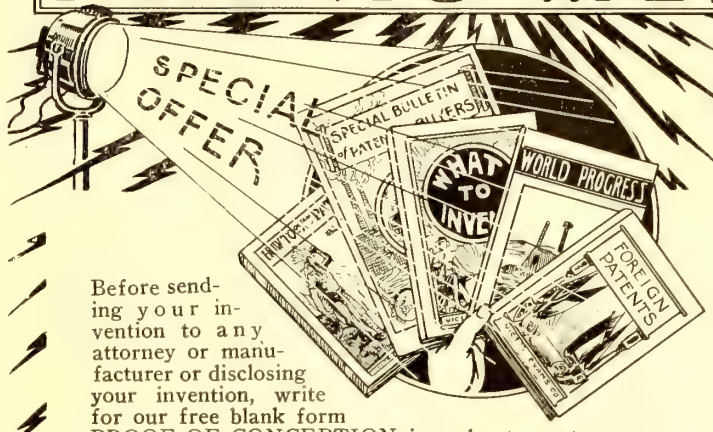
A. There is nothing unusual in the idea. As a matter of fact, a great many transformers of this kind are on the market at present, several types being made by the General Electric Co.

CINEMATOGRAPHIC DEVICE.

(188) Henry Gruen, New York City, claims to have invented a scouting camera for the purpose of taking cinematographic records of the entire surrounding country or a battlefield, thus substituting an aeroplane and eliminating dangers for aviators. Use is made of a miniature balloon of the Zeppelin type, the apparatus to work by means of electricity from the ground. Our correspondent asks if an invention of this kind has any possibilities, and if it is patentable, etc.

(*Continued on next page*)

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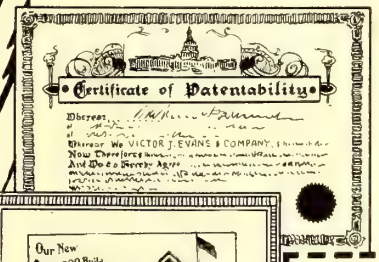
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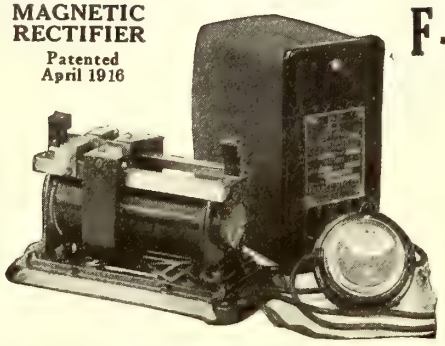
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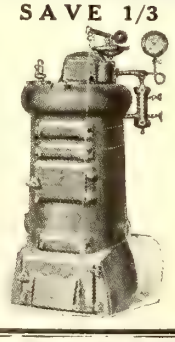
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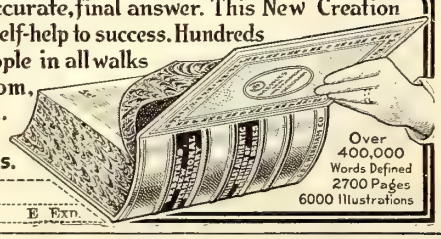
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A. Nothing new is contained in this idea, schemes of this nature having been in use by the Allies as well as by the Central Powers, and sometimes quite good pictures have been obtained. More times, however, the balloons with the camera have been shot down by enemy fire.

SAFETY COAT HANGER.

(189) John F. Bingham of West Toronto, Can., has submitted an idea for an automatic coat and umbrella hanger, making it impossible for an unauthorized person to take either coat or umbrella, the idea of the device being that a coin, say for instance, one-cent or five-cent piece is dropt thru a slot which delivers a key to the patron. Then the coat as well as the umbrella is hung up on the device which automatically closes, and the wearing apparel can then not be taken from the device unless a key opens the lock.

A. This is a really excellent idea, the best part being that it is simple and should be rather cheap to manufacture. This is an important consideration, as for instance, restaurant proprietors would not wish to invest a heavy sum for a device of this kind. To our mind the invention looks original, and we think that little trouble will be had in securing a patent. Our records do not show that anything like it has been patented in the past.

SOME DISCOVERIES NOT MADE BY TEUTONS

(*Continued from page* 563)

pedo, shrapnel, automatic cannon, magazine rifle, breech-loading gun. Gatling gun, revolver, Maxim silencer, hammerless gun, gunboat, ironclad batteries or ship armor plate, revolving turret, submarine or airplane.

Germany did not produce the first aniline dye, vulcanized rubber, liquid gas, gas engine, water gas, thermometer, barometer, piano forte, barbed wire, cut nails, plate glass, circular saw, cable car, electric car, sleeping car, air brake, bicycle, automobile, pneumatic tire, sewing machine, typewriter, calculating machine, cash register, steel writing pen, etc., *ad infinitum*.

The greatest thing that Germany has done, however, is to falsely advertise herself as the light of the world. No son of hers invented the electric light, the gas light, the acetlyene light, the kerosene light, the searchlight, the flashlight, the safety lamp, the candle dip or the friction match. America, France, England and other "untutored" and "unkultured" (sic) nations performed these tasks. The sun, moon and stars are the only lights left for Germany's contention, and according to the Mosaic account, the Lord and not the Kaiser, made and placed them in the firmament.

Daguerre, a Frenchman, presented us with photography. Our own Edison brought forth the motion picture to delight and instruct the eye and the phonograph to please and teach the ear. Galileo, who first saw the heavens with a telescope, was an Italian. The men who first saw the earth and its teeming life with a microscope were not of German origin. By use of the compound microscope, Pasteur, the French biologist, as early as 1857 demonstrated a connection between the microscopic organisms and disease. This was nine years before Dr. Kock, the German bacteriologist had graduated. In this connection the important antiseptic surgery of Dr. Lister, of England, should be recorded. Edward Jenner, the discoverer of

vaccination, and Harvey, the discoverer of the circulation of the blood, were Englishmen. An American taught the world the use of anesthetics. Our dentists excel all others. They are employed by many crowned heads—even the Kaiser has his.

The Teutons have not shown the engineering skill of the French, who cut the Suez Canal, or of the American who joined the Atlantic and the Pacific at Panama. The decimal or metric system by which the Germans make their measurements is a gift from France. The method by which they make their steel is that of Sir Henry Bessemer, of England. Many of the fruits and vegetables of which they eat an enormous quantity were brought forth by our own peerless Burbank.

Lavoisier, the father of modern chemistry, was French. Linnaeus, the founder of botany, was of Swedish origin. To Hutton, of England, we are indebted for geology; to Mary, of Virginia, for the physiography of the sea; to Descartes, of French parentage, for analytical geometry; to Comte, of France, for sociology; to Germany for sauerkraut and pretzels. Her sons did not compose the crew of Magellan's fleet, the first to circumnavigate the globe. A German did not discover the North Pole nor lead the way toward the South Pole.

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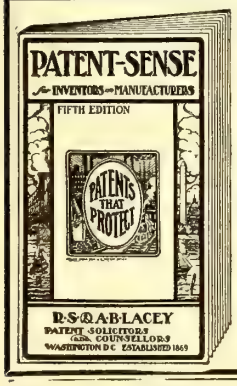
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WIRING FOR LIGHT AND POWER. By Terrell Croft. Flexible covers, 5 x 7¾ inches, Pocket size, 430 pages, 382 illustrations, price $2.00. Publisht by the McGraw-Hill Book Co., New York City, N. Y., 1917.

The first edition of a most concise and valuable treatise for electrical men, designers and electrical contractors. The aim of the book has been to give all explanations of rules and clauses of the Fire Underwriter's schedule in a clear and up-to-date manner; so that the layman as well as the more advanced and practical man can grasp them quickly.

The work covers all branches of the electrical art; plans are presented for the installation of interior wiring and general lay-outs of the various branch circuits, protecting devices and safe carrying loads. There are a number of chapters on the installation of high and low potential transformers, generators, dynamos and motors with the various best approved methods fully illustrated. Many important hints are given regarding the care and maintenance of equipments, covering storage battery systems, street and interior work, as well as stage equipment, showing the various approved methods of installing switch-boards, border lights, arcs and bunch lights—also the proper protection of these various systems in regard to fire hazard.

A very good idea is incorporated in the work, viz., a list of questions are provided at the end of each chapter covering subject matter on the same, that will act as a review, and thus enable one to commit to memory quite a bit of the work. The book is well edited, strongly bound—being pocket size—convenient to carry around, and should find a place in every student's, electrical contractor's and engineer's library.

THE MECHANICAL WORLD. Electrical Pocket Book for 1917. Cloth bound, 304 pages; size 4¼ x 6¼ inches, illustrated, price 45 cents postpaid. Publisht by Emmott & Co., 65 King St., Manchester, England, The Norman, Remington Co., Baltimore, Md.

A really pocket size and very useful compendium of electricity which should be in the hands of everyone interested in the art whether student or more advanced engineer. The authors have endeavored in this popular work, to cover as much ground as possible in a succinct, yet clear manner. The various chapters cover every branch of the art, starting with the electrical units, giving their definitions and derivations, Laws of Resistance, Arrangements of Batteries, Electrolysis, Magnetic Circuits and Materials, Hysteresis, Eddy Currents, Direct and Alternating Current Motors, Generators, Dynamos, Converters, their installation and care, troubles and how to locate and remedy same, etc. Various methods of wiring are shown and explained, and the means and formulas for calculations, proper sizes of wires, etc.

Chapters are given showing and explaining the latest and best methods for measuring and testing various circuits and apparatus and the instruments necessary for such operations. Some very important new contributions are covered in lengthy sections on Electrical Measurements and Testing. This is a large subject but is thoroly covered by the omission of all theoretical explanations, and the adoption of very concise methods of description and illustration. In another section much practical data is presented in a compact form on Transmission Line Calculation. In the section devoted to Electrical Meters, a note on Mercury Meters has been introduced, while the section on Lighting Circuits and Switching has been greatly revised.

A goodly number of pages have been devoted to useful tables and gages; also charts on square and cubic roots, Logarithms and Anti-logarithms. A novel idea is the diary and memorandum section, enabling one to keep notes from day to day for the entire year.

The authors shall be very pleased to consider practical contributions for future issues which will be paid for at a liberal rate if accepted. Taken all in all the work is thoroly up-to-date and the contents of this issue have been thoroly revised.

PRELIMINARY MATHEMATICS. By Prof. F. E. Austin, E.E. Cloth bound, size 4¾ x 7¾ inches, 169 pages, price $1.20. Publisht by Prof. F. E. Austin—Hanover, N. H., 1917.

A small book but chuck full of a series of problems which will help everyone, be he student or lay reader, to grasp the necessary mathematics and algebra that will enable him to advance in any chosen field of engineering.

While the book has evidently been prepared for

(*Continued on page 573*)



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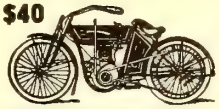
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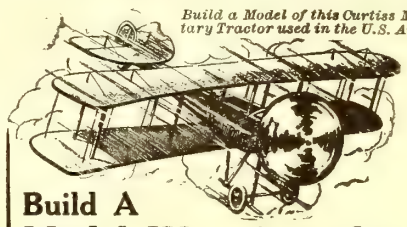
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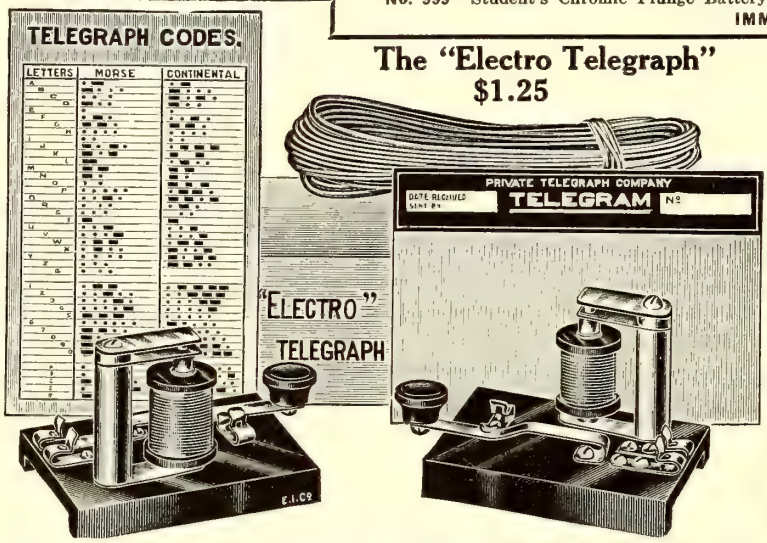
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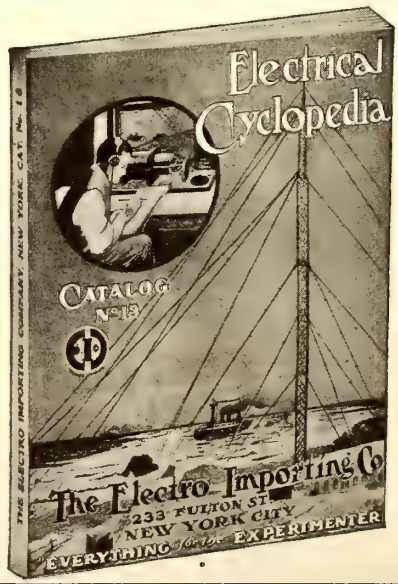
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RADIO ROLL OF HONOR.

(*Continued from page* 533)

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showing the volume of each liquid.

Into a clean, small beaker draw off 10 cc. of NaOH solution. To this add a drop of phenolphthalein solution or a few drops of litmus solution. Now move the beaker under the acid burette and slowly draw into it enough acid to exactly neutralize the alkali. The last portions must be let in drop by drop, with constant stirring. Neutralization is determined by the disappearance of color of the indicator, or the pink tinge in case litmus is used. At that instant stop the flow of acid.

Read the volume of NaOH solution and also of the HCl. Record as follows:—

Volume HCl (first) ....c.c. Volume NaOH Sol. (first) ....c.c.

Ratio of NaOH Sol. to HCl ....

Volume HCl (last) ....c.c. Volume NaOH Sol. (last) ....c.c.

Ratio 1 c.c. NaOH to HCl....

Volume HCl (used) ....c.c. Volume NaOH Sol. (used) ....c.c.

RADIO ROLL OF HONOR

Application for Membership in the Radio League of America

I, THE UNDERSIGNED, a Radio Amateur, am the owner of a Wireless Station described in full in this application. My station has been in use since....., and I herewith desire to apply for membership in the RADIO LEAGUE OF AMERICA. I will abide by all the rules of the LEAGUE, and I particularly pledge my services as a Radio operator, or for Signal Corps duty to the United States Government when called upon.

I understand that this blank with my signature will be sent to the United States Government officials at Washington, who will make a record of my name.

Witnesses to signature: Name.....

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Description of My Station and Apparatus

Sending .....

.....

Receiving .....

.....

.....

.....

I can send approximately.....words per minute.

I can receive approximately.....words per minute.

My age is.....years.

.....

.....

.....

.....

(12-17)

EXPERIMENTAL CHEMISTRY.

(*Continued from page* 559)

in 100 cc. of water. Draw off a few drops of liquid from each burette, to get rid of the air at the end.

Take accurate readings of each burette, (reading from the bottom of the meniscus, see Fig. 95), and make records.

NaOH ..... c.c.
HCl ..... c.c.

The experiment might be extended by evaporating the solution and weighing the solid NaCl and computing the weight of the NaCl per 1 cc. of HCl or NaOH solution used.

EXPERIMENT 110. (Quantitative.)

Do this experiment exactly in the same way as the previous one, except first to

(*Continued on page* 577)



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ELECTRIC EXPORTS ALMOST DOUBLED.

American electric apparatus is gaining rapidly in popularity the world over. A compilation by the National City Bank of New York shows that the value of electric machinery, appliances and instruments exported in the fiscal year 1917 aggregated more than $50,000,000 against $30,000,000 in 1916, $20,000,000 in 1914, and $10,000,000 in 1911.

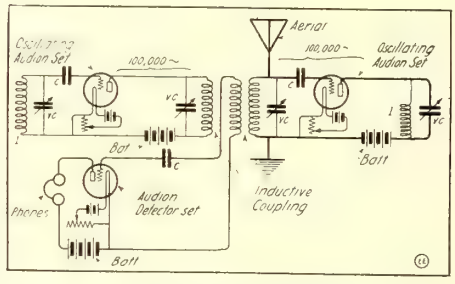
Of the nearly $2,000,000 worth of telephones exported, more than $100,000 worth went to Asia and South America. Nearly $100,000 worth went to Oceania; $300,000 to North America and practically $1,000,000 to Europe, the total telephones being exported in 1917 being twice as great in value as in 1912. Of the nearly $500,000 worth of electric fans exported in 1917, the largest market was in India, Hong Kong, the Straits Settlements, China, Japan and Siam got big shipments.

LOCATING THE SUBMARINE BY RADIO.

(*Continued from page* 510)

it will be heard in the telephone receivers as a distinct sound.

In other words, the beat frequency note giving an audible signal is the difference



Circuits Used in Radio Submarine Detector, as Devised by Mr. Bishop.

between the changed radio frequency oscillations in circuit (1) and those produced in the free oscillator circuit No. 2, which latter is non-radiative, as becomes evident.

In practise the different sets of apparatus are mounted in their respective cabinets and the cabinets moved about on the instrument table until the proper and most desirable inductive relation between them is obtained.

HOW I TELEGRAPH PICTURES.

(*Continued from page* 517)

24,000 revolutions per minute. This is the mechanical difficulty of tele-vision. As to the electrical difficulty, it will suffice to say that a picture requires several thousand variations of light and shade, and at the present stage of electrical development five hundred breaks per second cannot be exceeded over a long line. Animated cartoons should offer no great obstacle, but the problem of tele-vision is to render an object visible at a distance. Several wires, of course, make tele-vision possible, but a practical, one-circuit apparatus would seem to await a more complete knowledge of electricity or of the ether. Tele-vision for short distances may be accomplished with lenses, mirrors and the prism, but the impressions soon become indistinct.

The telegraphing of pictures is a more fruitful field, and as yet it is a comparatively undeveloped art, affording great opportunity to the electrical experimenter.

THE MARVELS OF RADIO-ACTIVITY.

(*Continued from page* 515)

latter from Colorado and Utah. Radium must be regarded as a changing element, its calculated period being several thousand years. Hence, in order that any radium exist in the geologically old minerals, the supply must be kept up by the transformation of some other substance. Since radium is always found in uranium minerals, it is plausible that uranium is the parent element for the derivation of radium. If this is the case in old minerals which are unchanged by the action of underground waters, the ratio of radium to uranium must be constant. This has been shown by several investigators to be true, the quantity of radium being determined by the emanation method previously described and the uranium by chemical analysis.

It is necessary to show, in proving the relation of radium to uranium, that radium appears after some time in a uranium compound previously purified. The first attempts at this were unsuccessful, using periods of a year. It was then decided that some intermediate product was formed between uranium and radium. This was demonstrated by Soddy, who proved that radium does appear in the uranium solution after several years in such quantities as to indicate another slow-period product as intermediary.

Actinium preparations were also found to give rise to a growth of radium, but later researches showed that the radium was not due to the actinium itself but to an associated substance, separated by Boltwood, and called "Ionium." From its calculated period the amount of ionium in uranium minerals must not be less than ten times that of radium, as the amount decaying into radium is one-tenth of its amount to supply the necessary radium. It has not yet been shown that uranium produces ionium, the parent element of radium, but there is no doubt that it does do so.

The constant relation between uranium and radium will hold only for minerals where there has been no opportunity for chemical alteration or removal of any part thru the action of underground waters, or other agencies.

End Products of Change

When the radio-active changes have come to the end, each of the elements uranium, thorium, and actinium should have a final product with a very slow period of transformation, either a known or unknown element. Since an alpha particle's expulsion lowers the atomic weight four units—the atomic weight of helium—the atomic weights of the end products now known can be calculated. For example, uranium gives off two alpha particles, so the atomic weight of ionium is 238.5—8 or 230.5. Radium comes out 226.5, in good accordance with experimental values. Similarly polonium is 210.5, and the final product 206.5. This value is very close to the atomic weight of lead, and so indicates this is the final product from uranium and radium.

Since in old minerals the transformations have taken place for long periods of time, the radio-active material should be accompanied by the end product, if a stable element, in considerable quantities. Boltwood has shown that lead invariably occurs in radio-active minerals, and often in the amount calculated from the uranium content and its age. This problem cannot be definitely settled until it is shown experimentally that radium changes into lead, or better that polonium breaks up into helium and lead. An extremely large amount of polonium would be necessary for this, but several have shown that one of the products of polonium is helium.

(*Continued on page* 578)

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BOOK REVIEW.

(*Continued from page* 569)

the use of those whose educational training has been somewhat limited, it has been so modeled as to adapt itself to the uses of pupils in the first grades of high school and to those desiring to enter college. The work contains a series of examination forms and proper solutions as required for entrance by a number of prominent universities.

Many of the examples and problems presented in the book are original, having been evolved in the process of many years of teaching, and this small book should prove the connecting link between the study of arithmetic and the study of algebra. The work is very thoro from the first stage to the last so far as it goes, and besides having a paragraph on how to study and concentrate, it also contains useful tables pertaining to interest, weights and measures, etc.

The principal aim has been to show practical applications of theory discust, and it should be in every real student's library, whether as a study or reference book. The treatment is such that one does not lose interest in reading the various chapters, as the author has happily combined the charm of applied mathematics with theoretical deductions.

ELECTRIC AND MAGNETIC MEASUREMENTS. By Charles M. Smith, Cloth Bound; 373 pages; 5 x 8 inches; illustrated; price $2.40. The Macmillan Co., New York, N. Y., 1917.

A valuable book to all persons interested in electrical work; especially to students and engineers. The various phases of electrical measurements are treated on very thoroly and the author has succeeded in bringing out many technical points in a popular way, which should appeal particularly to students of the subject.

The book has been developed from a course of lectures and laboratory notes which have been used by students for a number of years. In presenting the work, it is pre-supposed by the author that the reader has a general knowledge of physics and calculus. Much of the material has been gleaned from standard work, and the laboratory exercises are described in such a way that particular types of apparatus are not demanded, unless well-known and generally available.

The various terms are simply defined and everything is so arranged that the student is taken step by step thru the various laboratory experiments, in easy interesting stages.

The work is liberally illustrated with standard diagrams of commercial measurements. The book is unhesitatingly recommended to all students of measuring problems and the general treatment of the work is such that all will be able to grasp the explanations readily.

A TREATISE ON ELECTRICITY. By F. B. Pidduck; Cloth Bound; 640 pages; 6 x 9 inches; Cambridge University Press, England; G. P. Putnam's Sons, New York City, American Representatives. Price $3.60.

The author in this rather advanced work has covered a field highly above the average reader and it is to students of universities, engineers, etcetera, that this work will really appeal.

The general principle has been to cover in one volume the theoretical and practical side of electricity; much space has been saved by omitting detailed treatment of elementary topics. Starting from the beginning, the reader attains the real gist of things, but he must be a good mathematician.

The following are some of the interesting chapters: Mathematics, Permanent Magnetism, Electrostatics, Electric currents and magnetic effects of the same, Magnetism, Induction, Electrolysis, Electric Oscillations, Conduction of Electricity thru Gases, Radio-activity, and the theory of Electrons. Calculations, Curve plotting, standard measurements and other similar topics are only a few of the advanced subjects treated.

The author has dealt in an interesting way with a very dry subject from the layman's point of view, and deserves considerable credit for the excellent manner in which the whole work is covered.

The chapters on "Radio-activity" and "Conduction of Electricity thru Gases" are aspecially interesting, many important developments of Radium being brought out. In summing up be it said that it is a very worthy volume, well edited, and a book that covers many difficult problems in a new way.

CORRECTION.

The book entitled "Chemistry in the Service of Man," reviewed in the November issue should have been priced at $2.00 instead of $1.60.

WIRELESS STATION AT WILLEMSTAD COMPLETED.

A wireless receiving station has been completed at Willemstad, Curacao, and began operations on October 4. Communication was establisht with various important stations. The newspapers now publish news from Nauen, Germany.

The station at Nauen is the principal distributing point for German wireless propaganda. From this station is sent the service of the Overseas News Agency, which was received at Sayville, N. Y., until the United States entered the war.

HOW TO BUILD A ONE-WATT MOTOR.

(*Continued from page* 545)

Slip the coils over the poles and hold them in place with two small strips of brass bent U-shape and having short right-angle bends at their ends, which press down in between the coil and the pole-piece, but a strip of paper must be put between this brass holder and the coils for there is the possibility of "shorting" the two coils, one to the other. Connect the coils in series and see that they are so hooked up that the current in passing produces a *North* and a *South* pole at the business (armature) ends of the field-poles. This is best done by starting with the end of one coil and see which way the current turns, either clockwise or counter clock-wise and connect the other end to the next coil so that the current still rotates in the same direction.

The last step in construction is the second bearing and this is made entirely of fiber, cut from a piece one-eighth inch thick. This is three-quarters inch long and one-half inch wide and is cut as shown in the drawing. It will be seen that the ends of the two braces are filed a little to fit under the frame-work and a small hole drilled thru frame and fiber, which enables you to force a large size pin thru and lock the bearing to the iron frame. It should be noted that the two braces are placed between the field coils, thereby making the fiber bearing lie at right angles to the brass bearings which of course makes no difference in the final result. For the brush support cut two pieces from the same brass tube that was used for the commutator, about one-quarter inch long and bore holes in the braces just large enough for them to pass thru, but before forcing them into place solder two thin copper strips three thirty-seconds inch wide to them. This is done by cutting a wider strip and boring holes in the ends so that the tubes can pass thru. After soldering cut strip to proper width and bend it somewhat like the sketch, so that when inserted into the fiber brace it rests on the commutator with a light but even tension. The ends of the field coils can be forced



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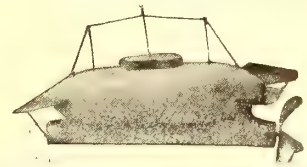
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under the strip where it is soldered to the tube and the tubes themselves act as very good binding posts for the connecting wires from the source of supply, which are merely inserted into them. It may be found that upon testing the motor runs backwards. This can be remedied by reversing the field connections, altho it don't make very much difference if the motor does run in the wrong direction.

The motor is of the shunt type, altho it could be connected for a series type if intended to run on a little higher voltage than one or two volts. As a shunt connected machine I find that it runs very well on one dry cell and draws somewhere in the neighborhood of one-half ampere, more or less. This means that it delivers about one-eight-hundredth of a horse-power and a small fan can be soldered to the end of the shaft so that if the motor cannot be heard, *it can be seen running.* This fan need not be over five-eighths inch in diameter and has four plates; it is cut from thin sheet brass. A small brass case can be made to carry the motor in, for after making one, the temptation to take it on a visit is very strong and one does not want to smash it after the time and labor has been put upon the construction of the machine. I made it in about eighteen hours which is fairly good time for the first one, but of course the second motor ought not to take as long.

Under running conditions I find that with the proper voltage there is very little sparking at the commutator; in fact sparking is not known unless excessive voltage is applied and this is due to the large brushes and small current handled. Just a little drop of vaseline on the bearings helps wonderfully and the motor hums like a Jersey mosquito; it will run for fifteen minutes or more without undue heating. The power developed can be measured by letting the motor wind up a thin thread with pins stuck in it, until just enough pins are used so that the motor can pull them up easily. Then from the exact weight of the thread and pins and the distance they were pulled thru and the time it took to do the work, the fractional horse-power can be determined.

THE HOW AND WHY OF RADIO APPARATUS.

(*Continued from page* 537)

out of one turn, about two-thirds the way down on any ordinary transmitting helix. This results in two distinct windings being formed, as becomes evident; the shorter winding being used as a primary and the longer one as a secondary. The clips can be moved along the coils to vary the coupling as aforementioned.

Fig. 6 shows what is known as the transmitting *variometer.* It is usual to build these non-adjustable as to turns, and the inductance of the instrument is varied by simply moving the two spiral coils nearer to each other or farther apart, as the case may be. When the two coils are brought parallel on the same axis, and when connected as shown in the diagram Fig. 6, then the minimum inductance is obtained for the reason that one coil "bucks" the other or the inductance of coil (2) neutralizes that of coil (1). When the coils are drawn completely apart, their maximum inductance is obtained. The variation of inductance by this means is quite precisional, and the "Telefunken" radio sets utilize this tuning principle to a very large extent.

At Fig. 7 is shown the method of making a continuously variable contact with transmitting inductances. This trolley wheel contactor was first used on Fessenden radio inductances. Some of these, in the larger sizes are built of hollow copper tubing, thru which water runs to carry away the heat, and it is interesting to note in this respect that a hollow tube is fully as efficient as a solid rod, size for size, in radio transmitting inductances. This is so for the reason that the current at these high frequencies, varying from 50,000 to 300,000 cycles or possibly more per second, only penetrate a very slight distance from the surface, due to what is known as the "skin effect." This is the reason why radio transmitting sets are best hooked up with either woven wire ribbon or with a substantial flat copper strip, instead of with a small size round copper wire.

The conical tuning inductance shown at Fig. 8 has come much into favor, during the past few years, and provides one of the most efficient forms of radio frequency inductance there is. The primary as well as the secondary coils are made in conical form as shown, and the coupling is varied by sliding one within the other in the usual manner. The number of turns and the position of the active turns in use in any case is adjustable, as in the previous examples.

The principal advantage of this form of inductance coil is when a small amount of inductance is required only, the operator has the privilege of selecting a number of smaller diameter turns instead of using one or two turns of large diameter, which is less efficient owing to the low flux density in this case. There are several other desirable factors involved in the design of conical inductances, such as the rise in potential by auto-transformer action and means for distributing this more effectively, and the fact that a larger inductance variation in a given space can be obtained, all things considered.

Conical oscillation transformers have been utilized with great success by the National Electric Signaling Company. The advantage of this type of oscillation transformer is that a finer and closer mutual inductance can be obtained, since the movable coil can be placed in closer proximity with that of the stationary one.

One of the most efficient methods of arranging an oscillation transformer, and involving the use of three "pan-cake" inductances is shown at Fig. 9. Usually the center coil or "pan-cake" is connected as the primary, while the two outer movable "pan-cake" coils are connected in series and form the secondary. As the dotted lines indicate the flux distribution with this arrangement is the most efficient in that both or the secondary coils are in active use in a strong field in contradistinction to the usual oscillation transformer of this type, utilizing but two "pan-cake" coils, in which case the coil acting as the secondary is cut by only one half the flux that this one is.

NEW ELECTRIC BOMB DROPPER FOR AEROPLANES.

(*Continued from page* 511)

The other novel features of this invention consist of an electric clock that drops the bombs automatically and a fixt schedule or table arranged for the aviator so that he can tell at a glance how to set the automatic bomb dropper, after he has decided on the altitude from which he will drop his bombs and checked up the speed at which he is flying.

Suppose for example, he decides to drop his bombs at sixteen hundred feet elevation, after checking up his speed by sighting some object several miles before he reaches his objective. In the right hand column of the schedule index, Fig. 4, opposite 1500 feet altitude, he will find the degree or angle at which to fix his telescope, which is given as 35°. As soon as he has located this

object over his sighting bars and then picked up his object on the telescope cross-hairs, he pushes the electric button directly under the clock, the face of which is divided into sixteen seconds and the space between into tenths. This releases the "second" hand and the clock ticks off the seconds; when he is directly over his object he reads the time, and finds he is flying say eighty miles an hour. He then moves the indicator on his schedule to 1,500 feet, 80 miles, and the time is shown directly opposite—eight seconds and nine hundred eighty-two thousands, which should correspond to the time he has just taken to pass over the tangent of his triangle, see Fig. 1, which is the line from C to B, at the 1,500 foot level. At D, the aviator would release his bomb, as a projectile dropt from a moving object is carried along by the momentum for some distance in an arc before its speed is diminished, is attracted by gravity, and starts down on a vertical line. This would have to be checked up by actual test and deducted from the schedule provided.

The triangle, Fig. 1, is formed, first by deciding on the altitude, then fixing the telescope at the proper degree; this second line is variable, according to the altitude determined on. The instant the object shows on the cross-hairs of the telescope the other vertical line B of the triangle is formed and the aeroplane flying at the pre-determined height establishes the third line or tangent, C to B.

The clock mechanism is run by a spring but is controlled by electricity, (see Fig. 7). The "second" hand and "set" hand are insulated and connected on a separate circuit from the starting device; the hands close the circuit, operating the arm of the solenoid and releasing the catch which holds the bomb, when the second hand reaches the set hand. The circuits to the bombs are changed after each bomb is dropt by the switch, (see Figs. 4 and 7), or all are dropt at once as desired.

It is to be noted that with the Lewis device for automatically dropping bombs from air-craft it is only necessary for the bombing officer to take his preliminary sight before he reaches the scene of his activities. Then when he "approaches" the object of attack he turns the sighting telescope to the predetermined angle. Having done this he watches thru the telescope until he spots the building, or other object to be bombed, and as soon as it appears at the intersection of the cross-hairs, he punches the clock release button. The aviator has then nothing further to do: flying at the given altitude, the machine is piloted over the target, at the speed allowed for. As the aeroplane passes over the target (theoretically) the clock hands make contact, actuating the bomb releasing magnet. As already explained the clock would be compensated so as to drop the bomb a short time before the object was reached.

To the extreme left of the instrument is an emergency lever so that if the circuit for any reason should not work, the manual control lever will drop all the bombs together.

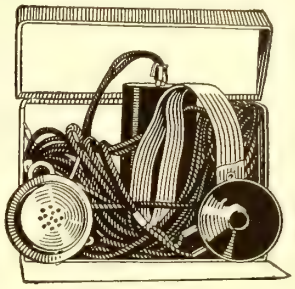
At the bottom of the board are arranged four red lights that light automatically as each bomb is dropt. The illustration also shows the arrangement of the bomb shutes in the cockpit of the fuselage. The red lamps indicate the number of bombs that have been dropt or those that remain, so that if the aviator is interrupted in his work, he can tell by looking at his instrument board just how many bombs he has left. The schedule index shown is computed for illustration, the speeds being 60-80-100 miles; while an actual schedule would have to show 60-65-70-75-80-85-90-95-100 and more miles per hour.



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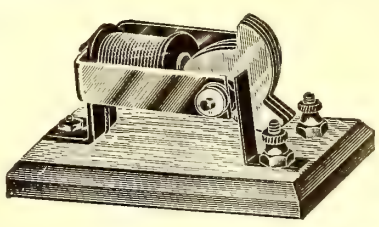
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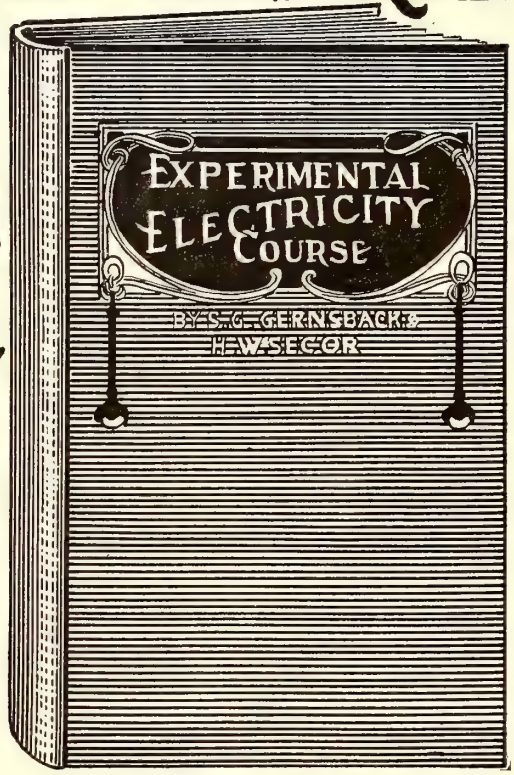
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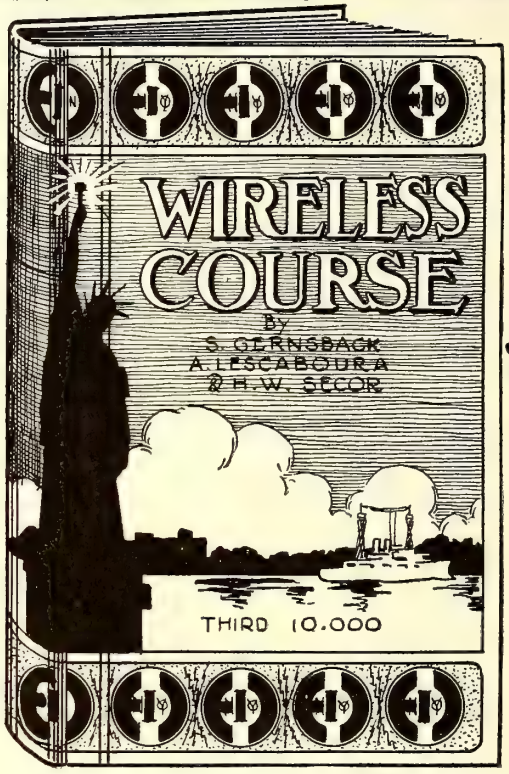
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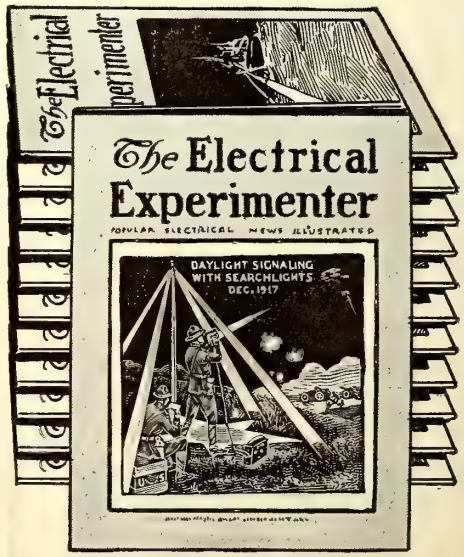
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EXPERIMENTAL CHEMISTRY.

(*Continued from page* 571)

draw into the beaker a different amount of NaOH, say 15 cc., and neutralize that amount. Make records of results as before. Find the ratio of NaOH solution to HCl used, and reduce it to 1 cc. of either the NaOH solution or HCl. Compare this result with that of the previous experiment. Is it approximately the same? If not, repeat it.

EXPERIMENT NO. 111. (Quantitative.)

Make this experiment like the two previous, only start with 20 cc. of NaOH solution. Keep accurate notes. Compare your final results to see whether a unit of NaOH solution combines with approximately the same amount of HCl, or vice versa. If it does it must illustrate a general law, namely the law of fixt weight.

SOME INTERESTING NEW RADIO APPARATUS.

(*Continued from page* 534)

at Fig. 2, is an instrument of wide usefulness. It has a range of 150 to 10,000 meters wave length, the calibration curves being mounted in the lid. It is equipt with hy-tone buzzer, battery in special removable pocket, crystal detector, vacuum tube, 'phones, thermo-couple and galvanometer. The condenser is calibrated and the four inductance coils are wound on Bakelite spools. The exploring coils may be connected by means of a special flexible duplex connector as shown in figure, or may be connected rigidly if desired. Special inductances can be had, giving a higher wave length range.

In the realm of radio transmitting keys, we find the new combined manual and radio relay type shown at Fig. 3, which has a capacity of 5 kilowatts without overheating. This key has been approved for use on Government wireless sets, and possesses among other excellent qualities a very strong hammer action in the opening and closing of the contacts, which are of very substantial character.

One of the most interesting of these new instruments is the "flame-proof" key shown at Fig. 4. This key is intended especially for use on submarines, aeroplanes and dirigible airships, where there is the least possibility of gases being present, and which might be ignited with disastrous results by opening the usual key. As will be seen, this flame-proof key comprises a substantial instrument of the usual pattern, with the exception that the contacts are opened and closed in an air-tight compartment. It is of very substantial design, and will stand a very heavy overload.

The universal wave meter shown at Fig. 5, while not possessing some of the features of the one shown in Fig. 1, is well adapted for all ordinary work, and has the advantage of rather a wide range of wave lengths—200 to 2,600 meters. In its standard form it includes a variable air condenser mounted beneath a Bakelite panel, with a scale engraved with 100 divisions; two inductances for long and short waves—a simple crystal detector mounted upon the panel and a single high-resistance 'phone, with headband.

Binding posts are provided for connecting in a sensitive hot wire meter or thermo-couple and galvanometer. For all ordinary purposes, however, the crystal detector and 'phone will be found to fill the requirements. The binding posts are so arranged that the detector may be connected either double or unilateral. The two inductances and 'phone are contained in compartments of the case, which is of oak, while the graph of the wave lengths is fastened in the lid of the case, where it may be read easily. The meter measures 9 by 7½ by 5½ inches, and weighs 7 pounds. It can be furnished with a third inductance to read to 12,000 meters.

An interesting variable step inductor is shown at Fig. 6, and is intended particularly for use in Audion detector circuits, such as those devised by Armstrong. Two or more of these variable step inductor coils may be coupled up in duplicate for use in the Armstrong regenerative circuit.

The receiving variometer shown at Fig 7, is of interest as these instruments have been accorded more and more recognition in recent years, owing to their fine tuning possibilities. The variometer here shown comprises three coils, which are connected to a special switch, enabling the operator to instantly throw the coil circuits in series or parallel; thus changing the inductance value of the instrument decidedly.

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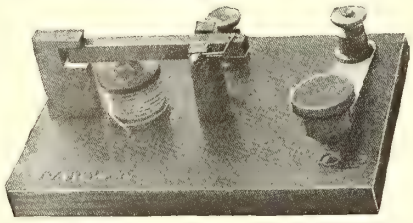
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THE MARVELS OF RADIO-ACTIVITY.

(*Continued from page* 572)

And here we have the much-talked-of modern *alchemy*.

The action of radium on human tissues was unknown until 1901, when Becquerel received his famous burn, fourteen days after carrying a tube of active material in his pocket for several hours. Since that time very active investigation has taken place. Many countries have establisht special laboratories for radium research. The U. S. Government has a large plant in Denver for the extraction of radium from carnotite ore to supply the needs of hospitals and medical laboratories.

The diseases which radium has been applied to, up to the treatments developed during the present war and on which we have no definite data, are papillomata, lupus vulgaris, epithelial tumors, syphilitic ulcers, pigmentary naevi, angromata, and pruitis and chronic itching of the skin. The different varieties of rays used are controlled by the use of screens or filters of lead, silver and aluminum. Radium is analgesic and bactericidal.

Since a large amount of thorium is separated annually from thorium minerals, for use in Welsbach mantles, it would be of great importance at the same time to separate the radiothorium and mesothorium. For many purposes active preparations of these substances would be as valuable as radium itself, and the supply of material would be greatly increased.

Experiments have been carried on as to the effect of radio-active matter on plants, but no definite results have been compiled from the mass of data obtained, and due particularly to the scarcity of material with which to work.

(THE END.)

THE AUDION AND THE "EDISON EFFECT."

(*Continued from page* 536)

direct line of the carbon, no effects were recorded on the galvanometer.

At that time (1884) quite a lengthy discussion took place as to the whys and wherefores of the phenomena thus evolved by Mr. Edison, but be that as it may, we can readily see that the foundation of all present day valves was laid down by Mr. Edison's early experiments with heated and cold electrodes within an evacuated chamber as here described.

Now, we "started something," but these statements are backed up by proofs taken from that time, and to make a long story short, it does not tell us how we "Radio-bugs" are going to profit by this discovery. The single, one-step, two-step, waltz or any other brand of Audion won't do us much good, so let's simply hope that some day we may again fish out our "B" batteries and tune up for Nauen or the Eiffel Tower.

THE UNCROWNING OF THE GIM-CRACK KING.

(*Continued from page* 540)

piece to the tail of its predecessor on one of several huge balls of the same. The piece he was handling when I appeared was about four inches long, so I gathered that every little bit was expected to help, as the song goes.

This sight was not what you'd call inflaming with encouragement to one about to propound royalties of ten to fifty dollars per week. Altho string at that time was more expensive than now, it was quite evident that $10.00 would cover Mr. Crowell's savings from this source for the rest of his natural life; and to suggest his parting with it for a single delirious week of advertising seemed distinctly too forward. I forgot the magnificence of his realm upstairs, his standing as a merchant prince, and the large additional profits to accrue to him thru my invention. With a sickening sag, like the breaking of a Ford rear spring, my asking-price dropt to $5.00, and my courage to one degree above zero absolute. In the semi-falsetto of an assumed breeziness, it was all I could do to sputter forth, "M-Mister Crowell, may I show you something interesting?"

Zebediah grudgingly allowed that I might, altho he kept right on with his sorting and tying of the strings. So with shaking fingers I unpacked my big double board, my boat in its separate box, and my two wet-cells.

Oh, those wet-cells! I knew they'd been slopping, because I'd been leaving a trail of drops behind me for some distance; but to my horror I found they'd spilled so much that they would no longer work my motor.

I'd prepared to get along with a hypothetical electric fan; but when I had to explain also, while poking the Mary Ann on her course with my finger, that the gallant craft would, it most surely would go of its own accord with proper battery-power, I felt that imagination was carrying an overload. However, Zebediah acknowledged that the thing was very pretty, and when operating as planned must be decidedly interesting. He thanked me for taking so much trouble to amuse his "idle hour," and seemed to expect that I would now shove along to the next citizen I designed to favor.

It was an awkward moment; still, with a lump in my throat so large that it seemed a miracle the throat could hold it, I managed to pronounce a statement of its great value for advertising purposes, as demonstrated by Uncle George's experience in New York; how his store would be thronged with watchers of the marvel, a given percentage thereof buying his wares. Zebediah was a perfect audience, in that he listened without a word; but there was a quizzical smile on his face that disconcerted me. Father was right, it didn't look in the least like money; and when at last I'd instructed Crowell how to run his business at greater profit, and approached the subject of my modest share thereof, what was left of the prospective $79,920.00 sank with all on board, leaving on the surface, like a single bubble, the timid query. "W-wouldn't you be willing to g-give me something for the use of it?"

Instead of shattering my hopes, Zebediah was kind enough to dismantle them gently, being able to spare the time because he was also occupied with his string-ends; they say he never gave away his time without extracting the nutriment first in some such way. Eye-catching devices might go in New York, he said, where there were so many strangers, but in our town the need was rather for something to get rid of people who didn't come to buy; and he mentioned with some feeling the names of a line of inveterate chair-warmers who spent all day in his store but never spent anything else.

Skilled by long practise in avoiding persistent drummers, Zebediah, having relieved his mind, proceeded to get rid of me with bewildering dispatch. Unstinted in his praise of the Sailing Boat, he predicted a great future for it—in New York, of course, where conditions were so favorable. He pronounced my father a lucky man for his opportunity to finance the undertaking,

only I must be careful not to allow him too large a share of profits for his aid—something adequate, of course, but strictly limited in time, because frequently parties let themselves in for very oppressive conditions by neglecting that precaution. And so, good day, and I must be sure not to forget him when in the market for young men's snappy furnishing-goods.

He talked me out of the store, and I dript along home primed to impress father with visions of living high at the Hoffman House, or the Astor, or another of the then smart hotels, while we treated haughtily with suppliant tradesmen in figures that made my $79,920.00 blush with humility.

The old adage says that it's darkest just before the dawn. Turn it inside out (as you can do with any genuine adage) and it's equally true that it's brightest just before a total eclipse; and my eclipse was approaching, strictly on schedule time. On hearing my story, father was imprest all right, but the pressure was on the wrong spot. He was a deliberate man, and before replying he seemed to struggle with an emotion of some sort. Having conquered it and rectified the frontiers, he spoke as one intending to give an example of self-restraint: he said he was glad to know there was one thing that meddling old hypocrite Crowell would part with freely, even if it was only hot air; that the home town exclusively was to be favored with my destinies for many years yet; that my immediate future was concerned with splitting up a few slags for the morning's fire; and finally, would I please learn something in school conducing elsewhither than to such nauseating nonsense?

From these neatly worded expressions I gathered that the great merchant's guidance of our family affairs had not met with father's heartfelt gratitude. With an excellent running-start, my $79,920.00 was unquestionably beating it; and nothing has occurred since to make me doubt that it is going yet.

THE SUBMARINE AND KINDRED PROBLEMS.

(*Continued from page* 524)

In case the water is more than 200 feet in depth a submarine must be kept in motion to obtain steerage way in order to hold its proper depth of submergence. This speed may not exceed 4 or 5 miles per hour, but to remain submerged, and at the same time unobserved, the water must be at least 60 feet deep.

The latest type of submarine which is being used abroad has a surface speed of at least 17 knots per hour and a submerged speed of probably less than 10 knots. The superior gun fire from the merchantman which has been properly equipt would make it necessary for the submarine commander to obtain his observations, such as would permit accurate aiming of the torpedo, during the very brief interval of time required to come to the surface for observation thru the periscope and to again submerge.

If running near the surface, the periscope might be raised, a quick observation taken, and lowered again within 30 seconds. If, however, the submarine is on the surface and hatches uncovered, from one to four minutes will be required to completely submerge, depending upon circumstances.

A submarine of recent type probably has a total radius of action of as much as 8,000 miles when traveling at a moderate cruising speed of from 10 to 11 knots, and may remain away from its home-base for as much as one month, without requiring either fuel or other supplies during this period.

This type of submarine may have as many as three periscopes, two conning towers and two rapid-fire guns attached to the upper portion of its hull.

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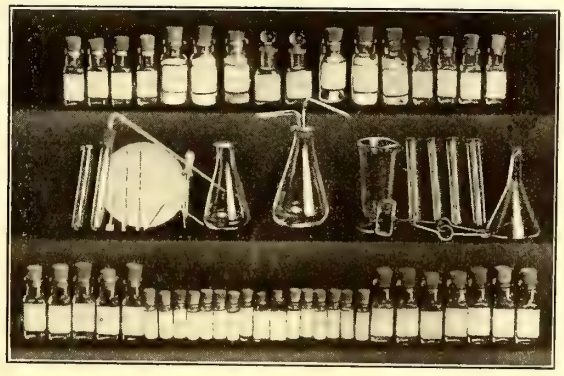
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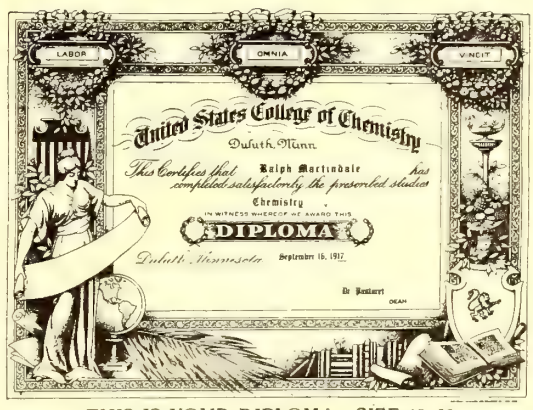
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are unable to fly far out to sea where the submarines are now most active. Mother ships for carrying and launching aeroplanes might be used in this connection, but there are only a small number of such ships in operation and the construction of others under present conditions is necessarily a slow process.

Various *sound-recording* devices, intended to locate surface-vessels, submarines, and even moving torpedoes, are now being carefully tested. Water is an excellent conductor of sound, and the development and improvement of such apparatus offers a promising field for inventive endeavor to those who possess adequate scientific training and laboratory facilities.

Many devices are suggested which depend upon optical means of detection, such as special forms of telescopes and field-glasses to be mounted on ships, or on scouting vessels. Many special forms of searchlights and projectors have been suggested. The fact that a moving topedo leaves in its wake a stream of air-bubbles caused by the exhaust-air from its propelling engines, offers, under favorable conditions, one means for discovering the approach of a torpedo. This evidence is, however, difficult to detect in a rough sea or at night, and, furthermore, the bubbles do not reach the surface of the water until after the torpedo has traveled onward a distance of from 50 to 200 feet towards its target.

The dragging of trawls, or nets, by special guard-boats, not only with the view of locating submerged submarines but also to sweep up floating and stationary mines, is frequently suggested. Under certain conditions this operation is practicable and effective.

It will be seen that each of the above methods, however useful, has its limitations, and scientists and inventors should apply themselves not only to the task of improving these, but also of finding supplementary methods and devices.

(b) Protection of Cargo-Carrying Ships by Nets or Screens

Many designs of such devices are suggested, and most of them are intended to be attached to the hull of the vessel to be protected. Many other suggestions along these lines, and differing only in some of their minor characteristics from the foregoing, have been received by the Board. Up to the present time not one of these proposals involving screens of any kind has received the approval of the Navy Department or of the Merchant Marine. The principal objections offered to these devices are that they are heavy, difficult to hold in position, unmanageable in a heavy sea, and that they interfere with the speed and with the ability of the vessel to maneuver. The undeniable evidence which has been accumulated during the past few months of submarine activity has demonstrated that the immunity of a vessel to submarine attack is dependent very largely on its speed and also its maneuvering ability. The percentage of vessels having speeds of 15 knots or more which have suffered from submarine attack is very small, while the losses of slow vessels, whose speed is less than that of a submerged submarine, is practically one hundred per cent of those attacked. Many of the suggested devices would prevent the launching of life-boats or rafts from the vessel to be protected. It is barely possible, however, that there may be developed some form of this general plan which will be found practicable. In no other field have so many suggestions or so many duplicate inventions been presented to the Board.

(c) Protection Thru Invisibility

The point of lookout on a submarine being close to the water, the position of a vessel at a distance can only be determined by observing its smoke, which floats high in the air. Improved smokeless combustion is therefore desirable. Relative invisibility may also be afforded by methods of painting.

(d) Destruction and Blinding of the Submarines

A *rapid-fire* gun is effective when the submarine is seen within accurate range of the gun; but the target is so small that it is difficult to hit.

The *powerful effect* of any *submarine explosion on all neighboring bodies* provides a simple means of *destroying or crippling* an undersea boat. Once it has been even approximately located, the setting-off of a heavy charge of high explosive, well submerged in the vicinity of the submarine, will bring about this result.

In certain areas, a quantity of heavy, black *petroleum* or similar substance which will float on the surface of the water has proved an effective means of clouding the optical glass in the periscope's exposed end.

Under favorable conditions of wind and position, many vessels have saved themselves from torpedo attack by the production of a *smoke screen.* This may be formed either by incomplete combustion of the oil used for fuel by most naval vessels, or it may be created by burning chemicals, such as phosphorous and coal tar, or mixtures in which both of these and other materials are used.

After hiding itself from the submarine in a cloud of dense smoke, the vessel, if possest of sufficient speed, may be able by a quick maneuver to change her position and escape before the submarine is able to discharge a torpedo.

MINES AND TORPEDOES FOR NAVAL OPERATIONS

(a) Mines

Ever since the first use of gunpowder in the prosecution of war, mines and torpedoes have received great attention both from the warrior and the inventor. Mines are either *fixt* or *floating.* The *fixt or stationary submarine mine* is fired by contact, electricity, timing device or fuse. Such mines, which are extensively used by all navies, are rugged in design and may contain large charges of explosives. They are placed in position by especially equipt mine-laying vessels. Such a mine is provided with an anchoring device.

Floating mines differ from fixt mines in that they are unanchored, and, unless guard boats are at hand to warn friendly vessels of their proximity, may be as dangerous to friend as to foe. Such mines must be, according to laws of war, designed to become inoperative within a few hours after being set adrift.

(b) Torpedoes

The *modern submarine torpedo* is about 20 inches in diameter and 20 feet in length: is *self-propelled; is not steered by magnetic means;* and keeps a fairly accurate course for several thousand yards at an average speed of more than 30 *miles an hour.* Its *weight is approximately a ton and a quarter;* and, when traveling at normal speed, possesses great *momentum*—in fact, in one case, when the high explosive charge in the "warhead" failed properly to detonate, the body of the torpedo pene-

trated the steel hull of the ship attacked. Torpedoes are also provided with means to more or less effectively cut through screens, nets, or guards placed in their path.

A torpedo is projected from a submarine or other vessel by means of a special form of tube or gun. A small charge of gunpowder or comprest air is employed to start the torpedo, after which—if of the usual self-propelling type—it is driven through the water by its own comprest air motor, the air being supplied from a strongly built reservoir within the body of the torpedo itself. The torpedo is kept upon its course by a *gyroscope* steering mechanism, which is *immune to outside magnetic disturbances.*

The detonation of the torpedo is accomplished through a mechanism placed within its warhead; and if the torpedo is either *abruptly diverted from its course or is checked in its forward motion, the firing device,* which is *operated by arrested momentum* rather than by any form of a projecting firing-pin, instantly ignites the heavy charge of explosive contained within the warhead. The *explosion,* if it takes place *within twenty feet of the vessel,* will usually *rupture the ship's plating,* because of the terrific blow transmitted through the water from the point of the explosion to the ship's side. The *depth* at which a torpedo travels is usually between 12 and 15 feet below the surface.

Confining the Submarines

The question as to why submarines are not destroyed before they reach the open sea is a most natural one, and the best answer which it is possible to give, according to the officers of our Navy and those of the foreign commissions who have visited this country, is as follows:

The submarine bases are very strongly protected by land batteries, aeroplane observers and large areas of thickly mined waters extending to such distances that the largest naval gun cannot get within range of the bases. In spite of these protections, there is now going on a continuous attempt on the part of the Allied navies to entrap or otherwise defeat the submarines as they emerge from the protected areas. Nets are laid and as promptly removed by the enemy, whose trawlers are in turn attacked by our destroyers. The design of these nets and the detailed arrangement of their fastenings and attachments offer a broad field for invention, but it should be remembered that they must be capable of being used in waters in which there is a tidal current running from two to five miles per hour. Many suggestions for "bottling up" these bases have been offered, but, as will be realized, it is not desirable to publish information which would indicate even in the smallest degree this country's plans.

Ships and Shipbuilding

Many suggestions are made for ships of *unusual form* to provide for safety in case of a torpedo or mine exploding near or against the hull. Most of these plans are an elaboration of the usual watertight bulkhead construction now required as structural design for all modern ships.

The *multiplicity of waterfront compartments* in any hull design tends to add to the vessel's *safety.*

The *modern tank steamer* used to carry fluid cargoes, such as petroleum products or molasses, is a *good example of this design,* which has been in general use for many years.

The explosion of a nearby submarine mine or torpedo frequently tears great rents in the ship's plating, in some cases opening a jagged hole ten feet or more across, but the destructive effect on the hull of a ship caused by the explosion of a mine or torpedo may be greatly diminished by special hull construction.

General Instructions to Those Offering Suggestions to the Naval Consulting Board

A very large proportion of the letters and plans that are received describe devices or schemes which are obviously impracticable or which show no novelty or improvement as compared with existing methods. After the elimination of these, the more meritorious inventions are submitted to the various standing committees of the Board for examination. If an invention receives the approval of a standing committee, it is presented to the Board with a favorable report and, if then again approved, it is forwarded to the Navy Department with the endorsement of the Board.

The fact that inventions, plans and devices must be forwarded to the various departments of the Board for examination makes it essential that everything be presented in writing.

Communications should be addrest: Thomas Robins, Secretary, Naval Consulting Board, 13 Park Row, New York, N. Y.

Presumably the Government intends to pay for inventions which it adopts, but as yet no specific provision has been made by law for this purpose.

Statement of the Ownership, Management, Circulation, etc., Required by the Act of Congress of August 24, 1912, of THE ELECTRICAL EXPERIMENTER, publisht monthly at New York, N. Y., for Oct. 1, 1917. State of New York, County of New York, ss.

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Hugo Gernsback, who, having been duly sworn according to law, deposes and says that he is the Editor of THE ELECTRICAL EXPERIMENTER and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc, of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 443, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, The Experimenter Publishing Co., 233 Fulton St., New York City; Editor, Hugo Gernsback, 233 Fulton St., New York City; Managing Editor, Hugo Gernsback, 233 Fulton St., New York City; Business Manager, Hugo Gernsback, 233 Fulton St., New York City.

2. That the owners are: The Experimenter Publishing Co., 233 Fulton St., New York City; Hugo Gernsback, 233 Fulton St., New York City; Sidney Gernsback, 233 Fulton St., New York City; Mrs. K. Hymes, 233 Fulton St., New York City; H. W. Secor, 233 Fulton St., New York City.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: None.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

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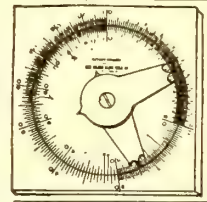
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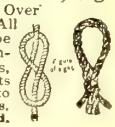
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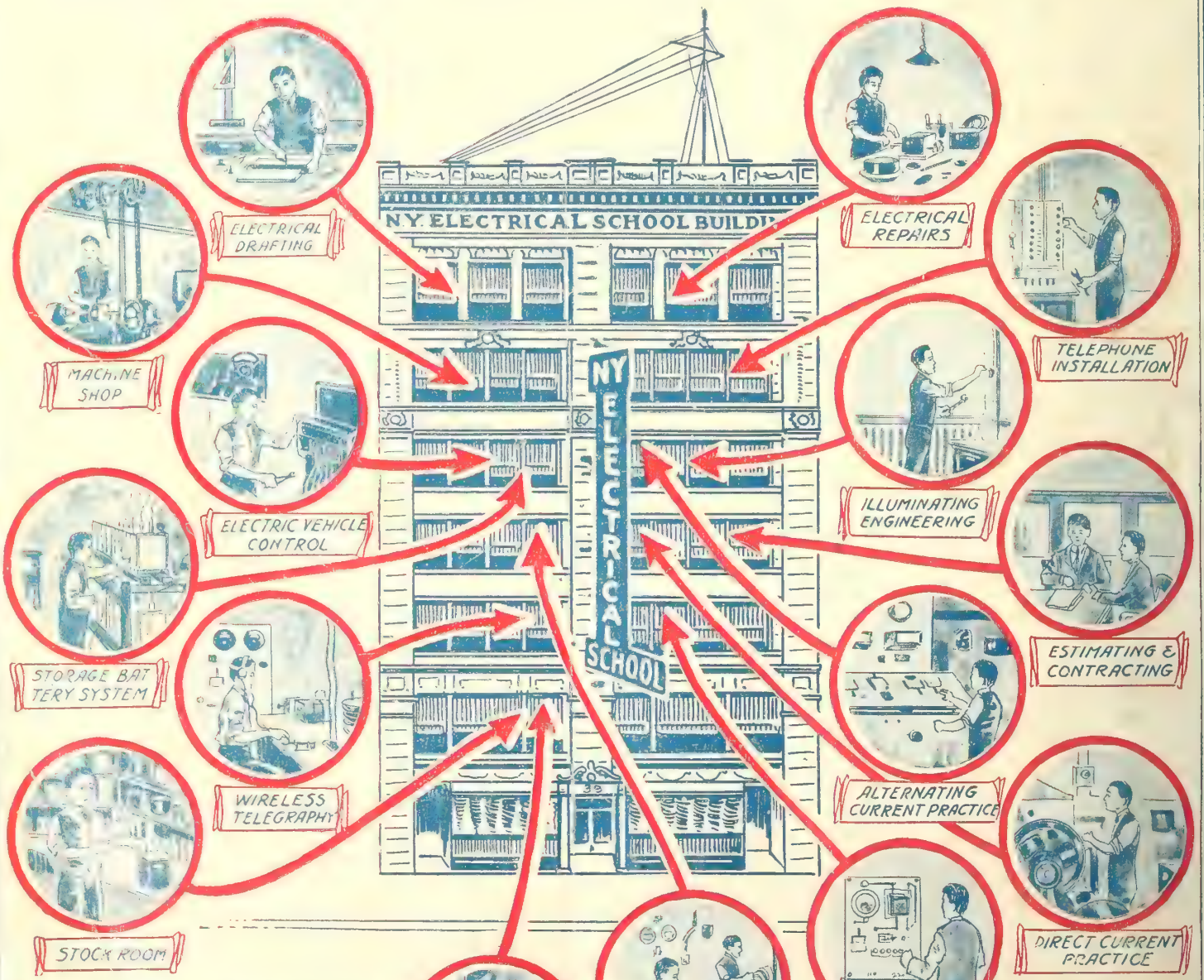
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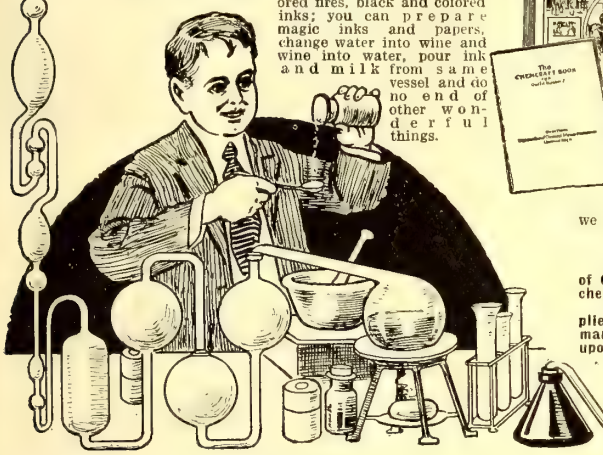
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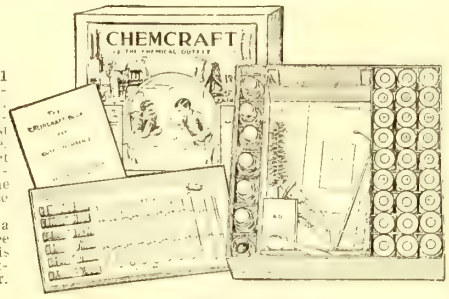
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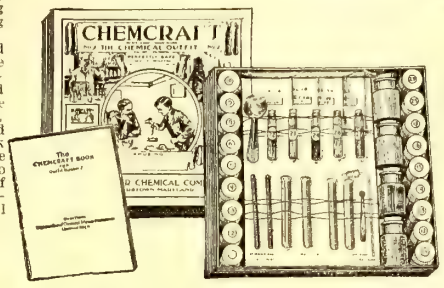


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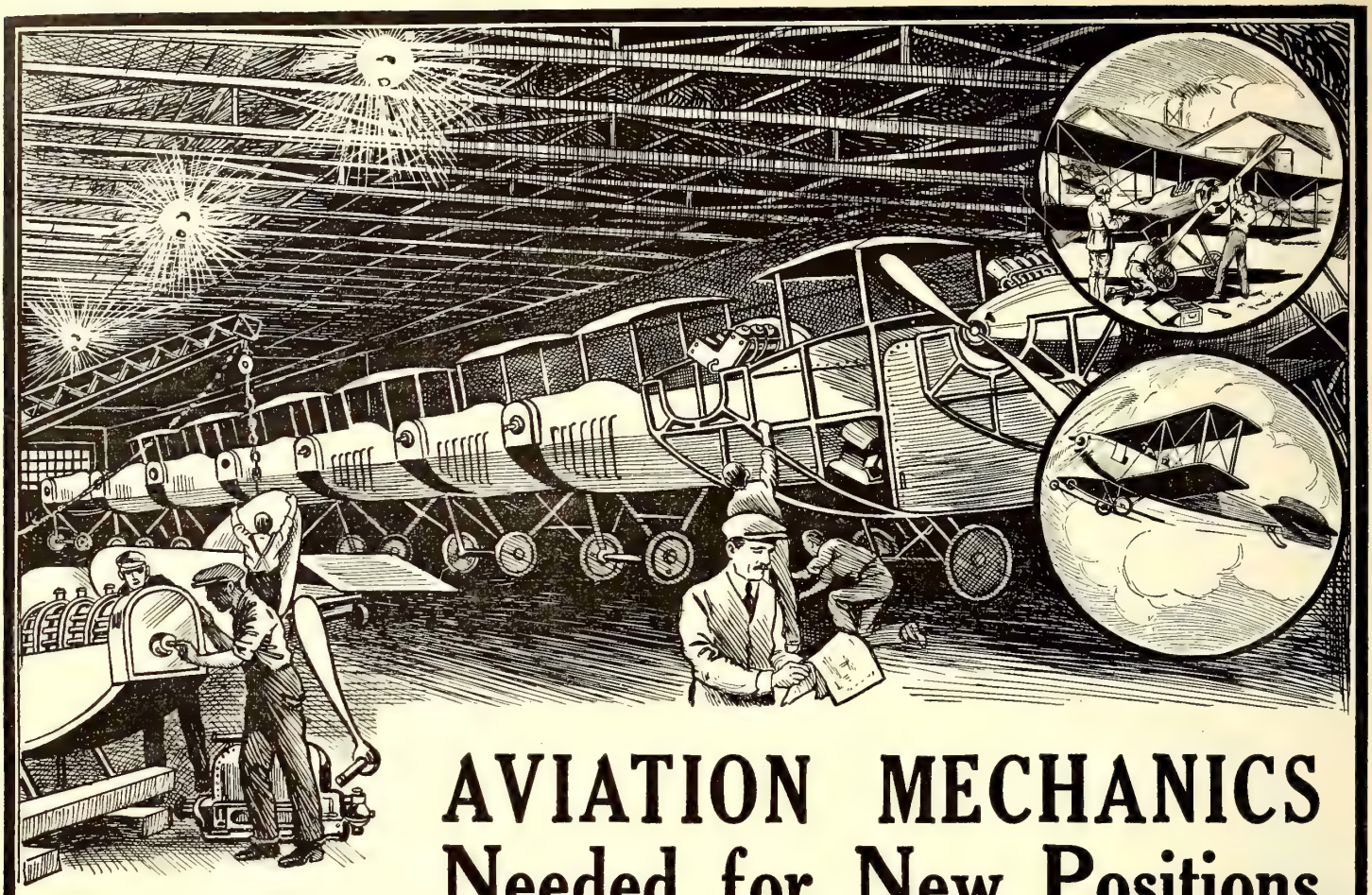
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Raising Sunken Treasures

EVER since the Phoenicians set sail upon the Mediterranean, man's imagination has been stirred profoundly at the idea of recovering priceless cargoes resting at the bottom of the ocean. Whether it is Captain Kidd's fabled treasure or the real $10,000,000 gold treasure sunk at Vigo in 1702 and now peacefully resting, not far from the Spanish coast, makes little difference. All of us nurse a secret desire, that somehow, some day we will be in a position to raise one of the many sunken treasures. If ever mankind was interested in salvaging the cargoes of sunken vessels, the first few years after the present World War is over, will surely eclipse anything of the kind ever imagined before. Billions of dollars worth of priceless cargoes now stud the bottom of the oceans, and while many of the torpedoed ships contain perishable cargoes, not worth raising, there are just as many ships and perhaps a great many more that contain valuable cargoes of metals, coal, ore, etc., which are not at all affected by a prolonged stay in salt water. These ships then are worth while raising—if they can be located—in order to salvage their treasures.

Several companies have already been formed in this country (and we understand in Germany too) whose sole business it will be to sail the high seas in quest of sunken treasures, immediately after peace is declared.

Now comes an interesting point: The oceans, beyond the three mile limit belongs to no nation. By ancient custom a ship sunk in the open sea belongs to whoever salvages it. Neither the original owner, nor the insurance company who paid for the loss, has any claim on the sunken ship. Will this ancient custom prevail after the present war? We much doubt it. Great Britain, the greatest loser of ships and treasure during the war, may be counted upon to propose a new international law, whereby the sunken ship no matter where lost, will revert to the original owners, after the latter have paid a premium for the expenses incidental to salvaging the hull. The British at the end of the war will have several billions worth of treasure on the bottom of the ocean. We may be sure that they will make a Herculean effort to salvage whatever cargo can be raised economically.

Now the curious part about this is that the very submarine which was the direct cause that occasioned the loss of all these ships, will prove to be the one—and perhaps the only one—instrumentality to salvage these same ships.

Already we can picture in our mind's eye flotillas of specially constructed submarines, which will roam thru the inky depths of the seven seas. For there is no technical difficulty today to build a submarine capable of withstanding the tremendous water pressure even at a depth of one thousand feet. And it is safe to say that the majority of ships rest at a considerably lesser level. But how to find the sunken ships? That is the question. Nevertheless the problem is not half as difficult as it may appear at first. Science progresses fast, and it has a trick of making today's impossible, tomorrow's commonplace.

A deep-sea submarine equipt with very powerful searchlights can exploit the bottom of the ocean without any trouble whatsoever. Each such submarine exploits a certain square of territory and it will be but a few weeks till every such area is charted. Undersea growth or sea mud or drift sand will not be much of an obstacle, even if a ship is totally hidden from view. For the exploring submarines will be equipt with sensitive electric Hughes Balances, which indicate at once the presence of metal masses. Incidentally such electric explorations will surely be the direct means of discovering sub-oceanic ore deposits which in the near future will certainly be exploited by sinking down caissons over the under-water mine. A similar method by the way, is already in use near the coast of California where oil is taken out of sub-aquatic oil-wells.

Once the wrecking submarine has located the sunken ship, it is a comparatively simple matter to raise it. Great steel tanks are sunk about the ship, which are then made fast to the latter by well-known methods. A wrecking steamer from above now forces comprest air into the tanks which blow out the water in the latter. Providing we have sufficient tanks, the resultant buoyancy will raise any ship to the surface of the ocean, after which it is towed to the nearest port.

H. GERNSBACK.

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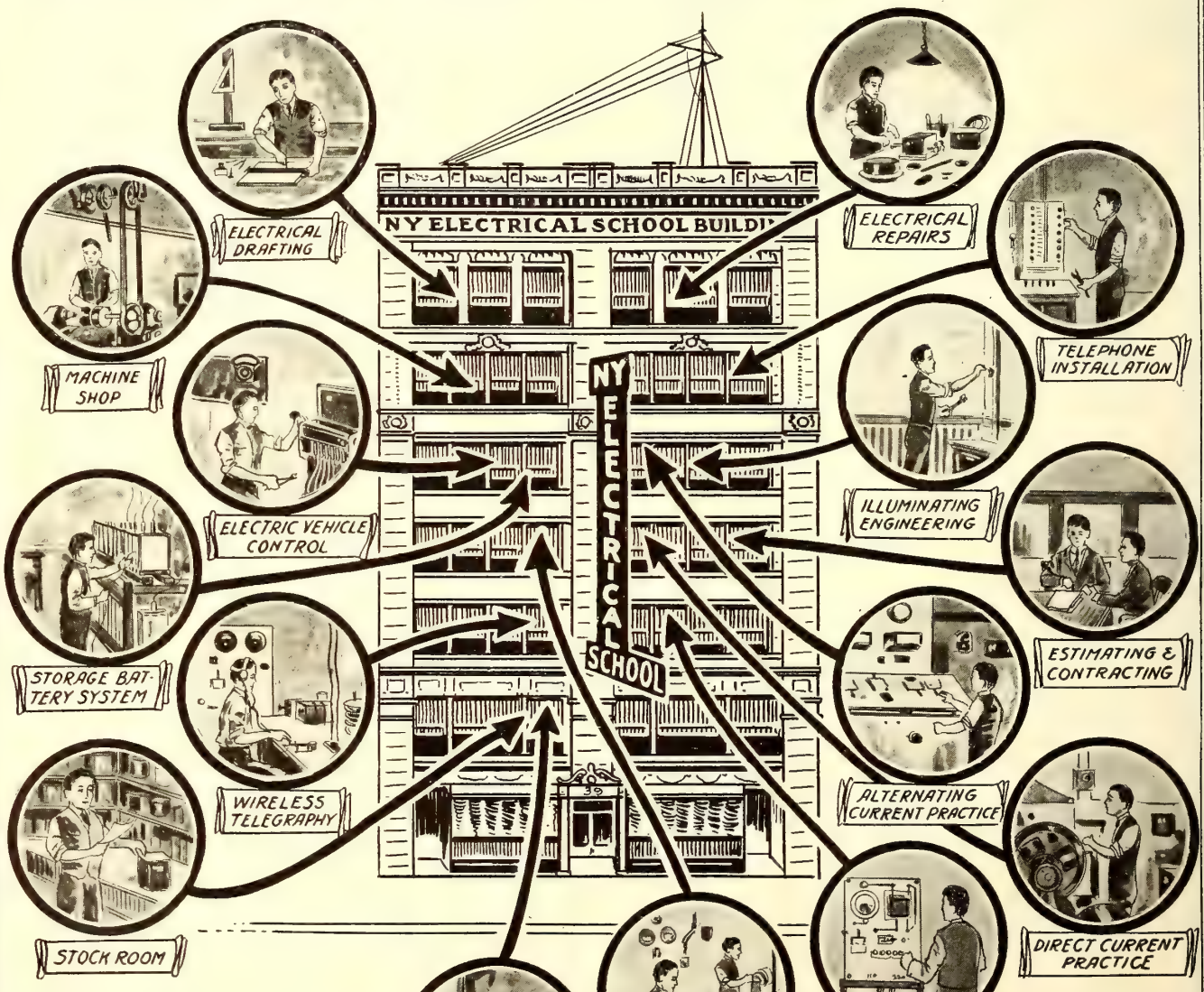
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ELECTRICAL EXPERIMENTER

H. GERNSBACK EDITOR
H. W. SECOR ASSOCIATE EDITOR

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Are the "Huns" Using Electric Raiders?

By H. WINFIELD SECOR

IT is stated in recent press reports, one of which professes to be an English Admiralty statement, that the Germans have put into commission a remarkable new war-vessel controlled from shore by means of an electric cable attached to the boat, and which craft is *crew-less.*

The report in question further says that —"the electrically controlled motor boats used on the Belgian Coast are twin petrol engine vessels, partly closed in, and travel at a high rate of speed. They carry a drum with between *thirty* and *fifty miles* of insulated single core cable, thru which the boat is controlled electrically. The forepart carries a considerable charge of high explosive, probably from 300 to 500 pounds in weight.

"The method of operating is to start the engine, after which the crew leave the boat. A seaplane, protected by a strong fighting patrol, then accompanies the vessel at a distance of from three to five miles and signals to the shore operator of the helm. These signals need only be 'Starboard,' 'Port' or 'Steady.' The boat is zigzagged while being steered into a ship and the charge explodes automatically.

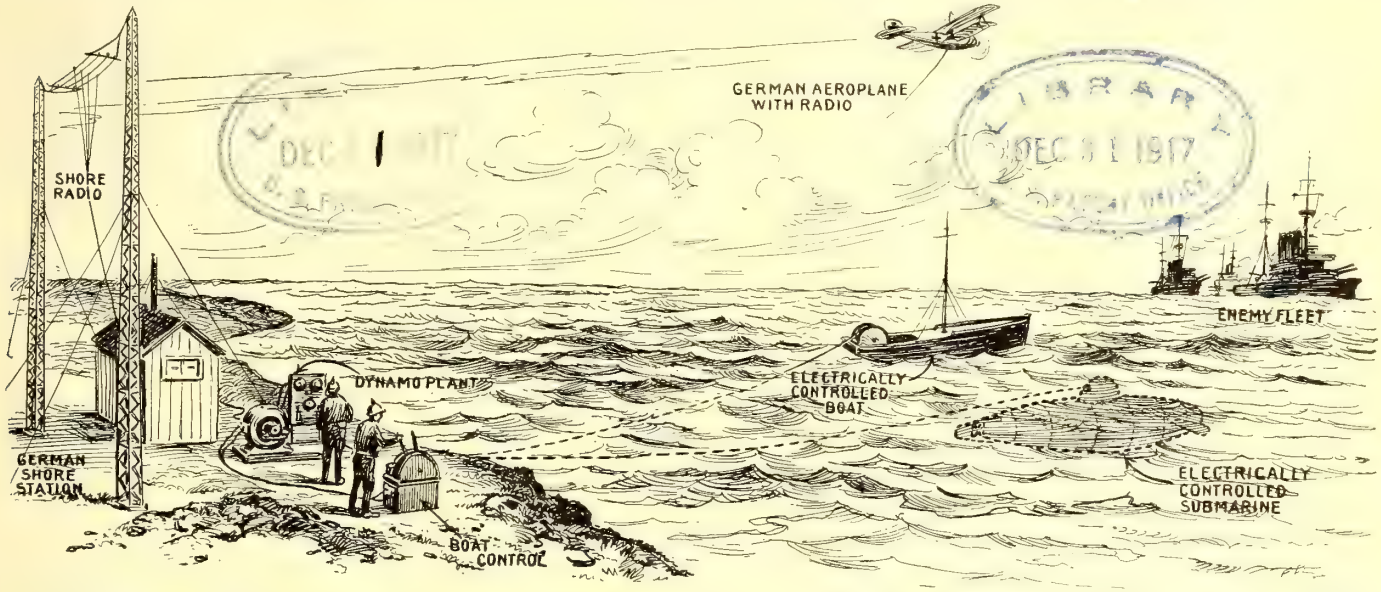
"The device is a very old one. A boat quite similarly controlled was the H. M. S. *Vernon,* a torpedo experimental ship, as far back as 1885. The only new features in the German boat are the petrol engines and wireless signals, neither of which existed then."

So much for the press descriptions. But is such a craft practical? How is it possible to maneuver such a strange acting vessel; for strange it certainly would be, for *hailing* signals could not be answered with no crew on board; without the enemy vessels opening fire and destroying it? Again, is it possible for such an engine of war to be made with a range of 50 miles—or even 10 miles? After considering the above and numerous other questions, it seems that it would be quite possible and, under certain favorable conditions, distinctly practical, for the following reasons:

In the first place, it seems rather problematical whether or not the "electric raider" could approach the enemy vessels close enough to do any serious damage, when the weather is clear. This seeming disadvantage might be overcome, however, by the utilization of reserve engine power on the "raider" when she had approached her target, permitting her to descend on the ship at a speed of 40 to 50 miles per hour. By suitably disposing the magazine containing the 500 pounds of high explosive in a compartment well below the water-line, it would appear to be possible for the "raider" to undergo quite a little shelling without being blown up, and if such was the case, the "raider" might eventually reach her objective.

However, there is another very promising side to the question. Low visibility—in other words, foggy or partly foggy weather. Here is where the "electric raider" shines. The seaplane would, of course, be the all-important means whereby, the raider could be maneuvered in any case. With foggy weather to help, the location and movements of the craft could at all times be ascertained by attaching a kite to it, which the aviator could see above the fog layer, or a light, extra high mast could be provided. In this way, and by other means, such as by arranging a radio transmitter on the raider, it would be quite practical indeed to operate such a boat.

Another interesting problem concerns the 50 miles of cable, which is presumably carried on a reel on the boat, the cable being anchored on shore and properly connected up to the necessary control instruments. Here also is a radio station to receive the instructions sent by the seaplane watching the progress of the "raider." With regard to the great length of cable mentioned, this



It Is Reported That the Germans Recently Sprung a Surprise on the Allied Fleet Off the Belgian Coast in the Form of An Electrically Controlled "Man-less" Boat, Loaded With High Explosives. The Idea Seems Feasible—and Why Not Use a Submarine in the Same Way? The Seaplane Reports the Boat's Movements Back to Shore Where the Control Apparatus Connects With a Cable Joined to the Boat.

Artillery Telephone Service on British Front

THE telephone has solved thousands of complex problems in the great conflict across the ocean, as we well know today. However, it is not often that we read very much or see photographs of military telephone stations located but a short distance from the firing line, especially those in active use by the artillery units.

The accompanying photograph is therefore of supreme interest in that the grim-looking "Tommies" in their steel helmets seen telephoning orders, are actually located in a concrete dug-out but five hundred yards from the "Boches."

The brave Britishers here shown are telephoning orders from the observation officers to the men behind the guns of an adjoining artillery unit, and altering the range figures as they are given to them by the observers.

These underground dug-outs, such as the one here shown occupied by a Signal Corps squad, are always built with the idea in mind to make them as nearly bomb and shell-proof as possible, but with the large size shells now in use, it is not unusual for these massive projectiles to pierce the roof of a "bomb-proof" and destroy it. Such work as this, of course, all comes in the day's work of the soldier.

Not only does it require men of stout heart and excellent physique, not to mention the best of nerves, for such operations when under fire, but equally as dangerous and even more so in many cases is the work of the telephone and telegraph linemen attached to the Signal Corps division of the army, who may be ordered to complete a circuit suddenly opened by a stray shell. When an advance is made, no matter whether it is large or small in magnitude, the Signal Corps men will always be found right on the job, stringing their communication lines from shell-hole to shell-hole, thru forests and across rivers.



British Official War Photos

A Recent British Photograph Which Is Remarkable In That it Shows a Telephone Dug-Out Within 500 Yards of the Boches. These "Tommies" Are Under Fire and Telephoning the Orders For Altering the Gun Range.

Without a word these men, clutching up their rifles and tools, may have to pass out into the white light of the German star-shells at night. More dangerous shells may be falling with monotonous regularity as they go forward. Such happenings go unheeded. At length they reach a shell-hole, the cause of their unwisht for promenade. If the telephone line has been broken by a shell, the work of splicing a new piece of wire to the broken ends in soon accomplisht. They then retrace their steps to the dug-out.

When a hostile trench is about to be taken, the telephone operators, in accordance with orders, wait until their comrades have taken the enemy position. The attacking forces have scarcely reached their objective before the telephone linemen are doubling across "No Man's Land," in order to establish their lines.

(*Continued from page* 589)

presents no unusual difficulty, this for the reason that the cable need only carry a single pole current, the return circuit being thru the water. A special step-by-step relay or other selective device on the vessel can serve to control several functions, by sending different impulses over the cable. At the proper time the detonating impulse would be sent thru the cable.

But granting all these things—the author would suggest—why not use an electrically controlled submarine? The idea is not new, as the Edison-Sims electric cable-controlled torpedo bears witness, not to mention several other attempts in this direction. The electrically controlled "sub," guided by a seaplane, which would "radio" back to shore its various movements, would seem to be a powerful weapon under conditions where it could be employed. According to the latest data an aviator can see a "sub" when it is submerged 100 feet under the water. There would thus seem to be a good chance of applying this scheme. Old submarines could be used for such operations.

The author has ascertained that several well-known engineers hold ideas similar to the above, concerning the feasibility of the "electric raider," including Mr. Christian Berger, inventor of the submarine wireless signaling scheme now used by all submarines.

There has been much talk of late of various fanciful and gigantic schemes for forcing a way thru the Heligoland defenses, and other heavily mined and fortified approaches, harbors and channels. Mr. Arthur Bennington, of New York, a keen observer of all war-time maneuvers and inventions, recently told the writer that he thought this "electric raider" game seemed to hold forth great promise indeed, for just such gigantic operations.

"Let us take a veritable fleet of old submarines and other nondescript vessels, and fit them with electric control cables, engines or motors, etc." said Mr. Bennington. "Load them up with high explosives and get everything in readiness. Have the Allies' battle fleet ready for business—Then start the first electric boats thru the mine fields. Every time a boat is blown up, an ever-increasing swath will be cut thru the mine field, and, woe be to the U-boat that tries to pass thru the zone under attack. It looks really very feasible to carry out just such an operation as this, with the result that before long the Allied battle fleet would be able to reach the German sea defenses and readily destroy them."

WHAT MARCONI DREW.

Mrs. Alec Tweedie's entertaining book dealing with her wonderful collection of autographed tablecloths—a hobby of hers—contains the following:

"Among the little drawings on one of the cloths," writes the authoress, "is a telegraph pole from which hangs a broken wire.

"Can you guess who drew it? The artist was sitting beside me when I begged for something more than a name. He quietly replied:

"'Well, I can draw a little, if I have time.'

"'You shall have all the time you want,' I suggested. 'We can keep the dessert waiting.'

"'No, no, I'll try to be quick. Would a telegraph pole do?'

"'Certainly, tho it will hardly be emblematic of your work.'

"'Yes, it will,' rejoined my guest, 'for I can break the wire.'"

Needless to add, the guest in question was Signor Marconi, the inventor of wireless telegraphy.

BACK NUMBERS!—Many readers desire to obtain back numbers of this journal. We have a limited quantity of these back issues on hand and can supply them at the following rates:—Back numbers of The Electrical Experimenter not over three months old, 15 cents each; over three months old, 20 cents each; over one year old, 35 cents each.

Fog Warning by Radiophone

By GEORGE HOLMES

WHETHER for business or pleasure there is not one of us who would not enjoy an ocean trip to chase away our cares and worries. Those of us fortunate to share such a luxury certainly enjoy the bright sunny decks, the beautiful skies and the fine sea air.

This is only one side tho for there are often days and nights, even weeks when storms are raging or heavy misty fogs set in, wherefore it becomes necessary for the passengers to amuse themselves indoors, in the salon, at the piano or in the smoking room swapping stories and playing cards. And—Oh, yes, . . . leaning over the rail for "enlightment"?

At such times as these the grizzled sea captain must worry, for on him rests the responsibility of bringing his ship and passengers safely thru the storm.

Of recent years, inventors have constantly sought to make navigation less hazardous and each year sees new improvements along these lines. What with submarine signals, automatic engine-room signals, searchlights and wireless to keep in touch with the world and safeguard the ship, passengers travel with a really wonderful sense of safety compared to the olden days.

Lately a very important development in the line of radio has come to the aid of the lighthouse crews to assist in warning ships of dangerous shoals and rocks. We are indebted to the well-known radio inventor Dr. Lee de Forest, for this latest application of Radio. A short official description is given in a recent Hydrographic Bulletin issued by the U. S. Naval Hydrographic Office.

The first real test of this apparatus is now taking place at Point Judith Light (near Narragansett Pier) and is arranged on a very compact scale so that it can be attended to by the regular lighthouse keeper and assistant. A regulation gasoline engine connected with a 36 volt direct-current generator and storage batteries is used to supply the energy, to which is coupled a motor-generator set which operates the transmitting apparatus.

This apparatus is entirely enclosed in a very small cabinet measuring but 18x18x18 inches. On the front of the cabinet is the *Oscillion* bulb and necessary switches for regulating it; also connecting posts for aerial and ground wires. On the side of the cabinet is a small door which gives access to the mechanism inside.

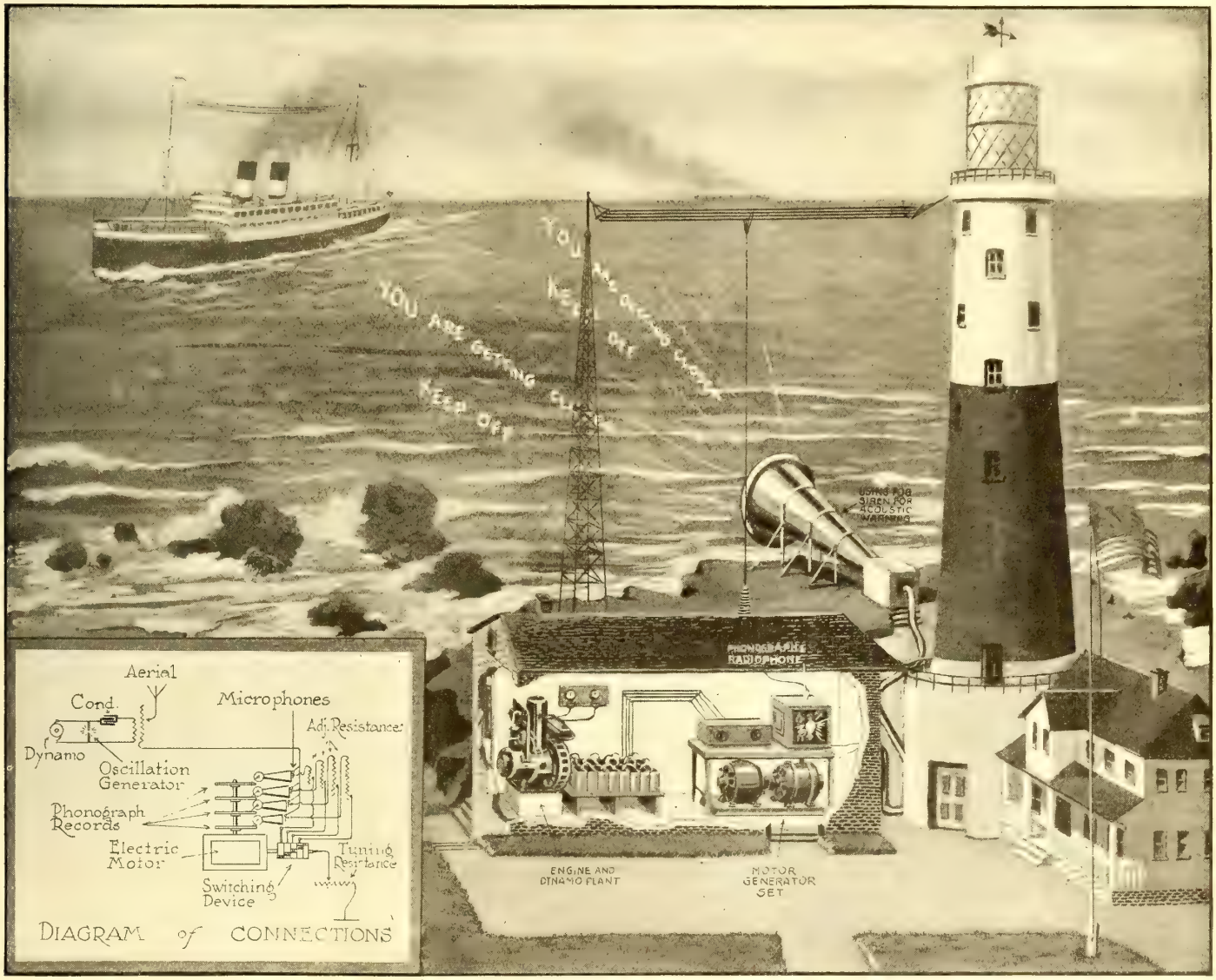
All the working parts are mounted inside the cabinet, including a motor-driven phonograph speaking directly into a microphone. The arrangement of the cylindrical records is such that they repeat automatically, the saffire needle being set back to the beginning each time after it has traveled the length of the record. Each record has an average life of about 60,000 repetitions.

The fundamental idea of this method of radiating fog warning signals, by varying quantity with ranges or power, was covered in a U. S. patent issued to Dr. de Forest in 1916, number 1,183,802, on an application filed in 1908.

In the circuit diagram may be seen the relative layout of the various horns, microphones, and the commutator arrangement which permits the proper sentence to be sent in its turn.

Several other modifications of the underlying principles may also be utilized as

(*Continued on page* 645)



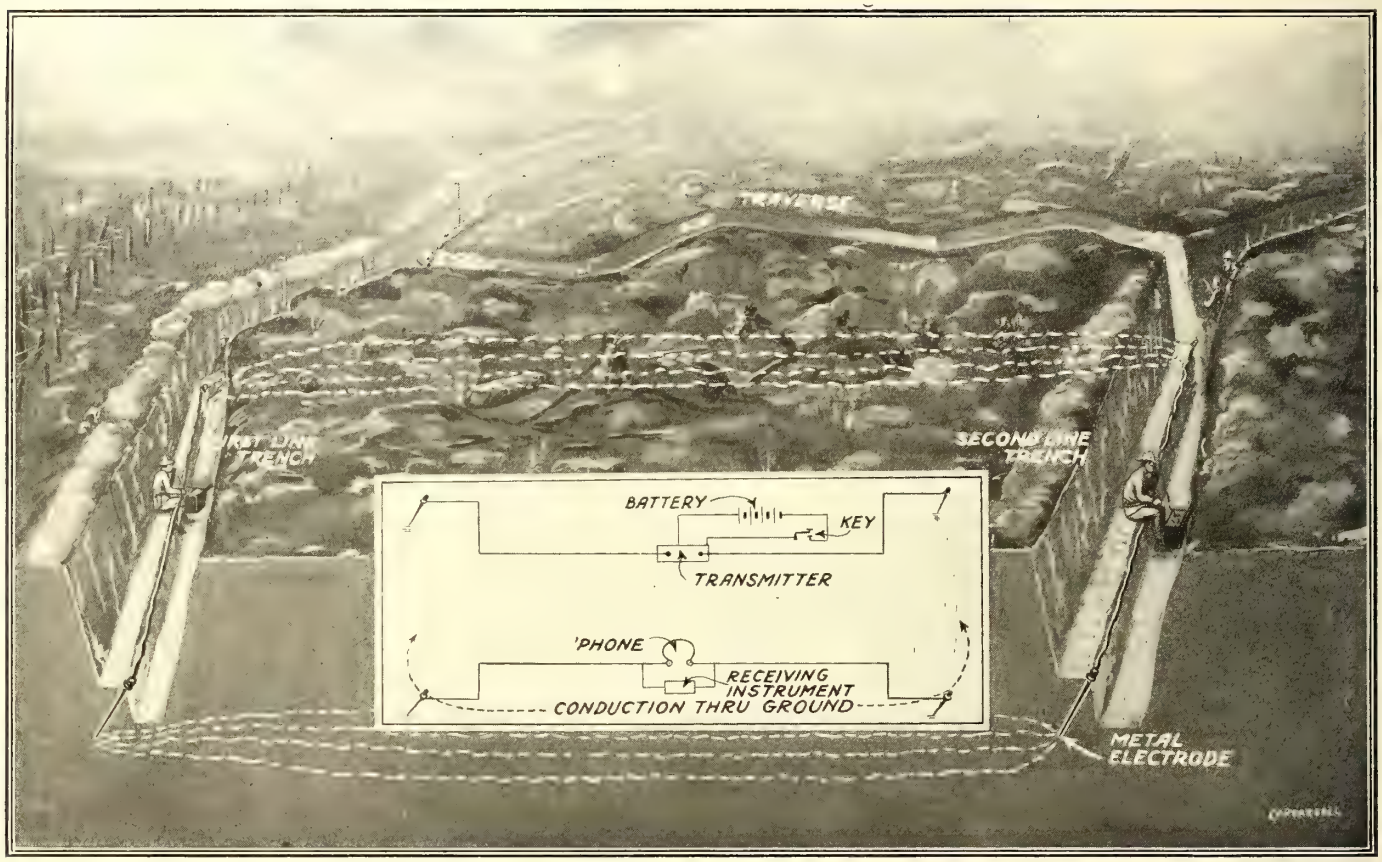
The U. S. Government Is Now Trying Out the New de Forest Radiophone Fog Warning Device Here Illustrated. By This System of Warnings It Is Possible to Radiate Either Wireless Telephone Signals or Acoustic Signals, the Latter Being Reproduced From a Phonograph, Amplified With Audions, and Propagated Thru the Air From the Regular Fog Siren Horns as Shown. Each Warning Extends For a Certain Predetermined Range.

Ground Telegraphy in War

By H. GERNSBACK

WHEN trench warfare first became an accepted fact it became of vital importance that the front trenches should be in permanent communication at all times with the supporting trenches, as well as the general command behind the lines. At first it becomes more or less an easy matter to shell these, and for that reason during the past year or so, the French have found it advantageous to do away entirely with metallic lines, running from the front to the supporting trenches, and thence rearward.

Ground telegraphy as its name implies, means sending impulses thru the earth without the use of intervening wires. The simplest system of this kind is shown in the annexed sketch where A and B are two metallic spikes driven into the ground, these spikes being connected with a bat-



A New "Wireless" Communication Scheme Is Now Being Used In the French Front Line Trenches. This Is Nothing More Nor Less Than "Ground Telegraphy" in a New Dress. By Using Specially Tuned Transmitters and Screens, Interference By the Enemy Is Practically Eliminated.

nothing but regular telegraph lines were laid, either at the bottom of the communication trenches, or otherwise the wires were suspended by some form of insulator. Such lines were not in all cases permanent, but served the purpose, as none of the wires were intended to stay up forever but were changed around more or less due to varying war conditions.

Trenches under fire make it impossible to maintain unbroken cable or wire lines, and it goes without saying that such lines are severed with annoying frequency by shell shots, bombs or surprise raiding parties. After the enemy has raided a trench, and the latter is taken away from him subsequently, there is not much left of the cables or telegraph lines, and they must be replaced immediately in order to keep up the communications with the rear. Particularly when trenches were being shelled in the past, it became a ticklish proposition to keep the lines open, as it is always the business of the enemy to search out the communication trenches with a view of disrupting the telegraph lines, which in such cases are nearly always hit.

The communication trenches being necessarily at right angles to the enemy's lines,

It has been the writer's good fortune recently to interview a French "T. S. F." *"Telegraphie Sans Fil"* officer (Wireless Telegraph Corps) and the officer in question has been kind enough to give us interesting particulars as to the new *ground telegraph* system as is now used on practically all the fronts thruout Europe. This is nothing more or less than the ground conductive system, and it is not by any means something new, having been described almost half a century back. The French, however, have added considerable new features to the system, as will be evidenced in this article.



This Diagram Gives a Clear Idea of "Ground Telegraphy." Current Impulses Sent Out Thru Electrodes A and B Will Be Heard In Telephone Connected to Spikes C and D, Due to Current Leakage.

tery and a buzzer. If we now drive two further spikes C and D, say fifty or one hundred yards (or more) away from the first spikes, *paralleling the latter,* and if we connect spikes C and D by means of a telephone receiver T, then when we operate the buzzer by means of a telegraph key the sounds will be clearly received in the far off telephone T.

The explanation is that a certain amount of current is received by the spikes C and D, and the sound while weak is readily heard in the telephone receiver. Of course, this is the crudest system, but it works surprisingly well over equally surprising distances. Not only is it possible to telegraph over such a system, but by substituting a microphone for the buzzer, and provided we have enough current, articulate speech can be transmitted over such a ground system without the use of intervening wires. It is of course not as efficient as the "ether wave" radiophone system, but has certain military applications.

A system of this kind works always at its best when the spikes A and B are separated as far as it is possible. The further the spikes are separated, the further

(*Continued on page* 646)

How Aurora Borealis Affects Telegraph and Cable Lines

Here for the first time, are told the inside facts of just how the "Aurora Borealis" affects telephone and telegraph lines, as well as ocean cables. The facts presented are from the records of a leading American electrical engineer who has been in a position, fortunately, to carry on official observations and tests on this little understood phenomenon for many years.

THE Aurora Borealis, commonly called the "Northern Lights," pays us a visit now and then, the last severe attack on telegraph and telephone circuits, as well as ocean cables, having occurred on August 9th. The display was both spectacular and demoralizing to man-made electric communication lines. A few words on this remarkable phenomenon and its origin, which is now thought to be due to sun-spots, should be of interest.

"Since a magnetic storm of the intensity of that of August 9th demonstrably has power to arrest the operation over a whole continent and a whole ocean of telegraph, cable and telephone lines, how much more intense would a similar storm have to be in order to stop the engines of prowling submarines and of soaring aeroplanes, which in one case directly and in the other indirectly depend for their functioning on electricity? The source of the disturbance is in the sun, which exercises its power of interference from a distance of 93,000,000 miles" says a well-known scientist.

"In these questions lies the new significance of such a magnetic storm as that of August 9th, which occurred coincidentally with the existence on the sun of a vast disturbance that broke up millions of square miles of its fiery surface.

"The force of that disturbance, as it reached the earth, perhaps in the form of torrents of electrons, was only sufficient to be noticed in its effect, thru the magnetic currents of the earth, upon delicately balanced energies in electro-magnetic instruments; but imagine it magnified ten times or a hundred times, and then what? Sun-spots and their repercussion upon the earth have only been studied for a few decades, and it is but a few years since we first came into possession of instruments and engines depending on electricity for their action, so that we have not yet experimental knowledge of what the maximum of this solar explosive influence upon them may be.

"There are various theories concerning the precise manner in which the solar influence is transformed to the earth. One of the most probable supposes it to be done thru shafts of invisible radiations, resembling the cathode rays, which come from the sun, and, upon meeting the atmosphere, alter the conductivity of the upper strata and thus stimulate the circulation of aerial electric currents. The shafts of radiation, or of electrons, arise from centres of violent disturbance on the sun's surface."

A good explanation is given by the famous French astronomer—Camille Flammarion, who explains in *L'Illustration* that these northern lights are caused by the feverish condition of the sun. It seems as if the face of the sun had broken out in a fearful rash, so numerous and so large are the spots that have been observed, some even large enough to be seen with the naked eye.

"The sun," writes Flammarion, "is always a furnace of inconceivable physical and chemical phenomena, bombardments of electrified particles and enormous eruptions of gas, of which we can gain no idea even from the thunder-bolts of heaven which flash in lightning from the clouds, nor from the thunders of man which escape from the monstrous throats of cannon. These spots on the sun are actually at least 158,000 miles in diameter. Our earth is about 8,000 miles in diameter, so it could fall into one of them and be lost."

The great streamers of light that flickered over the northern sky, like the rays of giant searchlights, on many evenings in August and September were, according to Flammarion, radiations of electric light directly from the vast volcanoes and fiery tornadoes that are torturing the face of the sun. And these radiations extend out as far as the orbit of Neptune, more than 2,793,000,000 miles away!

The action of the "Northern Lights" on telegraph and other long circuits would

(*Continued on page* 645)



The "Aurora Borealis" Visits Us Every Now and Then, the Last One Having Occurred on August 9, 1917. At These Times There are Severe Electrical Disturbances Set Up on Telephone and Telegraph as Well as Cable Lines. Transient Electric Currents Often Surge Thru the Circuits, Which Register a Potential of Several Hundred Volts.

The "Electro-Magnetic Depth Bomb"—Terror of the "Subs"

THE "Depth Bomb" has been featured in all recent official and unofficial despatches in which submarine activities have figured—much to the mystification of the man-in-the-street, let it be said. In the present article the general operating features of the "depth bomb" are explained as well as several new ideas which are being tried out, these modifications being due to Mr. F. R. Lewis of New York, inventor of several new war appliances, including an improved aeroplane range finder for bomb dropping, which was illustrated and described at length in the December number of the ELECTRICAL EXPERIMENTER.

Our front cover illustration shows in a striking manner one method of using the Lewis "depth bomb." The general arrangement of this promising anti-submarine device is illustrated in the accompanying sectional drawing.

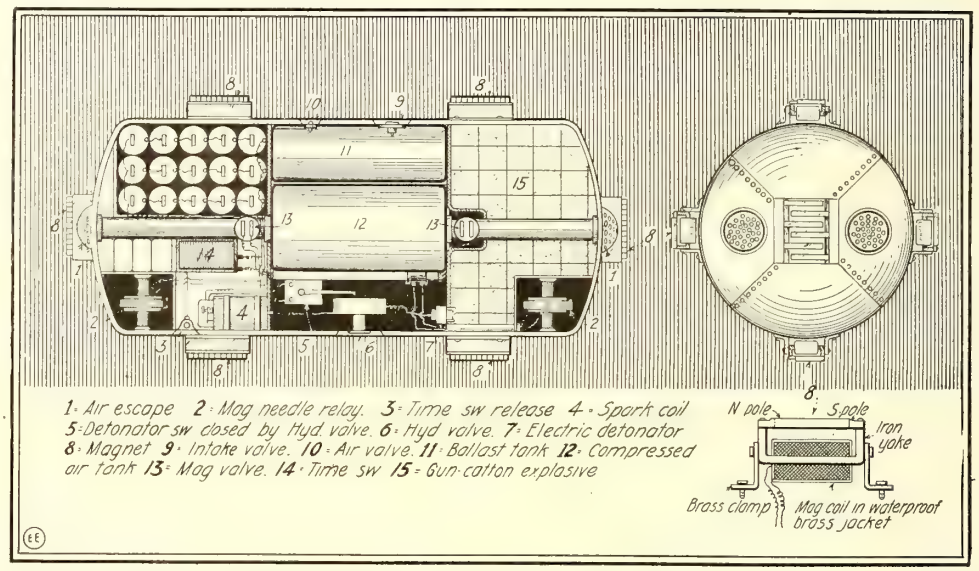
This bomb while harmless to vessels passing thru the submarine zone is sure death to the submarine that comes within the magnetic radius of its powerful electro-magnets. The bomb can be planted in waters infested by enemy submarines with the aid of patrol boats or hydro-aeroplanes. By turning the screw that opens valve (9) to the ballast chamber (11) the bomb immediately sinks under the surface of the water fifteen feet, where it lies in wait for its prey. If by chance a merchant or patrol vessel should attract the bomb, the bomb would attach itself to the side of the vessel. It should be understood that this electro-magnetic depth bomb is not of the class constantly invented by well-meaning but electrically uninformed patriots, wherein the magnet is supposed to pull the ship or the bomb thru a radius of several yards. The Lewis depth bomb is fitted with powerful multipolar electro-magnets all over its outer shell in the manner here shown. These are not normally excited, but as soon as a submarine comes within a few feet of it, the presence of her iron mass causes a sensitive magnetic needle relay to close the battery circuit thru the powerful electro-magnet nearest to the submarine's hull. If the submarine is close to the depth bomb, the bomb will attach itself to the submarine, all unknown to the "sub's" crew. Besides all this use is made of a comprest air tank and two discharge jets, one at either end, the air jet farthest from the "sub." being actuated by a magnetic valve opened by the magnetic relay 2. The depth bomb will be propelled toward the "sub." by the escaping air, even tho the bomb is several yards away.

If a patrol or merchant vessel happens to pick up any of the electro-magnetic depth bombs, it must be remembered that they stay at a fixt draft, which renders the bomb *harmless to them,* but when a submarine picks one up (all unknown to its crew) it is harmless only until the submarine dives to fire a torpedo at its prey. The submarine must go to a depth of at least 30 to 35 feet, when the water pressure causes the hydrostatic valve (6) to work the electric switch (5) which in turn operates the spark coil (4) exploding a powerful high explosive charge in the chamber (15). The charge is heavy enough to blow in a plate or two or cause the plates to be blown in to such an extent that the submarine would sink in a very few minutes, so that the subsea craft, by its very act to destroy, destroys itself.

There is provided an airtight chamber around all electrical parts and the explosive chamber, as the bomb lying in the water, would be affected by the different temperatures which would cause *sweating* (condensation) and this moisture would sooner or later cause the bomb to become dead and consequently harmless. A special time switch is provided which keeps all circuits open until after a predetermined time period, thus enabling the ship's crew to cast them overboard and get away from the spot before the depth bomb becomes active.

These depth bombs can be cheaply made and could be planted by the hundreds in the zones picked out for this purpose, at night, (or by seaplanes in the daytime) and as the bomb sinks to a depth of fifteen feet, there is nothing to show the enemy where danger lurks. The hydro-static valve is controlled by a tension spring and set-screw indicator which can be adjusted for the bomb to explode at a predetermined depth of 30 to 100 feet.

The depth bomb would seem to have distinct advantages for carrying on anti-submarine operations in such waters as those off the coast of Belgium, and in the German coastal waters of the North Sea. The Allied war-vessels cannot enter these thickly mined waters, anyway. They are netted off to a large extent so that floating depth bombs would hardly menace the Allied ships. But the "Huns" in their subsea war-vessels know safe channels thru the mined areas and manage to cut thru nets and finally show up "somewhere in the Atlantic." When Uncle Sam's aerial fleet reaches the other side, and even with the present Allied air-fleet, it ought to be possible to sow the forbidden water areas with tens of thousands of such electro-magnetic depth bombs. Depth bombs seem to be very efficient.



The "Electro-Magnetic Depth Bomb" Represents the Latest Departure in the Design of Anti-Submarine Devices. These Bombs Are Harmless if Picked Up by Steamships. When Picked Up by an Enemy Submarine, However, They Make Short Work of It, For When the "Sub" Dives, the Increased Water Pressure Explodes the Bomb.

SUCCESSFUL RADIO SCHOOL UNDER NOVEL CONDITIONS.

A free Government school to train radio operators for the rapidly-growing American merchant marine has been established at Boston thru the initiative of Radio Inspector Arthur Batcheller, of that city, with the active assistance of Mr. Walter Butterworth, assistant radio inspector. When Congress made its first appropriation for building merchant vessels Mr. Batcheller, at that time assistant radio inspector at Boston, was quick to realize that a large number of commercial operators would be needed, and in June he suggested to the Commissioner of Navigation the establishment of a free school which, unlike the great school conducted by the Navy Department, would accept only such applicants as would agree to take a position in the merchant marine. The suggestion was approved and Mr. Batcheller was authorized to carry out his plans.

Thru the coöperation of the collector of customs permission was obtained to use the office of the radio inspector in the Boston customshouse during the evening for school purposes. Benches and tables were made from second-hand lumber obtained thru the assistance of the Customs Service, and camp stools were loaned by the Boston & Gloucester Steamship Co. Thru the mayor of Boston the loan of a blackboard was secured from the school department. The Marconi Wireless Telegraph Co. aided the project by supplying a typical radio installation, and the Bureau of Navigation furnished the necessary head telephones, telegraph keys, dry cells, wire, buzzers, etc.

These facilities permitted the instruction of a class of 40 men, and nearly that number are taking advantage of the opportunity. The classes meet three evenings a week and the work is progressing with marked success. The school opened on July 16, and each student will have an opportunity at the end of a six months' course to win a first-grade commercial radio operator's license.

The instruction is under the supervision of Mr. Batcheller, who had previously had four years' experience as a teacher of electricity and radiotelegraphy. The Secretary of Commerce has visited the school and has officially commended Mr. Batcheller and Mr. Butterworth for their helpful and patriotic service. They have had the active assistance of Mr. McCarthy, clerk in the radio inspector's office, and of Mr. E. W. Thompson, chief electrician, radio, United States Navy.

Electric Buoys to Mark Torpedoed Ships

By E. T. JONES, Chief Electrician; Radio, U. S. N. R. F.

RECENTLY I have seen and read much in regards to torpedoed ships, the raising and saving of the same, and some of them are indeed excellent ideas. Now of late I have been studying this subject myself and I have devised a method, here illustrated, by which ships could be raised if the proper apparatus were used to do so.

The main idea is to fit all merchant ships with the buoys shown, having enclosed inside of them coils of cable on a reel which unwind as the ship goes down. The buoy staying afloat access can be had to the cable by means of an entrance at the top of the buoy. The ship could be fitted with eight or more of these "floaters" and by using powerful floating cranes or other means of lifting, the lost ship could easily be brought to the surface and then towed to shallow water where it could be entirely saved.

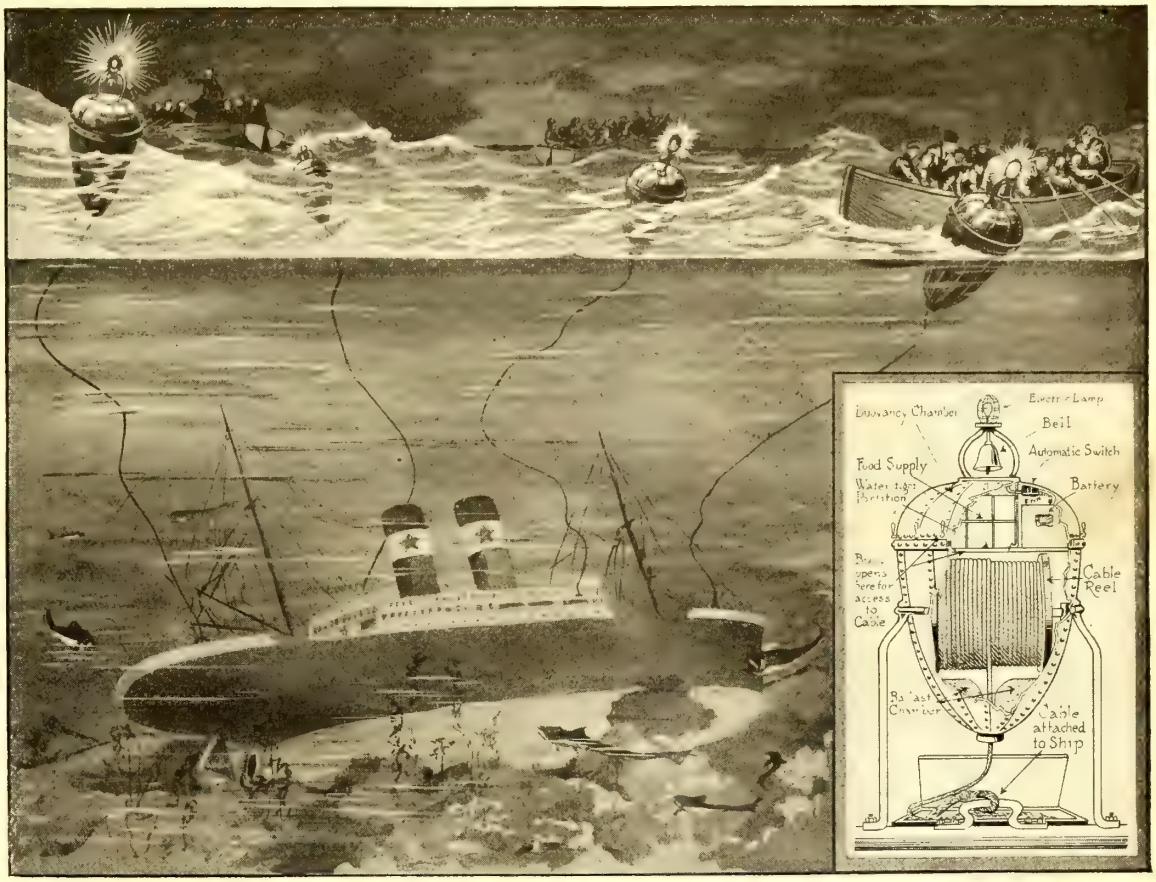
It is, of course, taken into consideration if the ship were sunk in mid-ocean that the cable could not be long enough, in fact the buoy would have to be too large, but if each ship were fitted with these buoys and a reasonable amount of cable inserted in each it would be no more than taking another chance, but this time a chance which would probably save the ship.

The buoys themselves could even be supplied with food when nearing the danger zone and should the ship be sunk this food could be used by the victims until relief came. Means of holding on to the buoy could also be supplied and add to the life saving devices now supplied on board every ship.

Several details of importance would have to be taken into consideration with such a device as this. For one thing the enemy would surely cut the cables if the buoys floated to the surface as soon as the ship sank. Some kind of retarding device, such as a slow-emptying ballast tank, would solve this problem, so that the buoys would float to the surface only after a period of several hours.

Further, it is not feasible, as aforementioned, to fit these buoys with a great length of heavy cable. Therefore, it would seem a good idea to equip the buoys with reels of fine steel wire only, which could then be of considerable length, owing to its light weight. Under each buoy position on the vessel there could be provided a magazine chamber in the hold, in which a suitable length of heavy steel cable could be stored on a reel. The action of the buoys so equipt would then be as follows:

Say the vessel was torpedoed; the eight or more buoys would, after several hours, float to the surface, carrying their fine wire connections from the sunken craft. If now salvage operations are to be started in an effort to raise the wreck, the buoy covers are opened and by pulling up on the small wires, automatic clutches are released on the deck of the sunken boat, permitting the heavy cable in the magazines to be pulled up. After the heavy cables are all pulled up to the surface, they are made fast to the lifting derricks. For that matter it would also be practical to arrange a second buoy to float the heavy cable to the surface, this buoy being released by pulling on the fine guide wires already described. The buoys would be fitted with a storage or other battery to light the lamp and an automatic switch to close the lamp circuit after the buoy reached the surface.



One of Uncle Sam's Naval Men Has Suggested a New Salvaging Scheme for Saving Sunken Ships. He Proposes to Equip Every Boat with a Series of Electrical Buoys, which Rise when the Ship Sinks. These Buoys Carry Cables From the Ship, and May Carry Electric Lights as Well as Food for the Survivors.

AMERICA'S ELECTRICAL CHRISTMAS CAMPAIGN

Some years ago, Thomas Edison predicted that it wouldn't be very long before practically everything that required labor in the home, would be done by "electricity."

Everyone knows to what extent labor, time and money saving electrical appliances have been introduced into the home, and how energetically and successfully central stations, electric shops, contractors and others have been promoting the use of such devices. But it has been only with the sudden descent of war upon this country that the full meaning of Edison's words, and their great portent comes to us.

Apropos of this question of selling Electrical appliances, this year's campaign of *The Society for Electrical Development;* "America's Electrical Christmas" comes along at a most opportune time. Never before in the history of the industry was there a time when electrical merchandise played the part it will this year.

These facts, and others, have all received the most careful attention in a book just publisht by the Society, which is being sent gratis to members and non-members alike, upon request. It is designed for Central Stations and dealers who have Arrived, those who are Already There, those who are Going, and the Just Started. It is a big book, 48 pages and covers, printed in many colors, profusely illustrated thruout, and filled with practical, timely suggestions, built for stores of all sizes in cities of all sizes.

The book has some twenty chapters, treating on everything from the store and window display, to the use of two very excellent "movie films" which the Society has prepared, in coöperation with the Universal Film Mfg. Co. All the helps, copy, cuts, etc., are furnished practically free to members and non-members along the same broad liberal policy heretofore manifest in such previous campaigns as America's Electrical Week, Electrical Prosperity Week, Wire-Your-Home-Time, etc. Readers are advised to correspond with the Society for Electrical Development, 29 West 39th Street, New York City.

SALVADOR—MEXICAN WIRELESS.

Wireless communication has been establisht between Mexico City and San Salvador. The wireless plant at the Salvadorean capital was presented to that country by Mexico and installed by Mexican electricians.

Training U. S. Aviators with Electric Map

UNCLE SAM has a real job on his hands now—namely, to train thousands of aviators in a few months. And they must be good aviators—capable of looping the loop with one hand, if need be—while with the other they proceed to flash a radio report to earth, telling just where the shells are hitting. Therefore, every student learns wireless; no one can gain his commission without passing a rigid examination in this indispensable art. Probably the most interesting work is that performed in the miniature range. This gives the student that preliminary instruction in artillery spotting which is perhaps the most useful service rendered by the aeroplane, says Burton J. Hendrick in the *World's Work*. In one of the instruction halls at Ohio State University is an immense picture map of a section of Belgium. It shows the city of Ypres and all the surrounding country, including every farmhouse, barn, country road, open field, river and pond. In a gallery, about ten feet above this map, sit several of our future aviators. They are supposed to be in aeroplanes, six thousand feet in the air.

The scale of the map is so graduated that, as they gaze down upon it, the terrain appears precisely as it would look were these men actually flying in the air at that height. Their business is to locate "exploding shells" and *wireless* back to their own batteries the accuracies or inaccuracies of the aim. And shells are actually exploding all the time on this miniature sketch of Belgian territory below them; not real shells, perhaps, but representations that convey a complete illusion.

Under the map, which is of paper and therefore transparent to light, are located hundreds of little electric light bulbs. The professor, by touching the appropriate button on a lamp control switch-board, can light his selected bulb, the little flash appearing on the map giving a complete representation of an exploding shell. The apprentice airman in the gallery selects the German battery which his own men are attempting to destroy. The professor touches off his imitation shells in close proximity to this battery—these are supposed to represent American attempts to reach the mark. As soon as each shell explodes, a tapping is heard up in the little gallery; *the student is wirelessing to his friends, telling them how far they have come from hitting the object.*

The wireless message may take such cryptic form as telling the American battery that it is "ten o'clock and three hundred yards." This may puzzle most people, but it locates precisely the spot where the shell has fallen. For purposes of signaling the German battery is taken as the centre of a clock, with twelve o'clock pointed perhaps due north. When the airman signals "ten o'clock" this means that the shell has exploded on an imaginary line which would represent the clock pointer in this direction. The "three hundred yards" gives the distance between the exploding shell and the German battery.



The U. S. Aviation School At a Western University Has Adopted an Electric Map for Coaching Future Birdmen. The Instructor Pushes a Button, a Light Under the Map Flashes, and the Students in the Balcony Must Instantly Locate Where the Supposed Shell Hit. The Students Telegraph Their Results To the Instructor.

The business of the student is to locate these exploding shells almost instantaneously. Unless he gains great proficiency in a short time, he has no future in the American air service. In no department of the service can mistakes become so costly and cause the loss of so many lives. The fate of battles may easily depend upon the reliability of the information wirelessed back by these aërial scouts. Clearly this is no business for a boy who does not have sharp eyes, a perceiving brain, a quick wit and absolutely boundless courage. The young men at the Ohio State University, perched in their gallery above this map of Belgium, can exercise all their gifts of observation and all the quick mental reactions necessary to fulfill their duty, but they cannot, after all, reproduce all the atmosphere of the aërial battlefield. In the calm of this university hall he works in peace, while, when in action, he will be threatened with attack by German airmen, constantly seeking to interrupt his little game. The school experience can train the future airmen's skill, but it cannot train his nerves. The rapidity with which the students are learning this art, however, and the eagerness which they manifest in the entrancing game, argues well for their actual work in the field.

Eight weeks they spend in the ground school. Those who survive this experience are past on to the flying field, such as that at Dayton. Here they continue their school work and also learn the real work of flying a plane and after eight weeks here they are transported silently to an American port and shipt to France. Here an American aviation school receives them, and thence they advance, by slow stages, to the "front."

SCIENCE AND INDUSTRY.

Sir Isaac Newton, shortly before his death, said: "I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the seashore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me"—yet Liebnitz estimated that Newton had achieved far more than all other mathematicians put together from the beginning of history. Lord Kelvin, at his jubilee, in reply to the homage of the whole scientific world, said: "One word characterizes the most strenuous of the efforts for the advancement of science that I have made perseveringly during fifty-five years; that word is failure." Yet he towered above all his scientific contemporaries, and was perhaps the greatest savant that the world has known. It is, in fact, a trait common to all who have spent their lives in the pursuit of knowledge, and have acquired a profound acquaintance with the hidden mysteries of nature and science, that they, more than all others, realize the immensity of the field that lies open before them—shrouded in mists, it is true, and beset with pitfalls, *culs de sac,* false clues, but also holding treasure in store of inconceivable richness for the reward of those who patiently grope amid its gloomy fastnesses. We have as yet but ventured over the border of that illimitable expanse; the further we penetrate into its depths the better we appreciate the wealth that lies beyond, and the greater becomes our strength to overcome the difficulties that confront us. We see, too, how far we have strayed from the true path in the complacent past when we thought we had approached finality in one or another quest.

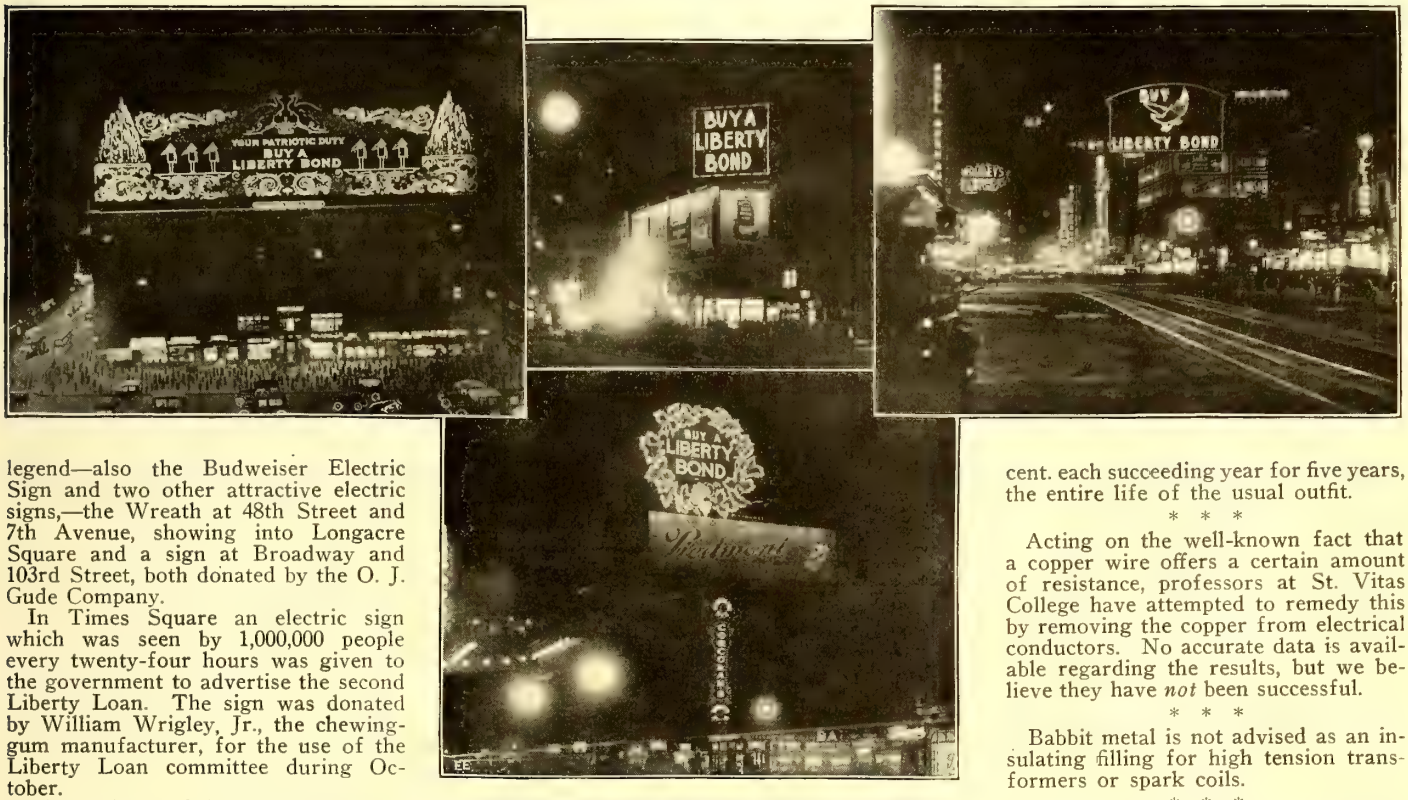
"Liberty Loan" Electric Signs

THE good people of New York City were not permitted to go pleasure-hunting along the "gay white way," without being frequently reminded that "your patriotic duty is to—BUY A LIBERTY BOND!" Electric signs large and small blazed the immortal message forth so successfully that the metropolis out-bid itself and bought considerably more than its allotted share of patriotism.

The accompanying photographs show the Wrigley Electric Sign with Liberty Loan legend—also the Budweiser Electric Sign and two other attractive electric signs,—the Wreath at 48th Street and 7th Avenue, showing into Longacre Square and a sign at Broadway and 103rd Street, both donated by the O. J. Gude Company.

In Times Square an electric sign which was seen by 1,000,000 people every twenty-four hours was given to the government to advertise the second Liberty Loan. The sign was donated by William Wrigley, Jr., the chewing-gum manufacturer, for the use of the Liberty Loan committee during October.

The statistics of the gigantic Wrigley sign are as follows:—The structure extends 56 feet in height and 200 feet in length. At either end are two magnificent fountains 34 feet high, at the top of the sign in the center are two majestic peacocks facing each other, each 60 feet long from head to tip of shimmering tail. The artistic gold scroll work border of the sign is entwined with beautiful varied colored flowers—all reproduced in electric globes — approximately 15,000 of which showing eight different colors, are required for the sign. The reproductions of the famous Spearmen, three on each side of the sign, are 15 feet high. These jolly little men are in constant action—they dance, salute, march, shoulder arms and present arms. The sign costs $5,000 a month to run. The Budweiser sign is 44 feet high by 73 feet long, and the Eagle is 24 feet high, by 22 feet wide. The Wreath is 33 feet high, and the sign at 103rd Street, while not as large as the lower Broadway signs, has a showing as far as 96th Street—one of the most important night sections of upper Broadway.—*Photos courtesy O. J. Gude Company.*



How New York Boosted the "Liberty Loan" With Flashing Electric Signs. "Buy a Liberty Bond" Greeted Your Eyes from Every Angle. Upper Left View Shows Mastodonic Sign Donated By William Wrigley, Jr., the Chewing Gum Manufacturer. It Measured 200 Ft. in Length.

ECCENTRIC ELECTRIC EFFLUVIA.

By Thomas W. Benson.

Despite the number of petticoats on a high tension insulator they do not noticeably hamper the kick.

* * *

The International Brotherhood of Blow-outs at their last annual convention adopted the pronoun "She" when referring to fuses. Their action was based on the fact that a fuse, like a woman, "goes off" when least expected.

* * *

A prominent storage battery manufacturer has announced that powdered glass is highly unsuitable for filling storage batteries.

* * *

A recent Underwriter's ruling prevents the laying of wires or cables in existing water pipes, on account of the damping effect experienced in the past.

* * *

Water has been found to be a poor substitute for oil in transformers.

* * *

At present tests are being made with a new type of ship that has one half of the hull made of copper and the other half of zinc. Calculations tend to show that the electrical energy derived from the battery thus formed will give the craft a speed of some 17.3 yards per minute.

* * *

Brocaded arc lamps with sateen ruffles have been announced by a Chicago concern. It is reasonable to presume that they will meet with great demand by the fashionable ladies for their boudoirs.

* * *

Cast glass boots are being supplied to the linemen of a power company in the middle west to protect them from shocks.

* * *

The DeNutt Power Co. have equipt all their engine room chairs with glass legs so the operatives in the generating plant may lean against the bus-bars without danger. That's comfort!

* * *

While drawing short-circuits on feeders it is suggested that dark glasses be worn to protect the eyes.

* * *

Special wet cells have been devised for use in "prohibition" states.

* * *

From close observation extending over a number of years an efficiency engineer has calculated that the depreciation on an electrical doorbell equipment is 163.3 per cent. the first year, decreasing some 23 per cent. each succeeding year for five years, the entire life of the usual outfit.

* * *

Acting on the well-known fact that a copper wire offers a certain amount of resistance, professors at St. Vitas College have attempted to remedy this by removing the copper from electrical conductors. No accurate data is available regarding the results, but we believe they have *not* been successful.

* * *

Babbit metal is not advised as an insulating filling for high tension transformers or spark coils.

* * *

An attempt to use one wire for feeder and return has failed, according to recent reports from Dubort, Mich.

* * *

A novel method of extinguishing an incandescent lamp under some conditions is to tap it with a small hammer. Two or three taps are usually sufficient to obtain the results desired.

* * *

The carrying capacity of a plug fuse may be appreciably increased by filling it with mercury.

* * *

Water turbine generating sets have been falling into disuse as watchfobs of late; steam plants seem to be taking their place in many localities.

* * *

By clamping the shaft of an ordinary electric fan in a vise and switching on the current a very interesting collection of by-products is thus formed.

MAZDA LAMP PRODUCTION.

In 1907 the carbon electric incandescent lamp business represented 99 per cent of the total sales; in 1916 the relative proportion between these lamps and the Mazda lamp has practically been reversed. The change has been brought about since the public has learned that the Mazda lamp will give three times the amount of light as the carbon lamp will give on the same amount of electricity.

Bronze Tablet to Mark First Edison Station in New York

TWENTY-TWO pioneers of the electric lighting industry assembled at the Electrical Exposition in New York City on October 18th to take part in the dedication of a tablet which is to mark the site, at 257 Pearl Street, of New York's *first electric central station*. Among the men were many who worked with Edison in laying out the original station and distribution system. Edison himself, however, was unable to attend the dedication—his work on the Naval Consulting Board taking up all his time.

Addresses were made by Boro President Marcus M. Marks, of Manhattan; Dr. George F. Kunz, president of the American Scenic and Historic Preservation Society; John W. Lieb, president of the National Electric Light Association; Reginald Pelham Bolton, Dr. Edward Hagaman Hall and P. C. Magnus, occupant of the building on which the tablet has since been placed. Arthur Williams, president of the Electrical Exposition presided.

A feature of the exercises was the gathering of 22 of the men who worked with Edison in establishing the first central station at 257 Pearl Street, where the tablet has since been placed. Some of these men are now executives of big electrical companies. All cheered enthusiastically when the announcement was made that their old boss, Al Edison, was too busy helping to win the big war to have time to attend the historic event.

Among the central-station pioneers who gathered at the reunion were William J. Hammer, Schuyler S. Wheeler, E. A. Harley, H. A. Campbell, Joseph Lee, A. T. Brown, O. J. P. Lang, A. E. Gilbert, W. J. Brown, J. F. Atkins, T. T. Wooley, Edward G. Acheson, Wilson S. Howell, Richard Darlington, Thomas Brown, W. T. Dempsey, Mrs. Nellie Curran, Andrew Brown, John W. Lieb, Arthur Williams.

The bronze tablet has since been erected at 257 Pearl Street, New York, marking the site of the first Edison electric lighting central station plant in America and commemorating the beginning of Edison service in the metropolis. The bas-relief at the top of the tablet shows the interior of the old Pearl Street station. (See also separate view of old station.) The generators, six in number, were each of 150 horsepower. The territory served by the station was only a square mile in area and the station began operation Sept. 4, 1882, at 3 P. M., with four hundred lights on the system, and on Oct. 14, 1882, about six weeks later, there were 85 houses connected, wired for 2,323 lamps.

In erecting the tablet, the American Scenic and Historic Preservation Society and the New York Edison Company have coöperated. On September 4, 1882, electric current was generated by the six 150-horsepower "Jumbo" dynamos, each dynamo weighing 60,336 lbs., or roughly 30 tons, and having a capacity of 1750-16 C. P. Edison lamps each. Up to the time of the construction of Edison's giant "Jumbos," two men could lift almost any other dynamo in the world. Today these dynamos would seem very small; probably even these pioneers with all their confidence and prescience never conceived how the force to whose generation this plant was devoted was destined to revolutionize the life of the city. Save Edison; for even before he perfected the incandescent lamps, which on that afternoon blazed out four hundred strong at the turn of the station switch, he had invented a motor modeled on the dynamo which he himself had also designed. In 1888 some printing presses on Pearl Street were operated by the strangely successful application of electricity and this

(*Con. on page* 647)

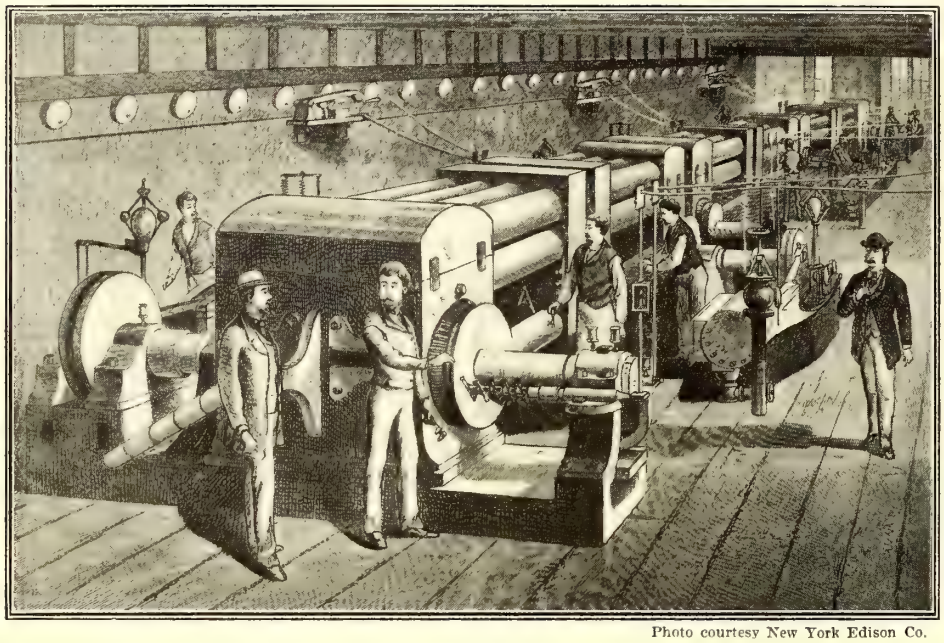


Photo courtesy New York Edison Co.

Interesting Picture of the First Edison Central Station in America, Which Was Officially Started Sept. 4, 1882, With a Load of Four Hundred Lights on the System. In Six Weeks' Time the Load Had Increased to 2,323 Lamps.

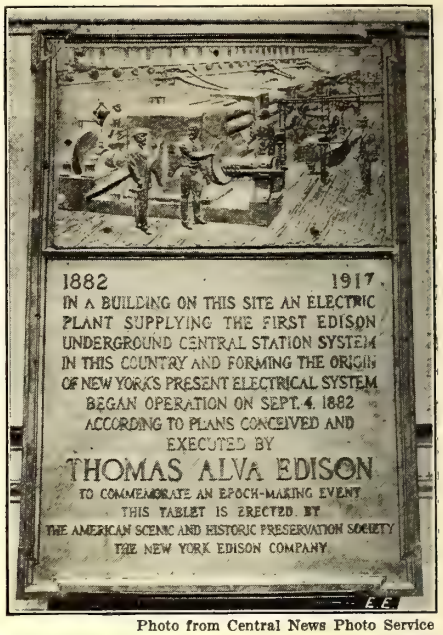


Photo from Central News Photo Service

Handsome Bronze Tablet Which Now Marks the Location of First Edison Central Station at 257 Pearl St., in New York City.

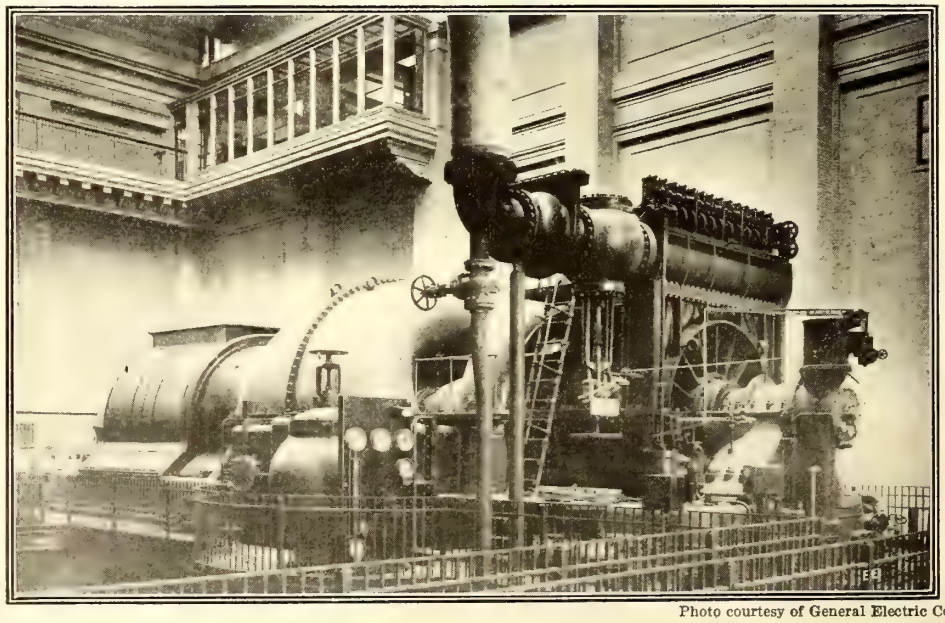


Photo courtesy of General Electric Co.

This Powerful Turbo-generator of Modern Type, Not So Much Larger Than the Early "Jumbo" Dynamos Shown Above, Develops 67,000 H.P. The "Jumbo," a Wonder In Its Day, Developed 150 H.P. Or 1-450 As Much.

The X-Ray on the Battle Front

AFTER many trials and tribulations it is indeed fortunate to secure the accompanying photographs showing a few of the great marvels being accomplisht in war-ravaged Europe by means of Röntgen rays, and we are

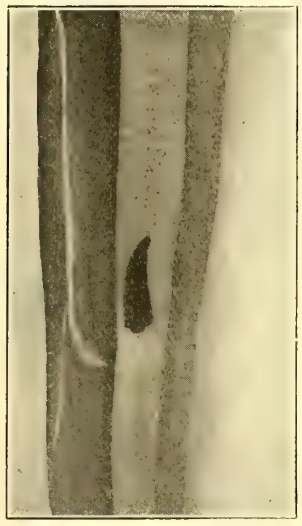


Fig. 4. The Case of Private "J. M.," B. E. F. The Bullet Fractured the Bone and Deflected to the Position Shown.

greatly indebted to Captain Dr. Thurston Holland of Manchester, England, for the Figs. 1 and 2 here shown. For every invention and appliance made to make the war's toll large, the Red Cross and Medical Units are equally struggling to alleviate the sufferings of the wounded and bring back to usefulness the shattered limbs of our heroes. All the photos are authentic and show real conditions as they exists at the present time.

We are indebted to Captain Dr. J. D. Morgan, of the British Army Medical Corps for Figs. 3 and 4, in archives of Radiology and Electrotherapy, London.

The greatest benefit probably comes from the ability of locating shrapnel, as this usually covers a wide area in the affected parts as shown in Fig. 1, a photo showing a shrapnel shell wound in the hand.

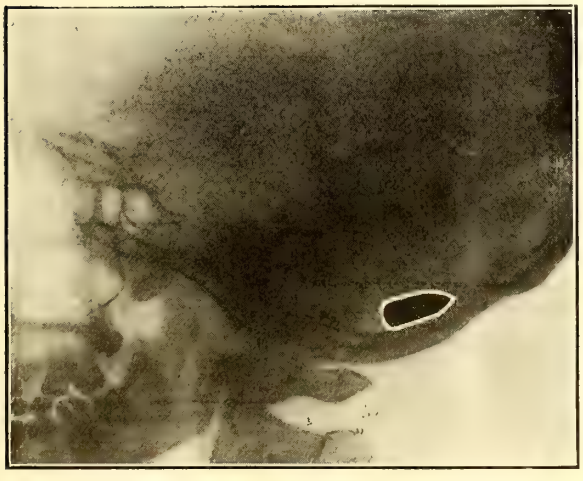


Fig. 2. "A Bullet in the Brain" Was the Diagnosis of the X-ray in This Case—and the Victim Lived.

A peculiar case is cited in connection with Fig. 2, the photo showing a bullet in the *brain.* A young officer was wounded in battle and in the rush and hurry at the advanced dressing station, the bruise on the head was taken for a slight scalp wound. While on leave, he complained of a pain in his head and decided to have the surgeons make a thoro examination, when to both their own and the officer's surprise, upon using the X-rays, it was found that he had been walking around with a *bullet in his brain.*

In Fig. 3, may be seen some of the terrible havoc that shrapnel is doing. In this radiograph the shattered bones may be seen and also the safety-pins which are holding the bandage around the hand and arm. Fig. 4 shows wherein the new methods of exact location of foreign bodies may be practically applied. The difficulty of estimating the depth of the bullet is obvious and the bullet is distinctly shown, also a fracture of the bone resulting most likely from the bullet striking same with resulting deflection.

Thru the courtesy of Dr. Sinclair Tousey of New York we give the folowing data on the new methods now being used in accurately localizing foreign bodies by X-rays, thereby eliminating all guesswork on the part of the surgeon when he starts to remove a bullet or other foreign body.

Localization by means of *radiography* presents no difficulty in the case of a finger. Here there are distinct, long land-marks and it is easy to take two pictures in planes at a right-angle to each other. And if we employ a ray vertical to the plate at the supposed position of the foreign body, the latter is so near the plate that no correction is required for the slight lateral displacement of its shadow, if not exactly at the spot where the ray is normal.

In many other cases two radiographs taken at right-angles are either impracticable or are totally inadequate, owing to the thickness of the part X-rayed, the absence of very accurate long land-marks and very often the great distance of the foreign body from the surface. In these cases radiographic localization resembles a problem in surveying like the exact localization of a point upon an island by observations from the mainland. The exact depth at which the foreign body is located is the difficult problem to be solved and solved quickly.

With this end in view some fifty-seven methods of radiographic localization have been publisht, many of them called forth by experience gained in the European war. The many methods employed may be said to follow somewhat the following general plan:—The patient is placed in an appropriate position in contact with the photographic plate, a small metallic *marker,* fastened to the surface of the body, shows in the picture and so does the foreign body; then without changing the position of the body relative to the plate, but with a measured displacement of the X-ray tube a second picture is made. The two positions of the image of the foreign body afford a means of determining the direction and distance of the foreign body from the spot where the metallic marker is fastened to the surface.

Or the finished picture may be laid on the table and above it are fastened two points in the positions occupied by the anticathode of the X-ray tube during the two exposures. From these two points threads are stretched to the two images of the foreign body and the juncture of intersection of these two threads is the point at which the foreign body was located when the pictures were made.

Dr. Tousey's localization method is new and distinctive, as well as a modification, of the above method. The apparatus required is:—A piece of galvanized iron netting measuring 8x10 inches and having meshes ⅛ inch square and the wire being of such a thickness itself that there are seven meshes to the linear inch. A single distinctive lead marker such as a small ring is also used as well as a set of lead numerals. There are also facilities for moving the X-ray laterally a measured distance

(*Continued on page* 636)



Fig. 1. "Explosive" Effect of Shrapnel Shell in the Hand. The Shell Splinters Are Clearly Visible in This Skiagram Taken At a British Base Hospital



Fig. 3. The Case of Private "W. D.," B. E. F. Showing What Happened When the Bullet Struck the Bone, Shattering It. Note the Bandage Pins.

HOW A GERMAN TELEPHONE OUTPOST LOOKS

The accompanying photo shows a German telephone outpost in operation on the Somme front. It is one of the first German pictures to arrive in this country since America's entry into the war.

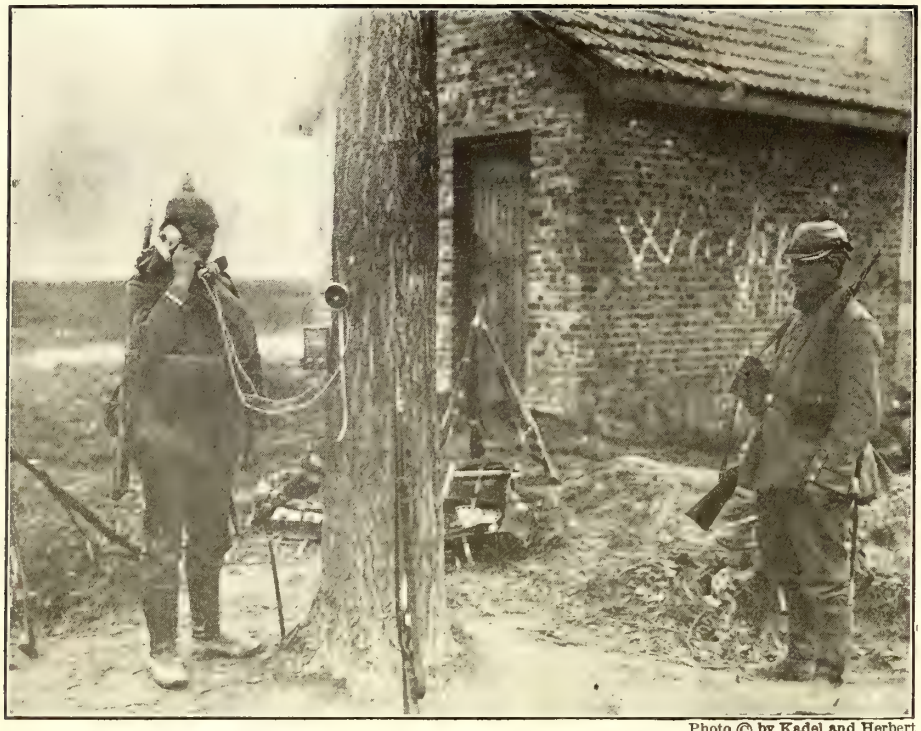


Photo © by Kadel and Herbert

One of the Few Recent German War Pictures to Reach the United States. This Shows a Typical German Telephone Outpost Near the Front Line Trenches. The Military "Telefon Vorposten" is a Fighter as Well as Electrician.

This photo shows only one of the many thousand German telephone outposts that are being used by the Kaiser's fighting legions on the Somme and other fronts. The military telephone linemen who install and maintain these front line instruments are all armed and often have to fight for their lives, as might be expected. In other words the *"Telefon Vorposten"* as he is called, is a soldier first and a telephone expert afterward. Some of these telephones are installed in dug-outs and shell holes even beyond the front-line trench.

It is really wonderful how the men of the signal corps actually contrive to place their listening posts right under the noses of the enemy. More often than not the telephone squad has to work its way from shell hole to shell hole, with ever-watchful snipers blazing away at them every time they expose their bodies. But the commanders must know at all times just what is transpiring all along the front and here we have our answer as to the supreme necessity of the telephone outpost here shown.

SPIES USING RADIO ON U. S. SHIPS?

In a statement recently issued the Patriotic Society, with headqarters in Washington, D. C., makes the flat declaration that German agents have been placed on American merchant ships for the purpose of betraying them in the submarine zone.

The wireless, it is charged, is used for this purpose, signals are flashed from port holes, a smoke pillar is employed by stoking the fires in a peculiar way, and at night a stream of sparks is substituted for the smoke by day.

Because of the situation which is declared to exist the society makes a plea for the manning of American merchant ships by the Naval Reserve. The statement says in part:

"German agents, it has now become certain, have been placed upon American merchant ships for the purpose of betraying them when the submarine zone is reached. These agents are German seamen, posing as neutrals, and neutral subjects in the pay of the Imperial Government.

"The wireless is frequently used to summon the U-boat to its prey. At night signals are flashed from port holes. In some cases the fires are stoked in such a way that a long, thick veil of smoke trails over the horizon marking the way of the ship. If the passage is made at night the firing is done in such a way that a shining trail of sparks point out the victim as clearly as if a giant searchlight had been turned upon her.

"Recently an oil steamer was sighted by a submarine. At a time when the U-boat was still at a distance, the fire crew deserted their post in a body. The men appeared on deck with life-preservers belted on, ready to take to the boats. An army officer happened to be on board. He looked at the oncoming U-boat, noted the distance she was away and calculated that there was still an opportunity to escape. At the point of the pistol he compelled the deserters to return to the fire room and the tanker was saved.

"The use that is made of the wireless on shipboard, however, is giving our navy men the most serious concern. Besides informing the submarines of the vessel's whereabouts the ship's wireless affords the German spy system an opportunity of communicating information of importance from the United States. Such messages can be sent within a few hours after any given vessel has cleared from an American port."

Anyone having information that would help the good work along should write the society.

A 30,500 MILE TELEGRAPH CIRCUIT.

During the World's Series baseball contest the Associated Press had its entire system of leased wires looped together at the various centers, so that the sending operator at the baseball grounds communicated directly with every newspaper served by the association. The mileage of the circuit was approximately 30,500 miles, or 500 miles longer than that of a year ago.

A HANDY PORTABLE LIGHTING OUTFIT

Difficulty is necessarily experienced in underground work because of the lack of light. This is particularly true of manhole work where the only natural light obtainable comes thru the entrance to the manhole from the street, and the limited amount of space is such that practically in every position a man works in a manhole he is bound to obstruct his own light. Because of this fact a good electric light is most essential and a portable light is the only practical one. The accompanying illustration shows a portable battery lighting outfit developed for just such a purpose.

This set is neatly and compactly installed in a small steel black enameled box. The equipment includes an Edison storage battery consisting of 5 cells completely assembled in a tray, fully charged, ready for immediate service, together with two properly guarded 12 C.P. lamps with reflectors and with eleven foot leads. One of these lamps can be used for 20 hours on one complete charge of the battery, constantly burning. Both of them will burn for ten hours.

Due to the use of the Edison storage battery no injury from overcharging or from complete discharging occurs. The electrolyte is a non-corrosive, alkaline solution; no acid being used. The manhole electric lighting outfit is a portable unit and for this reason the question of weight is most important. The outfit shown can readily be handled by anyone and carried an unusual distance without effort. The complete outfit, battery and all, weighs only 40 pounds.

The actual cost of maintenance and operation is really very small. The cost of upkeep on one battery for one year has been found to be less than 10 cents. By connecting a suitable number of batteries in series and figuring on a 10 cent rate per K.W. hour for current it costs less than 10 cents to fully charge each battery from a completely discharged condition.



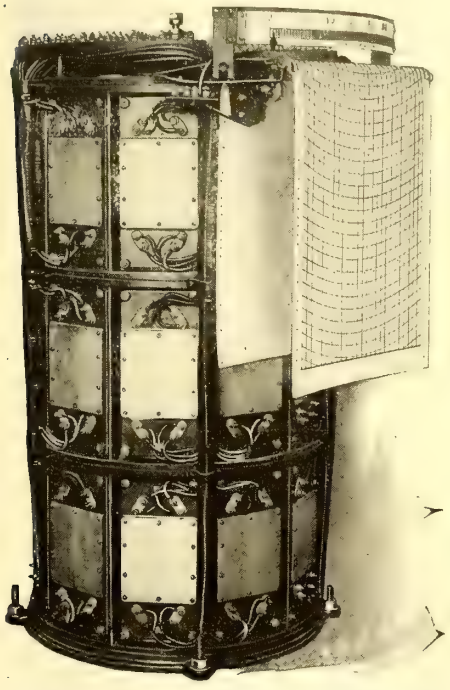
For Lighting Manholes, Cable and Pipe Tunnels, and a Hundred Other Places, This New Storage Battery Lighting Outfit Will Prove Ideal.

HUGE ELECTRIC METER RECORDS 250,000 KILOWATTS.

The largest graphic recording meter in the world is illustrated in the accompanying cut. It has a capacity of 250,000 kilowatts and is installed in the Keokuk plant of the Mississippi River Power Company. To meter the output of the thirty three-phase generators used in this plant required the use of thirty polyphase meter elements, each made up of two single-phase units. In carrying out the design of this instrument the desirability of using the same general design in other instruments was borne in mind, with the result that the supporting frame was made up of three sections as shown, each carrying ten polyphase meter elements, thereby making it possible to construct a similar instrument of ten elements or any multiple of ten up to fifty.

The induction type of meter element was adopted, after having devised an element capable of being calibrated mechanically for torque without effecting the correction for power factor. The moving element consists of six aluminum vanes, all mounted on a single staff, supported in such a manner as completely to eliminate friction.

All connections are carried to the top of the instrument to a circular terminal board carrying 240 binding posts, four being used for each single-phase meter element. The actual width of chart is 12.5 in. (31.8 cm.). The charts used are printed



Talking of Recording Electric Meters Compare this Giant, With a Capacity of 250,000 Kilowatts to Your House Meter. This Meter Is as Tall as a Man and the Largest Ever Built.

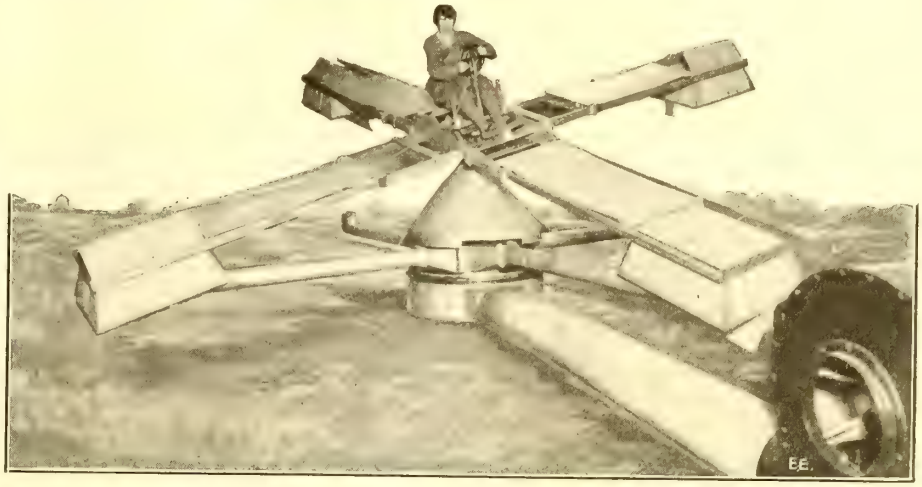
in twelve-hour sections and fed at the rate of 3 in. (7.6 cm.) per hour over two rollers, one of which carries pins for driving the paper and is rotated by means of a solenoid-operated ratchet connected in the electric clock system of the plant. The indicating scale which faces the system operator's desk is illuminated and graduated to the same range as the chart.

With an instrument of this type it is possible to totalize the output of a station of any capacity or a number of stations or systems, regardless of differences in frequencies, voltage and whether or not they are in synchronism, and instruments of the same type can be built for any number of circuits from five to fifty.

"Teratuter"—An Electrically Operated Flying Teacher

American inventive ingenuity has already solved the problem of speeding up the training of aviators. Considered scientifically, an aviator can move his aeroplane only in three dimensions while flying:—he can point it up or down, or prevent it from pointing up or down which is one; he can tilt it to the right or left, or prevent it from so tilting, which is two; or he can turn it to the right or left, or prevent it from turning, which is three and the limit of his control. From the combinations of these three movements, combined with the forces of the motor and gravity, "flying," with more or less proficiency, results.

The *Teratuter,* as the apparatus is called, was developed from the notion that if a man could be drilled to produce those identical movements with the identical wheels and levers that are used on an actual aeroplane, to the point where he could do it *instinctively* with the precision and speed of the accomplisht aviator, and the drilling done on a dummy aeroplane mounted to go thru a full range of the aeroplane's movements, much expensive flying practise would be dispensed with. The Teratuter is operated by a powerful blower driven by an electric motor.



The Powerful Electrically Driven Blower Seen At the Extreme Right Produces Strong Air Currents Which are Caused to Alternately Blow Against the Four "Wings" of This Aviation Teaching Machine So As to Reproduce Actual Flying Conditions.

Most of the more proficient of the world's famous aviators attained their wonderful control of the aeroplane by sitting in their machines, closing their eyes, and persistently operated their controls in long imaginary flights.

Aside from the field value of the Teratuter, it can be erected in college buildings to accompany the theoretical training of those who are to become officers in aviation corps. The one in the illustration, (the first one invented) is an accessory of a New York flying institution.

To make the device as realistic as possible, it is operated by a great volume of comprest air. The inventor, himself an aviator, has adjusted the aeroplane members which produce or correct the Teratuter's motion to be about equal to the movements of a real aeroplane flying in a 40 mile per hour wind.

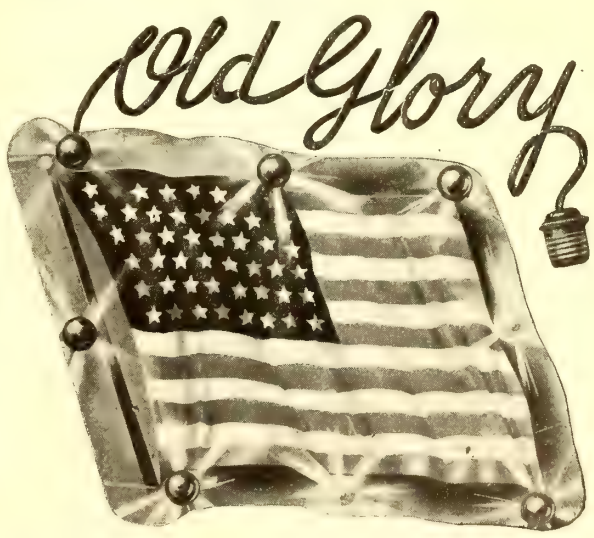
ILLUMINATED FLAG PROVIDES HANDSOME DISPLAY.

Everyone wants to show his patriotism now. Everyone can now show the colors night and day with this handsome electric flag. The flag is mounted on heavy board 12 x 18 inches with easel and hanger, and is equipt with Mazda lamps and six foot leader cord. It can be put in the window, the doorway or a dozen other appropriate places and provides a good advertisement as well as patriotic display. It is particularly well adapted for residence decorations and looks well in the front window of any house or apartment.

ONE TON OF METER JEWELS.

One ton of saffires will be used during the year 1917 in one factory where the jewelled bearings of electric meters are made. The jewels are purchased in the rough and are put thru finishing and drilling processes which require a degree of skill comparable only to that of an experienced watchmaker.

Three thousand electric fans are to be used on the cargo handling ships which are now under construction for the United States shipping board.



One of the Latest House and Show-Window Decorations Is This Electrically Illuminated Flag. It Is Small Yet Distinctive and Attractive.

Modern Physics and the Electron

How Professor R. A. MILLIKAN, the brilliant American Scientist, made the "Electron" visible and how the electrical dimensions of the "Electron" have been measured

IF you have any respect for my subject or any respect for me, you will not expect me to outline in the space of one brief hour the work of modern physics. It is utterly impossible to do, and I can say that without affecting an inordinate egotism.

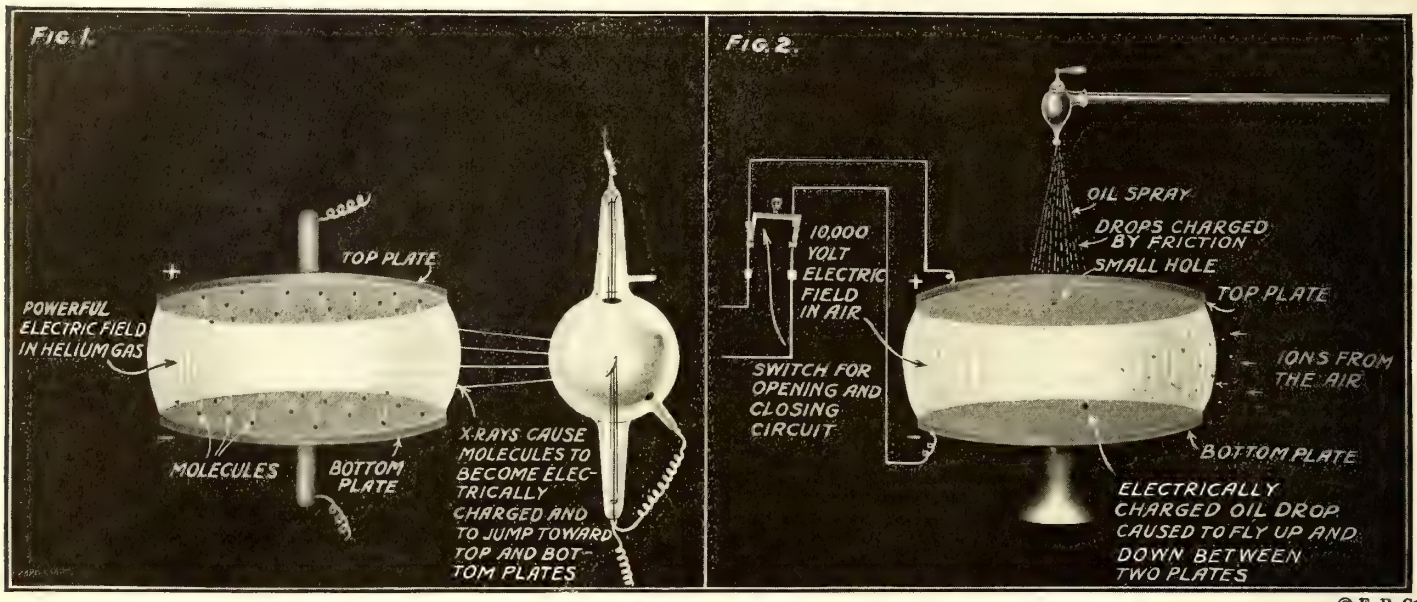
The spirit of modern science is something relatively new in the world's history, and I want, as an introduction to the main address, to give an analysis of what it is. I want to take you up in an aeroplane which flies in time rather than in space, and look down with you upon the high peaks that distinguish the centuries, and let you and me see together what is the distinguishing characteristic of this century in which we live. I think there will be no question at all, if you get far enough out of it so that you can see the woods, without having your vision clouded by the proximity of the trees, that the thing which is characteristic of our modern civilization is the spirit of scientific research—a spirit which first grew up in the subject of physics, and has spread from that to all the other subjects of modern scientific inquiry.

That spirit has three elements. The first is a philosophy, the second is a method, and the third is a faith, said Prof. R. A. Millikan recently before the *American Institute of Electrical Engineers* at New York. Look first at the philosophy. I say that is new for the reason that all primitive peoples, and many that are not primitive, have held a philosophy that is both animastic and fatalistic. Every phenomenon which is at all unusual or for any reason not immediately intelligible used to be attributed to the direct action of some invisible personal being. Witness the peopling of the woods and streams with spirits by the Greeks; the miracles and possession by demons of the Jews; the witchcraft manias of our own Puritan forefathers, only two or three hundred years ago.

Now, that a supine fatalism results from such a philosophy is to be expected, for according to it everything that happens is the will of the gods, or the will of some more powerful beings than ourselves. And so, in all the ancient world, and in much of the modern also, three blind fates sit down in dark and deep inferno and weave out the fates of men. Man himself is not a vital agent in the march of things, he is only a speck, an atom which is hurled hither and thither in the play of mysterious, titanic uncontrollable forces.

Second, as to the method of science, it is a method practically unknown to the ancient world; for that world was essentially subjective in all its thinking and built up its views of things largely by introspection. The scientific method on the other hand is a method which is completely objective. It is the method of the working hypothesis which is ready for the discard the very minute it fails to work. It is the method which believes in a minute, careful, wholly dispassionate analysis of a situation; and any physicist or engineer who allows the least trace of prejudice or preconception to enter into his study of a given problem violates the most sacred duty of his profession. This present cataclysm which has set the world back a thousand years in so many ways, has shown us the pitiful spectacle of scientists who have forgotten completely the scientific method, and have been controlled simply by prejudice and by preconception. (Referring to the World-War.)

In the mystical, fatalistic ages which preceded, electricity was simply the agent of inscrutable Providence; it was Elijah's fire from Heaven sent down to consume the enemies of Jehovah; or it was Jove's thunderbolt hurled by an angry God; and it was just as impious to study so direct a manifestation of God's power in the world as it would be for a child to study the strap with which he is being punished, or the mental attributes of the father who is behind the strap. It was only one hundred and fifty years ago that Franklin sent up his famous kite, and showed that these thunder bolts were identical with the sparks which he



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Fig. 1. If We Have Two Plates With an Electric Field Between Them and Nothing Else but a Monatomic Gas Like "Helium," Then This Gas Remains Stagnant When the Field Is Thrown On. A Beam of X-Rays Shot Between the Plates, However, Causes Some of the Molecules to Become Electrified and to Jump Toward the Plates, This Effect Being Measurable.

Fig. 2. Using Two Plates Charged With 10,000 Volts, It Became Possible to Isolate a Single, Minute, Charged Oil Drop and to Alternately Move It Up and Down by Switching the Electric Field On and Off. This Oscillating Particle Was Found to Attract Ions From the Air, Signaling Each Capture to the Observer by the Change in Its Speed in the Field.

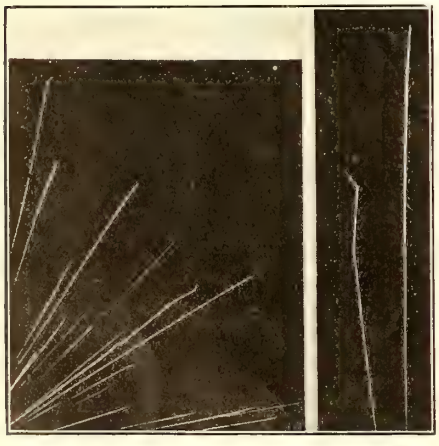


Fig. 3. Actual Photographs of the Tracks of "α"—Particles Shooting Thru the Air. We Now Know That These "α"—Particles Do Not Penetrate the Air After the Manner of a Bullet, i.e., by Pushing the Molecules of Air Aside, but Rather That They Actually Shoot Thru All the Molecules of Air Which They Encounter. An "α"—Particle Would Have to Make About 500,000 Such Passages Thru Molecules in Traversing 2.75 Inches of Air.

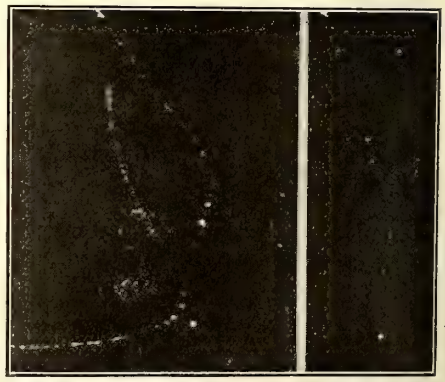


Fig. 4. Here Are Actual Photographs of "h"—Particles Shooting Thru Air. Cut At Right Shows Track of Very High Speed "h"-Ray. This Particular Particle Shot Thru On an Average as Many as 10,000 Atoms Before It Came Near Enough to an Electronic Constituent of Any One of These Atoms to Detach It From Its System and Form an Ion. This Shows That Electronic Constituents of Atoms Can Occupy but a Very Small Fraction of the Space Inclosed Within the Atomic System.

could draw on a winter's night from his cat's back.

And at the end of the nineteenth century there were many of us physicists and engineers who thought that all the great discoveries had been made. It was a common statement that this was so. I heard it publicly made in 1894, and yet within a year of that time I happened to be present in Berlin at the meeting of the Physical Society at which Röntgen showed his first photographs, and since that time we have had a whole new world, the very existence of which was undreamed of before, opened up to our astonished eyes.

We have found a world of *electrons* which underlies the world of *atoms* and *molecules* with which we had been familiar, and the discoveries in that world have poured in so rapidly within the last twenty years that there are no two decades in human history that compare at all with them in the rapidity of the advance. And these discoveries have been made too for the most part by groups of men interested merely in finding out how nature works. They have been made almost exclusively by college professors; and for ten years they remained the exclusive property of these professors. What has happened in the last ten years? The industrial world has fallen over itself in the endeavor to get hold of these advances, and by their aid it has increased ten-fold the power of the telephone, it has obtained four or five times as much light as we got a few years ago out of a given amount of electrical power, it has developed new kinds of transformers the existence of which was never dreamed of before—all these things are coming *now,* it is not in the distant future, that we are going to find the applications; we have found in the last five years a great quantity of them, and how many more are going to come, no man call tell.

Finally, before launching upon the sea of recent discovery, I wish to make one more remark about the method of science, namely this: The progress of science is almost never by the process of revolution. You see a great deal in your newspaper headings about revolutionary discoveries. They almost never happen! Thus when the atom was found not to be an ultimate but a divisible thing, there was no revolution, there was not a single law that had to be given up. We had simply opened up a new field, tapt a new lead, found an unexplored region, a sub-atomic region, and all that was above it remained just exactly as it had been, and no chemist had any occasion to be disturbed, for the chemist's laws were just as precise as they had been before. Sometimes we do indeed find that we have generalized too far, and that some law which we had supposed to be of universal application is limited in its scope, but this does not alter the fact that the growth of science is in general by a process of accretion, almost never by that of revolution. Once in a while we have something revolutionary, but not often.

We may aptly characterize the physics of the last twenty years as the physics of atomism, and the first discovery on my list is the recent verification of the adumbrations of the Greeks regarding the atomic and the kinetic theories—the proof that, as Democritus had imagined 500 B. C., this world does indeed consist, in every part of it, of matter which is in violent motion.

Up to within six years there were not a few distinguished scientists who withheld their allegiance even from these atomic and kinetic theories of matter. The most illustrious of them was Professor Wilhelm Ostwald, but in the preface to a new edition of his *Outlines of Chemistry* he now says frankly:

"I am convinced that we have recently become possest of experimental evidence of the discrete or grained nature of matter for which the atomic hypothesis sought in vain *for hundreds and thousands of years.* The isolation and counting of gaseous ions on the one hand. . . . and on the other the agreement of the Brownian movements with

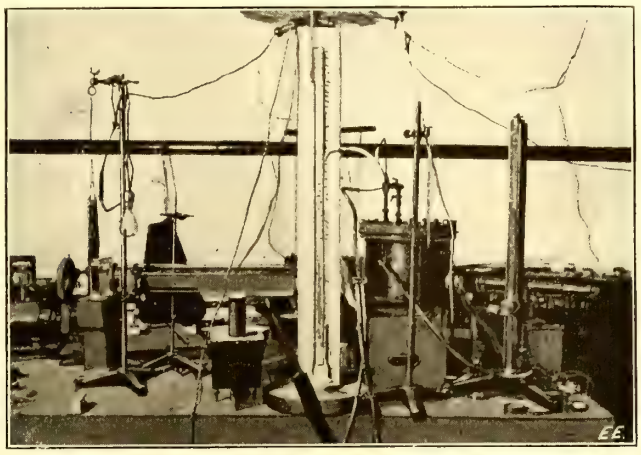


Fig. 5.—The Precision Apparatus Used by Prof. Millikan At the University of Chicago Laboratory For Determining the Physical and Electrical Constants of the "Electron." The Condenser Plates (See Figs. 1 and 2, Also Fig. 6 Below) Were Made With Surfaces Polished Optically to Such an Accuracy That the Error Was Less than One Part in 10,000.

kinetic hypothesis. . . . justify the most cautious scientist in now speaking of the experimental proof of the atomic theory of matter. The atomic hypothesis is thus raised to the position of scientifically well-founded theory."

I think you all know what the Brownian Movements are but I wish especially to call attention to the fact that this advance was made not by a practical man, but by a man who never did any experimental work in his life, Einstein, a mathematician, a man who was capable of analyzing a theory and predicting results, and the experimentalists have checked those results. The results consists in predicting how far a given particle that you can see in an ultra microscope will drift in a given time, and our own experiments have checked this prediction to within one-half per cent. It is that sort of evidence that has convinced Professor Ostwald of the correctness of

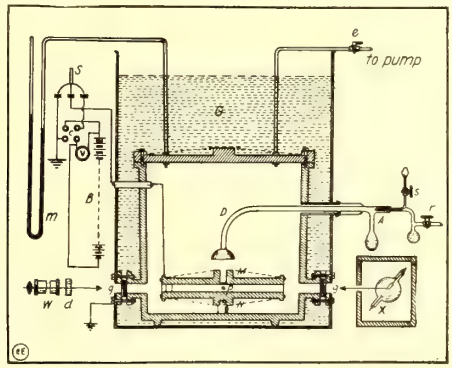


Fig. 6.—Sectional View of the Millikan Apparatus For Measuring the "Electron." Temperature is Kept Constant by Oil Tank G. Oil Spray Is Produced by Atomizer A, the Droplet Entering Between Plates M and N, Thru Tiny Hole in Top Plate. Light From an Arc Lamp Passes Thru Heat Absorbers W and D, Enters Thru Glass Window g, and Illuminates Droplet P. Additional Ions Are Produced About P, by X-rays From the Bulb X. A Special Microscope Enables Close Observation of the Droplet, As Prof. Millikan Explains In His Work—"The Electron."

the new kinetic and the atomic theories.

The second advance is the proof of the divisibility of the atom, a proof which grew out of the discovery of X-rays. Let me tell you how. If you have here two plates (Fig. 1.) with an electric field betwen them, and nothing else but a monatomic gas like *helium,* then it is found that when the field is thrown on the helium is perfectly stagnant, but when a beam of X-rays is shot between the plates *some of the molecules become electrically charged and begin to jump, some of them toward the upper plate and some toward the lower plate,* where their presence can be detected by an electrical measuring instrument. What does that show? It shows that the thing which we call an atom has electrical charges as its constituents; and the history of the last twenty years in physics has consisted pretty largely in determining what are the properties of these electrical constituents.

The third is the discovery of radio-activity, which occurred just a little after the discovery of X-rays. And here again we found matter doing things we had never dreamed it was doing viz: shooting off from itself both negatively and positively charged particles, the negatives with a speed which may approach close to the velocity of light, 186,000 miles per second, and positives with a speed of one-tenth of that, or 18,000 miles. The fact that such speeds could be imparted to projectiles of any kind was undreamed of twenty years ago.

The fourth discovery that I wish to mention is the discovery of the atomicity of electricity, the proof that the thing we call electricity is built up out of a definite number of specks of electricity, all exactly alike, and that what we call an electrical current consists simply in the journey along the conductor of these electrical specks, which we may call with perfect justice definite *material* bodies. Now, I can give you in just a word the proof of that statement. There are half a dozen ways in which it could be approached. I will mention the one with which I am most familiar, because it is the particular proof which we worked out at our (University of Chicago) laboratory.

We took these plates with a field of 10,000 volts between them, with a little hole in the top plate, and we blew an oil spray above the top plate so as to get an electrically charged body just as small as we could, for we expected that the frictional process involved in blowing the spray would charge the drops, which it was found to do. (Fig. 2.) We let one of those drops come into the space between the plates and then moved it up and down by an electrical field, throwing on the field as it came close to the bottom plate, and throwing it off as it approached the upper one, and so we kept that oil drop going up and down between the plates, in the hope that it would capture some of the ions which we knew existed in the air, put there by radium or other agencies. The drop met our fullest expectations as a police officer capturing ions frequently and signaling the fact of each capture to the observer by the change in its speed in the field.

For the oil drop is an electrically charged body, and in a given field it moves with a definite speed. If, however, it captures an ion, its charge increases or decreases, and hence its speed increases or decreases. If the charges on ions are all alike, then we can only get one particular change in speed. If the charge that is already upon it, put there by the frictional process, is built up

(*Continued on page* 643)

NOW FOR THE ELECTRICAL RAZOR.

We are truly living thru an electrical age and there is a never-ceasing demand for new inventions driven by electricity. Here we are offered the electric razor that is said to remove the beard, without the pull, with a smoothness that cannot be equaled.



The Electric Razor Is the Newest Novelty. Its Plug Terminal Fits Any Lamp Socket. It Combines a Massage and a Smooth Shave At the Same Time. It Actually "Cuts" the Hair Off.

To the busy man, when time means money as well as to the man who cannot shave himself, this machine will appeal. It can be used without electricity, the same way as any razor.

The construction of the electric razor is very simple: A vibrating motor is stationed in the handle wound with enameled wire which is water-proof. The head is made of the best treated steel.

With the new electric safety razor the blade vibrates 1,200 times a minute *and actually cuts the hair* instead of pulling; and there is no need of the necessary side stroke that must be used in the common safety razor. The new razor has the effect of both a shave and *massage*, leaving the face with the most pleasant feeling that is not possible without the vibrating effect here produced.

To shave with the electric razor is the same process as shaving with any razor, except that you connect the cord with a light socket and turn on the switch when beard is lathered. The device runs with alternating-current, but the makers are perfecting a direct-current type.

JAPANESE SUPERSTITIONS AND THE TELEPHONE.

The Japanese, like many Americans, believe there is luck in certain numbers, and are willing to go to great lengths to gain the protection of these lucky symbols.

A single figure telephone in Tokio sells for from 800 to 1,000 yen ($390 to $490) a year. The luckiest number in the estimation of business is eight, because the character for it spreads downward and suggests the idea of gathering prosperity. Number 753 is also believed to be a lucky number, because children are presented at Shinto shrines on their third, fifth and seventh birthdays. Indeed, odd numbers are lucky. Three-figure numbers are not objectionable, if they are as easy to remember as 123 or 555.

The most unlucky numbers are 42 and 49, because the former may be pronounced "shini," which means "to die," and the latter may be pronounced "shiku," which means "death" and "suffering." Therefore, it is said that those numbers are avoided by individuals and generally taken by government officers, schools, police stations, and other invincible institutions.

You Sign Your Name on This Time Clock

A new electric time clock recently patented and now being placed on the market is illustrated herewith. The invention in question is a new time recording device that "cannot be beat." We are all accustomed to seeing the big clocks with their hundreds of card racks, in working establishments, these racks being an entirely cumbersome and unnecessary item. Besides, who hasn't heard of the numerous ideas and schemes employees evolve to defraud the company by having a friend ring up their number for them.

Then again big corporations keep tabs on their hundreds of workers, whose time is only a small consideration, yet allow the big directors and various officials to come and go at leisure, whose time may be many times more valuable and expensive to the firm!

Therefore, it is of value to know and be sure that important persons in your employ are punctual and arrive on time to transact your business, otherwise many an important order may be lost by an executive being late.

Wherefore we have the "Signograph" perfected by Mr. H. Hartman, of New York.

The machine itself is of small and attractive construction taking but little space on the wall or desk, measuring only 9 inches long, 7 inches wide and 3 inches deep. It is made entirely of metal, black enameled. Its heart is an eight-day clock



The Time Clock That Can't Be Beat. It Automatically Registers the Day, Hour and Minute That You "Sign" Your Name. It Can Be Electrically Connected to Store Doors, Etc.

movement attached to the mechanism.

Attached to the clock is a large wheel on which are the figures for the hours of the day and night. Arabic figures show the time A. M. and Roman figures designate the time P. M.

Being named the "Signograph," it means exactly as its name implies. In the front of the device is a small glass door. When the person desires to record time, he or she simply opens the door. Immediately the door is open a record is made inside the machine by a device on the door hinge which presses the paper against the type wheel containing the hour numerals; then the person signs his or her signature, as the case might be, closes the door, moves the paper up and the trick is done! Very simple and yet effective, as a written evidence is obtained of the party being on time.

The eight-day clock movement can be wound from the outside, while the machine can be opened by one possessing the key for the purpose of changing records; these consist of a continuous strip of paper 3 inches wide, which shows at a glance the signatures thereon with accurate *day, hour* and *minute* printed opposite each signature.

The instrument has no complicated mechanism to get out of order and is constructed along lines that avoid every shock or sudden vibration which could affect the clock. Not only all this, but the clock can be fitted with an automatic electrical device that will register the time when a person opens or unlocks the door of an establishment, thereby showing the exact hour and minute at which the responsible party arrived.

Taking the device as a whole it appears to be a 100% efficiency machine, and a necessity to almost any class of business. By referring to the photos a clear idea of the entire mechanism may be obtained and will prove that this machine can't be beat.

WIRELESS COURSE AT UNIVERSITY OF WISCONSIN.

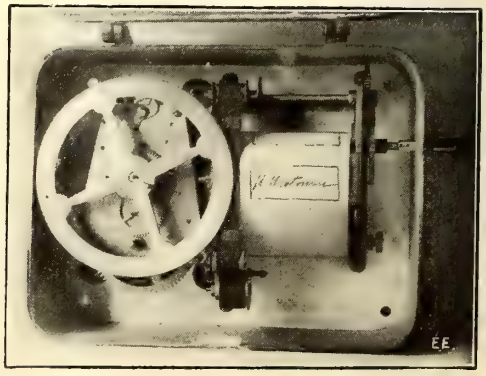
Wireless telegraphy, with special application to war service, has now been made a regular course at the University of Wisconsin. A number of students worked independently in the university radio station last year and during the summer session a course for operators was given, but university credit for the work is given for the first time this year.

The radio station at the university is one of the few to be left in operation after the declaration of war because war research is being carried on with the station apparatus. Lieutenant Taylor, radio communication superintendent at the Great Lakes naval training station in Illinois, recently visited the Wisconsin station and made a number of tests. An officer from the naval station will be in the university this year to carry on tests with the Great Lakes station.

The mathematical theory of electricity and magnetism as related to wireless telegraphy will be given careful study in the new course as well as a detailed study of the apparatus itself. The students will also have a chance to become expert operators.

A review of general physics, a special study of transformers and oscillating currents and their application to sending and receiving apparatus, as well as a careful study of special forms of sending sets, will be included in the work. The course will continue thruout the year.

It is estimated that this year's business in electric ranges will be in the neighborhood of $3,000,000.



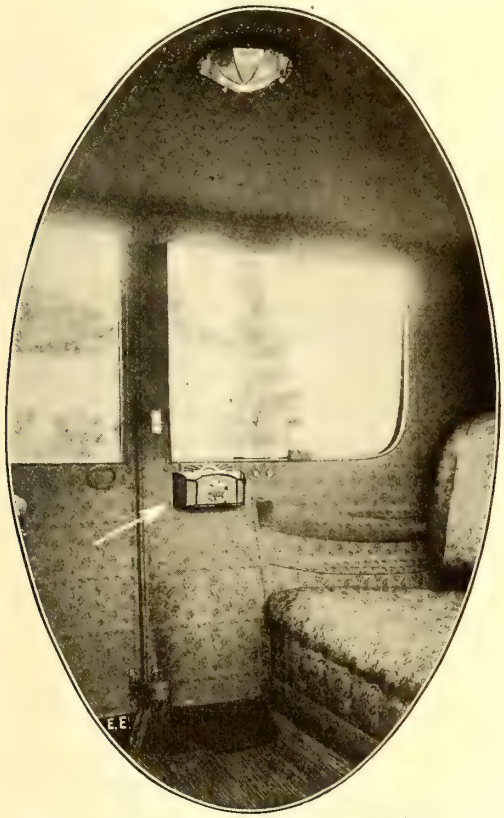
Interior of New Time Clock, Showing Record of Signature on Clockwork Driven Paper Roll and "Time" Typewheel At Left.

Novel Applications of The Dictograph

PEOPLE will not cease wondering at the seemingly marvelous and uncanny way conversations are picked up by the Dictograph, the original supersensitive microphone.

In its secret service adaptation, it is used by the U. S. Department of Justice, the Army and Navy, and governmental, state and municipal police authorities for securing the evidence wanted, when any other method would have failed. Numerous cases might be cited, the one most prominent in the public eye being the recent dynamiting cases of the McNamaras.

Then again, in business its application in interior inter-communication has proved a big help. By the aid of a "master station" a busy executive is able to hold instant communication with his stenographer, superintendent or factory, hold conferences, know exactly what is going on and never have to leave his desk; or he may walk around the room, file papers, etc., and still be able to converse with whoever is at the other end just as if they were in the room.



The Loud Speaking Telephone or Dictograph Has Found Its Way Into the Motor-Car World. Many of the Best Cars Are Now Regularly Equipt With This Convenience (See Arrow), Permitting One to Give Directions to the Chauffeur Without Moving.

But by far the greatest boon to mankind of this invention has been its adaption in aiding deaf people to hear, thereby making them more efficient and useful, and also lessening the chance of accidents.

To church and theatregoers it has also proven of great merit—heretofore deaf people could only see the show or sit dumbly in church, but by this application of the dictograph they are now enabled to secure seats which are equipt with receivers adjustable to each individual and hear everything that is said, not to mention the enjoyment of the music and singing.

In the first illustration may be seen the very latest application of the microphonic principle—to help Uncle Sam win this war with flying machines. Heretofore the training of men for the flying corps and their work on the battlefield has been hampered thru lack of adequate means of communication between the pilot and observer—thereby necessitating them to return to the ground before they could give any detailed or elaborate directions to one another or make changes in their plans.

This new system consists of a special headgear which is strapt over the regular helmet. In the back of the same is set a dictograph so that it is always in the vertical position; from this a tube leads downward to a specially constructed mouth-piece, to be strapt in place over the mouth.

A stop-cock regulates the sonority of the voice which is allowed to reach the dictograph—a special cable is run between the two seats and to which both operators attach their plugs. It is believed that this method will supersede all previous efforts in this line. Those who have never been up in a flying machine of modern type, which speeds along at a velocity of from 60 to 120 miles per hour at times, have no real conception of the physical action on the aviator. His face is often distorted by the terrific air pressure—his cheeks are pushed inward until they are hollow. And oftentimes he can just barely speak, owing to the severe cold, which fairly petrifies the skin and flesh. This condition was mentioned to the writer by a member of the Royal Flying Corps of Canada.

The interior view of the limousine shows the dictograph serving as a means of communication between the occupants of the car and the chauffeur, without the necessity of anybody moving their position or holding speaking tubes. Just press the button—talk in a natural tone—and the chauffeur hears every word clearly and distinctly. This type of equipment will be found on almost every car of note this season, among which may be named the following representative ones: Packard, Cole, Cadillac, Hudson, Pierce-Arrow, Winton, Chalmers and Willys-Knight.

Perhaps the most interesting and novel application of the dictograph is the installation in a very popular Broadway rendezvous—the "Palais Royal." In the ballroom, where diners and dancers wile away their hours, the management has had placed around the pillars carefully concealed horns. Near the orchestra, a number of special dictographs are placed, with wires leading to the cabaret performers' dressing rooms. When the music commences it is carried to the dressing rooms and the artists sing into transmitters which are connected with the horns in the dining room, causing the singing to come from a seemingly mysterious source, much to the amazement of the patrons.—GEORGE HOLMES.

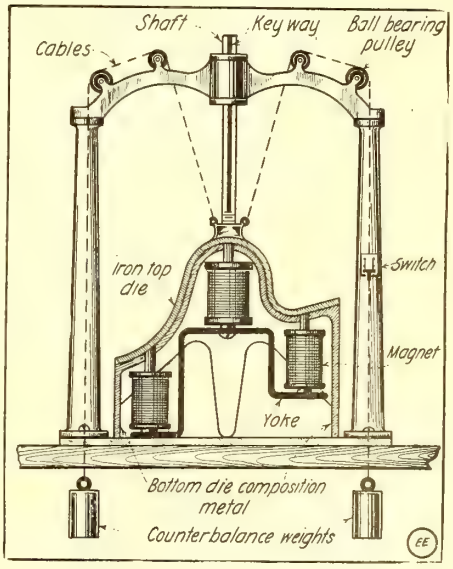


U. S. Aviators Are Being Supplied With the New Dictograph Here Shown, for Carrying on Conversation With a Second Officer, While in Flight. The Engine Noise and Wind Make It Difficult to Talk Otherwise.

A "MAGNETIC" HAT DIE.

By John P. Buckley.

The present hat-making machines are operated by hand and require a very strong and skilful man to operate them. I show herewith drawing of a "magnetic" hat die which dispenses with the press entirely. It is composed of the usual two members, the lower and upper die. The lower die is made of non-magnetic metal and is provided with one or more magnets, the respective poles of which pierce the frame of the die and even out smoothly with the outer surface; the upper die being of iron, when placed over the lower die acts like an armature, and, in becoming attracted, presses and heats the material to be shaped.



A New Hat-Die In Which the Moving Form is Pulled Against the Fixt Plate by Means of Electro-Magnets.

A girl may operate several of these machines or dies at one time.

OUT-LEVITATING BACHELET!

While in Manchester, England, recently I came across considerable local enthusiasm for gas-driven vehicles. I heard of one optimist who is working night and day to solve the problem with "comprest gas." His efforts, however, pale before those of a super-gas merchant who believes in the flexible holder on the roof; the chief plank in his platform is that when the holder is full there is a levitating effect which takes a lot of the weight of the vehicle off the tires and increases their mileage. Shades of Bachelet, what next!

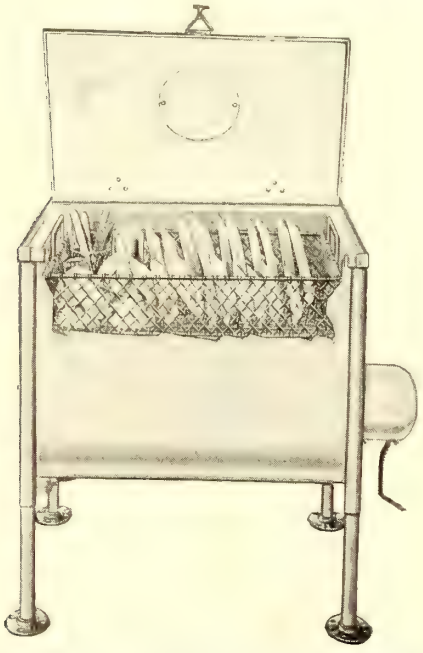
DISHWASHING BY ELECTRICITY.

Who wants to wash dishes? Answer—Nobody. Therefore and hence we have with us today the electric dishwasher here portrayed.

Under the basket containing the dishes as shown in the picture, is a square shaft to which are attached propellers or scoops. This shaft is connected directly to an electric motor by means of a spur gear. As the shaft is revolved at approximately 600 revolutions per minute, the water is thrown with great force upward and around the dishes in the basket. Every surface is cleansed and every trace of food particles, grease and accumulations of any kind removed. Breakage is practically impossible for the reason that the hot water comes in contact with all surfaces, inside and outside, at the same time and the expansion is fairly equalized.

There has been considerable agitation in recent months concerning the dangers of careless dishwashing and authorities agree that the only thoroly safe method is the machine method where practically boiling water can be used.

This electric dishwasher is of very rigid construction. The body is 24 gage steel—all joints and corners are welded—the legs are standard 1 inch wrought iron pipe, securely welded to the angle iron frame work—the propellers are riveted to the shaft and all parts are rust-proofed. The electric motor is enclosed with the housing

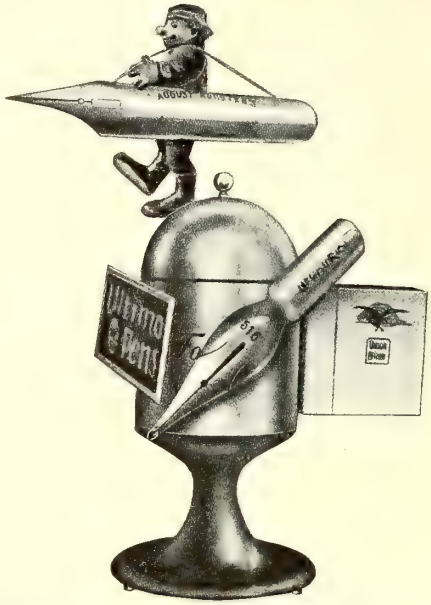


Mother and the Girls May Now Rejoice, for Here's the Genie That Washes the Soiled Dishes By Electricity. And It Never Wants a Day Off.

which the picture shows, protecting it from splashing, and also safe-guarding the children. The finish of the machine is baked-on white enamel.

A MYSTIC WHIRLING SHOW WINDOW ATTRACTION.

A distinct and startling novelty shown at the recent Electrical Show held at New



Pens, Boxes, Figures, Everything, Stick to This Mysterious Cylinder and Whirl Around It in a Fascinating Manner.

York was a whirling display which attracts electrically every variety of small object. Toy automobiles tour its circular surface, miniature yachts ride its metal sea with even keel, handkerchiefs, papers of pins, everything it is possible to purchase in a ten-cent store, cling to its electrified surface and attract the eye of the passers-by. H. J. Herberts, inventor of this selling device, placed his first contract with a German firm just before the war. As a result the first 10,000 made were confiscated by the German Government for the brass and copper they contained, and the inventor had to come to America and begin all over again. The machine is fully protected by patents.

This remarkable advertising device consists of electrically driven apparatus inclosed in a plated metal jacket and dome, upon which the goods are made to revolve without any visible means of suspension while the external part of the apparatus is quite stationary. No hooks or wires of any sort are employed. The approximate dimensions of the device are 24 in. high and 9 in. in diameter. Articles of unusual shape take peculiar lines of travel about the smooth metal cylinder, rolling over and over as they go.

RADIO TELEPHONY IN JAPAN.

The Institute of Radio Engineers held a meeting on Wednesday evening, November 7, in the Engineering Societies Building, New York, at which Mr. Eitaro Yokoyama, engineer of the Ministry of Communications, Tokyo, Japan, presented a paper on "Some Aspects of Radio Telephony in Japan." The paper contained an interesting summary of the little-known work which has been done in this field in Japan.

WIRELESS LOST BATTLE.

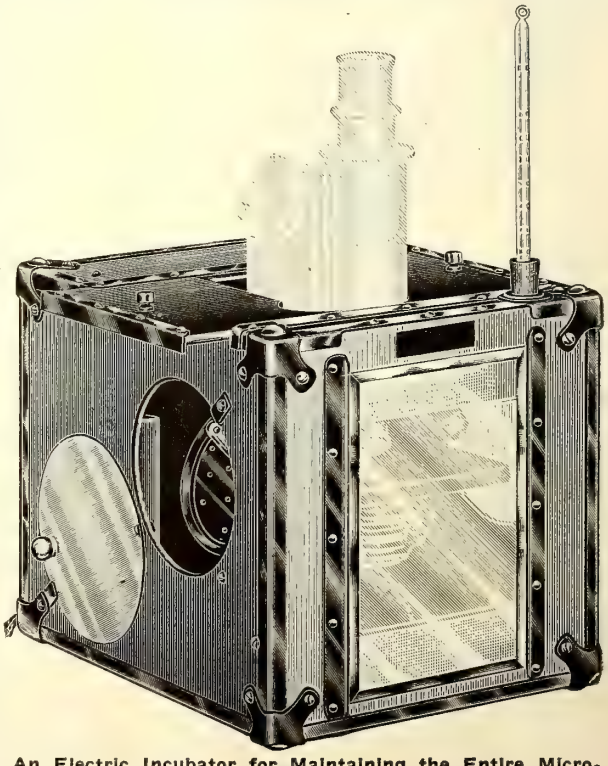
Great events turn on very small incidents. It is now given out that the reason the Germans were defeated in the battle of the Marne was largely because one of the commanding officers did not know enough about wireless telegraphy to know that the big instrument on Eiffel tower in Paris was picking up his messages as fast as he sent them back to German headquarters. As a result the French army was enabled to make preparations which turned the tide of battle against the Germans on the Marne. The German general was an expert fighter but he had not kept up with the modern progress of inventive genius in the development of wireless telegraphy, and consequently because of this lack of knowledge it is now given out officially that the battle was lost to the Germans. (*A very pretty tale, but incredible.*—EDITOR.)

THE ELECTRIC MICROSCOPE INCUBATOR CLEVER INVENTION.

For those desiring to make a special study of Micro-organisms at blood temperature for any length of time, there is now available a specially constructed incubator, in which the entire microscope may be placed. The illustration shows how this is accomplisht. To place the microscope in the incubator the two sliding doors on the top are pulled out and afterwards pushed back until they fit tight against the microscope. Both sides are provided with hand holes, which enable the operator to manipulate the microscope in the ordinary way. When not in use the hand holes are closed by metal slides.

The Incubator is made of insulating material and has a removable plate glass front. The heating element consist of special wire units, distributed inside the cabinet. It is controlled in the usual way by a clever adjustable electro-thermostat.

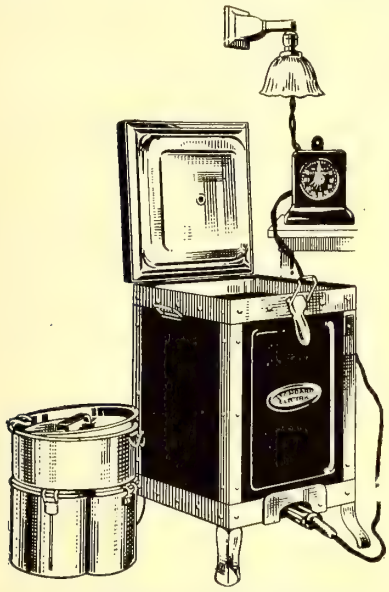
This Incubator is particularly well adapted for universities and research laboratories. It is used to advantage in watching developments of embryos of animal parasites and also in watching the growths of normal and abnormal tissues. It is convenient in bacteriological and zoölogical research work and in research work on blood.



An Electric Incubator for Maintaining the Entire Microscope at a Constant Temperature. A Necessary Refinement Where Live Organisms or Tissue are to Be Studied.

NEW ELECTRIC STOVE RESEMBLES "FIRELESS COOKER."

A new electric stove built on the order of the heat-retaining "fireless cooker" is shown in the illustration herewith and



The "Fireless Cooker" Principle Is Incorporated in This Electric Stove. You Start with 620 Watts for a Few Moments, Then Switch on the 40 Watt Heater, the Latter Doing the Real Cooking.

operates on 40 watts, (same as your lamps).

Place any food you wish in the compartment, and close the cover. Set the clock for a few minutes current, to heat up the calorator. At the expiration of that time the clock will turn off the 620 watt heater and turn on the 40 watt heater. The cooking heat will then remain at cooking temperature until you wish to use your food.

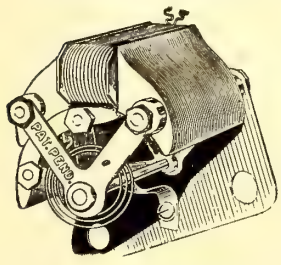
You can cook an average meal for less than two cents, its makers claim.

These new electric cookers are finished in blue enamel with nickel trimmings and are made of iron; lined with heavy gage aluminum. Each cooker is provided with one 3-quart circular kettle and two 2½-quart semi-circular kettles, all made of heavy gage aluminum. Thus you cook a whole meal—meat, potatoes and two vegetables—at one time.

The heat calorator in the bottom of the cooker is made with two heating elements. One consumes 620 watts (same as an electric iron) and the other 40 watts (same as one electric light).

AUTOMATIC LIGHT CONTROLLER FOR FLIVVERS.

The automatic light controller here shown is placed on the dash under the hood and requires no adjustment or manipulation by the operator of the car.



An Automatic Controller for Regulating Light from A. C. Dynamo System of the Ford Car.

By means of a moving armature which is automatically pulled under a magnetized field as the car speeds up and dropt out as the speed decreases, the lights are kept practically constant thruout the range of speed of the car. It is intended for use on Ford cars in which an alternating current magneto is used.

The controller operates on the impedance or reactance principle. The field is wound with suitable magnet wire and connected in series with the circuit of the magneto which furnishes current to the lamps. The current of the magneto passing thru this winding energizes the field magnetically in direct proportion to the strength of the magneto current which is governed by the speed of the car. The armature rotates in this magnetic field and is so adjusted that when the speed of the car is below ten miles per hour the field has not sufficient strength to attract it and consequently no impedance is offered to the current, and the lights burn at full voltage and candlepower. As the speed of the car is increased the magnetic strength of the field is increased, and the armature is drawn under it in exact proportion to the increased speed and voltage. Impedance is now set up between the field and armature in the same proportion, which reacts on the current and voltage generated by the magneto and keeps the voltage and candle power of the lamps practically constant thruout the range of speed of the car, as the greater the speed the greater the magnetic strength of the field, the greater the movement of the armature under the field and the greater the impedance set up between the field and armature.

SERVICE OVERSEAS!!!

Electrical men are wanted for early service overseas. The men in the front line trench need the help and coöperation of skilled men back of the lines, and electrical men are wanted at once for the Enlisted Ordnance Corps, National Army.

Uncle Sam is calling on our trade to come across and help his fighting men. There is a lot of work to be done over there, and the call has gone out for electricians and electrical men between the ages of 18 and 40 who want to do their bit, and who know their job.

Modern war is a tremendous business, and the army that wins is the army which has the best equipment and the best men. The men are over there now—they are ready to go ahead, but they still need experts in our line to repair and maintain their equipment. There is a fine chance for every man who wants to help.

Write to the Chief of Ordnance, War Department, Washington, D. C.

THE ELECTRIC TEA WAGON AWAITS! YOUR LADYSHIP.

It is often desirable to have an electric heater for teapot, chafing dish or toaster at the hostess' hand and to meet this requirement we have the new electric tea wagon here illustrated. At least two devices may always be heated, such as an electric percolator and a chafing dish or toaster.

The designer has incorporated a feature of considerable merit in connection with the wiring of this electric tea wagon, in the form of an adjustable table reel installed under the lower shelf. This is a spring-actuated device, operating as simply as a spring roller window shade, and it carries ten feet of silk covered lamp cord with an attachment plug at the end. When the tea wagon is not in use this attachment plug may be withdrawn from the wall receptacle, whereupon the adjustable reel will automatically take up the slack so that it does not trail on the floor or be wound up and stowed. On the other hand, a slight pull on the cord will extend it, allowing it to unreel to its full length whenever desired. There is no strain on the cord while it is connected, as the table reel locks automatically in any position to which you may desire to set it, and can be released by a touch of the finger.

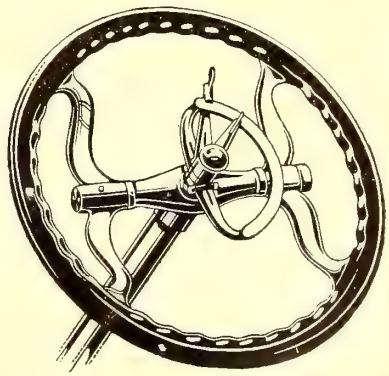


Yes, It's Here! The Electric Tea Wagon Simply Had to Come.

ELECTRICALLY WARMED AUTO STEERING WHEEL.

This electrically warmed hand wheel for autos may be applied to any car and it operates practically without cost, drawing but a slight amount of current, about as much as does one of the headlights from the storage battery when in use. When not in use there is nothing but the switch button to show that the heating attachment is present—as all the mechanism is embedded in the composition of the wheel with the wires self-contained within the steering column. The wheel is made either in Bakelite or Condensite.

To outside appearances the rim is identical with the plain model steering wheel, for the reason that the heating coils are self contained in the composition. The simple pushing of the small button located on the spider of the wheel turns the heat on or off. The heating wires are cast within the rim, concealed from view. Thus the driver is not conscious of the heating feature until he presses the button, when the wheel begins to warm his hands. This steering wheel is one of the best models yet developed. It always retains its hand-



A New Electrically Warmed Steering Wheel Which Has the Heating Wires Embedded in the Moulded Rim.

some appearance, not becoming shabby in a few months as varnished wooden types are wont to do. It operates from the car battery.

The Chemical Exhibition at New York

By ALBERT W. WILSDON

THE exhibits at the Third National Exhibition of Chemical Industries, held at Grand Central Palace, at New York City during the week of September 24, 1917, was very interesting and instructive both for the layman and the engineer.

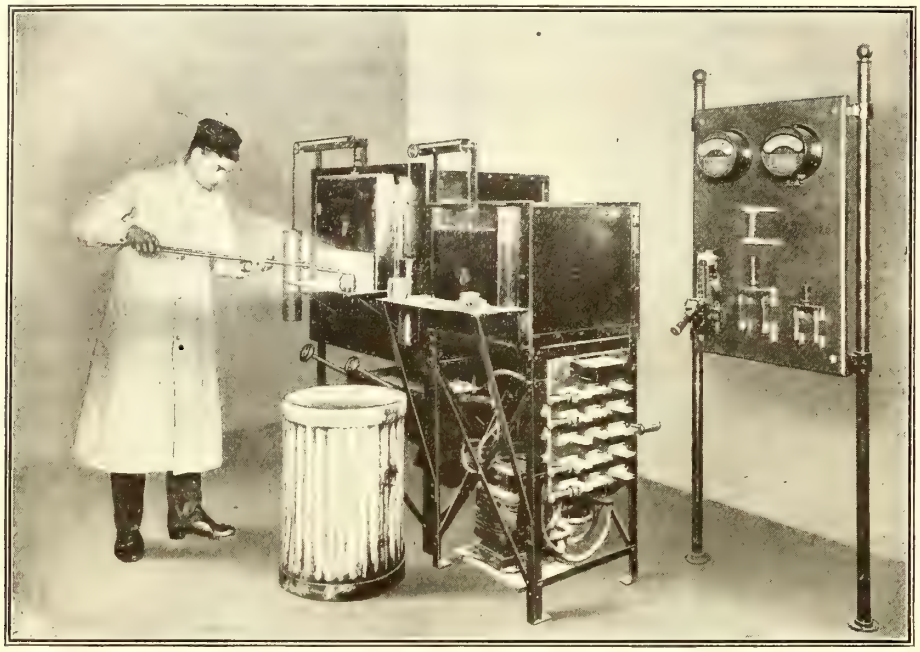


Fig. 4. Tool Hardening with Modern Electric Furnaces. The Furnace at the Right Is Specially Adapted for Hardening Carbon Steels and Pre-heating High Speed Steels. The Furnace at the Left Is for Hardening High Speed Steels. The Electric Furnace Is Ideal for All Such Work as the Heat Can Be Very Closely Regulated.

Electricity of course, played a very conspicuous rôle, and many new appliances were exhibited which had been improved upon by its use.

Among the exhibitors displaying electric devices were the following:

The Anaconda Copper Mining Company exhibited products showing various steps in the reduction of copper, commencing with the Butte ores, to the commercial refined copper shapes such as ingots, wire bars, slabs, cakes, etc. Also an interesting and extensive exhibit of the important by-products obtained by the *electrolytic refining* of copper, such as copper sulfate, nickel sulfate, white arsenic, selenium in all its allotropic modifications, tellurium, silver, gold, platinum, and palladium.

The Condensite people displayed molded electrical insulation as applied to automobile starting, lighting, and ignition apparatus, moulded commutators, high tension insulators, U. S. Navy wireless insulators and lamp sockets, electrical condensers, and miscellaneous insulation, condensite molding preparations, impregnating enamels and cements, molded condensite as used in disc phonograph records, moving picture machines, vending machines, fire extinguishers, etc.

Then there was a complete 5 H.P. industrial steam plant in actual operation. This miniature plant embodies an automatic boiler-feeding system, auto lifting and non-return steam traps. A coil kettle is heated to a definite temperature by the boiler, and the condensation is returned to the boiler—100 per cent efficiency is claimed.

A new *electrostatic separator*, Fig. 1, was demonstrated, and in which concentrations and separations of mixed ores are produced by *static* electricity. This device embodies an electrically charged electrode as shown, which serves to attract all the good conducting ore to one side while the poor conductors are past over the drum to a different container.

A complete line of pyrometers, including both recording and optical types was shown, the latter being of special interest, possessing both accuracy and simplicity. In connection with the recording instruments a red, white and blue light system of indicating variation, high or low, of the furnace temperatures from a fixt value was exhibited. Apparatus for determining the conductivity of electrolytes was shown, including the Vreeland oscillator for producing a high frequency E. M. F. of pure sine wave. The new design of the *Burrows permeameter* for magnetic measurements, and a useful type of *hydrogen electrode* was also demonstrated.

Technical thermometers of all descriptions were there, including thermometers for laboratory and research work, and for acid manufacturers, also the *Pentane* and *toluol* thermometer, for low temperatures, the toluol to minus 100 deg. C; the Pentane to minus 200 deg. C.

An eastern electrical instrument company exhibited a new line of pyrometers and electrical precision instruments. A very interesting booklet was distributed by this concern which contained considerable information regarding high and low temperatures. Fig. 2 gives a very instructive curve of the estimated number of laws and facts known experimentally, which was taken from this booklet. In this chart temperature elevation is indicated by the height of a vertical line, and the makers have, to an approximation, represented by distances measured to the right of this line the number of facts and laws of matter about which we have gathered true experimental evidence. Thus there is obtained a curved line bounding the *Region of Experimental Evidence.* All outside this curve belongs to the field of imagination and speculation, and may properly be called the *Region of Pure Surmise.* The former region is large when compared with the inner small *Region Known To The Ancients* —which the philosophers of antiquity could have drawn to represent the knowledge of their day. The *Region of Pure Surmise* extends beyond all assignable limits, and investigation of this Region is an aim and problem of modern industrial research. Its investigation is possible because a very large portion of it lies within the limits of producible and measureable temperatures.

The same concern exhibited one of the very latest adjuncts to science in the form of a *high-frequency induction electric furnace.* This device is shown at Fig. 3, and was developed by Prof. Northrup of Princeton University, for use in special work. The outfit illustrated at Fig. 3 is of the vacuum type with a rating of 20 kilowatts.

This high frequency induction furnace presents a radical departure from usual furnace practise, and embodies the first employment of *oscillatory* currents for the generation of heat and production of temperature. By reason of the highly effective induction possible without the interlinkage of a magnetic with an electrical circuit, currents can be set up in the containing crucible in the case of a non-conducting melt, or in the melt itself if the same has sufficient conductance to permit the flow of currents. *No iron is used.* Thus it is possible to raise the temperature of a melt in a crucible until its resistance becomes low enough to permit the generation of heat in the substance itself (as in the case of melting glass), after which the temperature producible is limited only by the durability of the insulation and refractory container.

Since this furnace operates by induction, conditions of the melting chamber may be controlled perfectly. Thus it is possible to produce temperatures exceeding 1600° C in a partial vacuum or pressure, with any conceivable atmosphere, and if desired, without the contaminating influence of carbon. The furnace works on a two-phase commercial circuit (60 cycles frequency), 220 volts, with balanced load at unity or slightly leading power factor.

Time was when the tool-maker and ma-

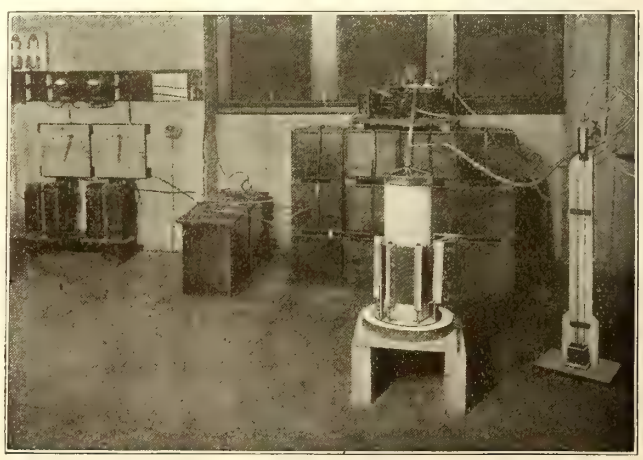


Fig. 3. The Very Latest Thing In Electric Furnaces—the Northrup High Frequency Vacuum Type. This Outfit Is Rated at 20 Kilowatts. No Iron Is Used and It Operates by Induction.

chinist thought that the gas furnace represented the last word in such devices, especially for tool hardening and treating. But now the electric furnace has come to the front. The furnace shown at Fig. 4 is being used to harden tools, reamers, taps, etc. It is also being used for hardening precision tools where it is required to produce a number of different pieces of steel

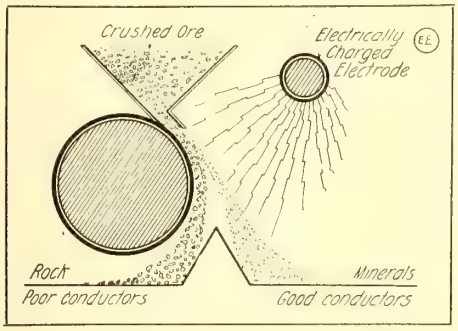


Fig. 1. Magnetic Ore Separators are Quite Common—But Here Is an "Electrostatic" Ore Separator. The Charged Electrode Attracts the Good Conductors So That They Fall Into a Separate Compartment as Shown.

to do duplicate work. Another use to which this furnace is put is the hardening of ball-bearing thrusts. It is widely employed also for the proper tempering of steel magnets, particularly small ring-shaped magnets such as used in telephone receivers, compasses, and other precision and measuring instruments. The electric furnace is susceptible of very accurate control, the heat being readily regulated to within a few degrees of the desired value. With improvements in design these apparatus have been brought to a high state of efficiency and cost no more to run than other types.

Recording thermometers, pyrometers and temperature regulators held the interest of many. A new development was shown in the "multipyrograph" for recording six different temperatures on one chart, employing only one electric galvanometer.

Electrical apparatus of particular interest to chemists were shown, including motors, starters, oil switches, circuit-breakers, meters and transformers. A laboratory line of apparatus was also exhibited including electric stoves, hot plates, water heaters, fans and air pumps. A number of Bakelite-Micarta gears were shown. Bakelite-Micarta is the only non-metallic gearing material that is self supporting and in most cases neither bushings nor flanges are needed. A Thury regulator was shown, which regulates the temperature of electric furnaces automatically.

The sponsors of "Bakelite" displayed numerous forms of Bakelite products, moulding mixtures, varnishes, lacquers, enamels, cements, transparent and colored, in sheet, rod, tube and special forms.

Dr. L. H. Bakeland, the well-known inventor of Bakelite, and gaslight photographic papers, and member of the Naval Consulting Board, gave a very interesting lecture regarding the dystuff industry under the heading of a paper "The Future of Chemical Industry in the United States."

Exhibitors of American made dyestuffs were the center of attraction and many remarkable shades of colors were shown which compared favorably with those which were imported from Germany before the war. Indeed, the exhibits of the large manufacturing concerns demonstrated how this country had past from a position of absolute dependence upon foreign sources of supply for both the intermediate and finished dyestuffs to one of potential independence, as regards both, in less than eighteen months! To-day there are more than *ninety* manufacturers of crudes and

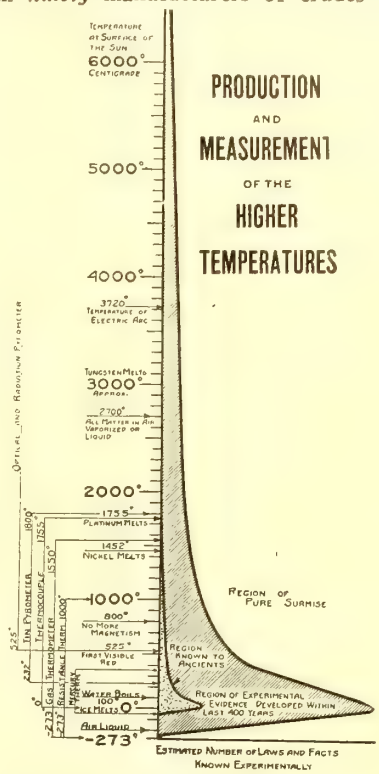


Fig. 2. An Interesting Temperature Chart Which Shows Graphically All We Know About This Subject. The Shaded Area Indicates Relative Known Facts at Each Temperature. At 6,000° C. We Know But Little, as Becomes Evident.

intermediates, and about *eighty* manufacturers of artificial products.

War Address by A. I. E. E. President-elect, E. W. Rice, Jr.*

(EXCERPTED)

IT GIVES me great pleasure to meet you here to-night and to be thus introduced as your President-Elect. I thank you, and thru you, all the members of our great Institution, for the honor which you have conferred upon me in selecting me to be, for a time, your official leader and chief servant. I hope I may have the strength, the ability and the opportunity to render such service as to justify, in some measure, your confidence. I fully appreciate that, with such a great honor, is coupled an equally great responsibility and I value the position as an opportunity to be of service to you, and thru you, to our country.

No body of men can get together at the present time without soon discussing the subject of the war, which is uppermost in everyone's mind.

The war is the one dominating factor in the world life and thrusts itself before our thoughts whether we wish it or not. We are in the war at last and will remain in it to the end. Whether it shall be a bitter end or a bright end will depend largely upon ourselves, as it is now our war.

It has been stated many times that modern war was largely a question of mechanics and engineering, a statement with which we must all agree. It is self-evident that engineering must, therefore, take a leading and dominant position in the war work. Now the electrical engineer stands for about the latest thing in engineering development; his activities embrace practically all other fields of engineering, being, so to speak, the last word in engineering. The electrical engineer must, therefore, realize that this is his war in a very personal and particular sense.

War calls for supreme sacrifices and the deepest devotion, but it also demands something more difficult to give, and that is *work*. War may be said to be the personification of work, not only individual work, but especially organized and disciplined work,—disagreeable, dirty, heart-breaking, backbreaking, nerve-racking work, but always work. No nation of loafers ever won a war. Other things being at all equal, that nation or people who are willing to work the hardest will surely win the victory. Now I wish to point out that the enemy we are fighting is recognized as the most industrious organization in the world. Our enemy has prepared for war for fifty years and has been working with ever-increasing energy ever since the war started three years ago. We made no adequate preparation during all this time and therefore started with a fearful handicap of lost time and lost opportunities. We must not delude ourselves that our enemy is exhausted, but remember that he has the advantage of a flying start. We must accelerate at an incredible rate if we are to get our war-motor going fast enough, soon enough to catch up.

Now, properly understood, the fact that no *single great invention* is likely to be made which will win the war, is no cause for discouragement. It does not mean that there will be no improvement, no new inventions, no new methods devised and put into effect. It simply means that we must not wait for the miracle which will never appear, but get to work and energetically take advantage of all present knowledge. We must survey the field, get at all the facts, carefully determine our plans and then proceed to put them into practical execution.

Take for example the matter of shipping. This perhaps presents the greatest immediate problem of the war, frightfully complicated as it is by the submarine. I feel sure that it can be successfully solved, if we are content to solve it by the simple, common-sense methods used by engineers and successful business men in the ordinary course of business. The problem must first be carefully investigated, all available data quickly obtained and checked, and all new conditions considered, after which a broad-gaged, well considered plan, or plans, can be formulated, criticised and then put into effect.

Of course it is elementary to say that we must provide shipping in enormous quantities to replace that destroyed and to provide for increased demands. It is evident that time is the essence of the problem. We must, therefore, build the greatest tonnage in the shortest time. The ships must be manned and navigated to their destination and the most efficient methods provided for docking, unloading and loading.

(*Continued on page* 648)

* Mr. Rice is president of the great General Electric Co., and his suggestions are of particular significance at this time of national stress.

"TOO LATE"

By CHARLES S. WOLFE

The Story of a Successful Relay That Was Unsuccessful

THE clock over my instrument table gave a reading of 10:30 P. M. The air had been particularly dead all evening and I was a trifle bored. I pried my ears loose from the *Holtzer-Cabots,* laid them (the 'phones, of course, you simp) on the table gently, and arose to throw my lightning switch.

But I didn't quite get away with it. Before I reached the window I heard a faint squeak from the table. I knew who it was, all right; Jimmy Hooven, the only other amateur in town. Jimmy did his ether blasting with a full, round kilowatt, and a kilowatt at a half mile gives forth an easily readable signal, brother! It is, in fact, quite audible.

I hastily donned the receivers, threw Jimmy a trifle off tune for my ear drum's sake, and discovered that he was calling me.

As soon as my little one-inch coil had given him a wheezy "G. A.," Jimmy told me that he had just received a message from Ashheap, Ohio, for a party who lived nearer to me than to him. Would I deliver it?

Would I? The one ambition of my wireless career up until that fateful night had been to be an accessory to a real, honest-to-goodness relay message, either before, after, or during the act. Countless times I had pictured myself striding up to a door and saluting the astounded and awed householder with a matter - of - fact "Wireless message for you, sir." And here was opportunity staring me in the face.

I assured Jimmy at the rate of twenty-two of five letters each that nothing would give me more pleasure, and the instant I got my antennæ switch over he handed me this:

H. Peck,
Skunkton, Pa.
Before lighting the kitchen fire, look in the oven. Billy sometimes sleeps there.
Maria Peck.

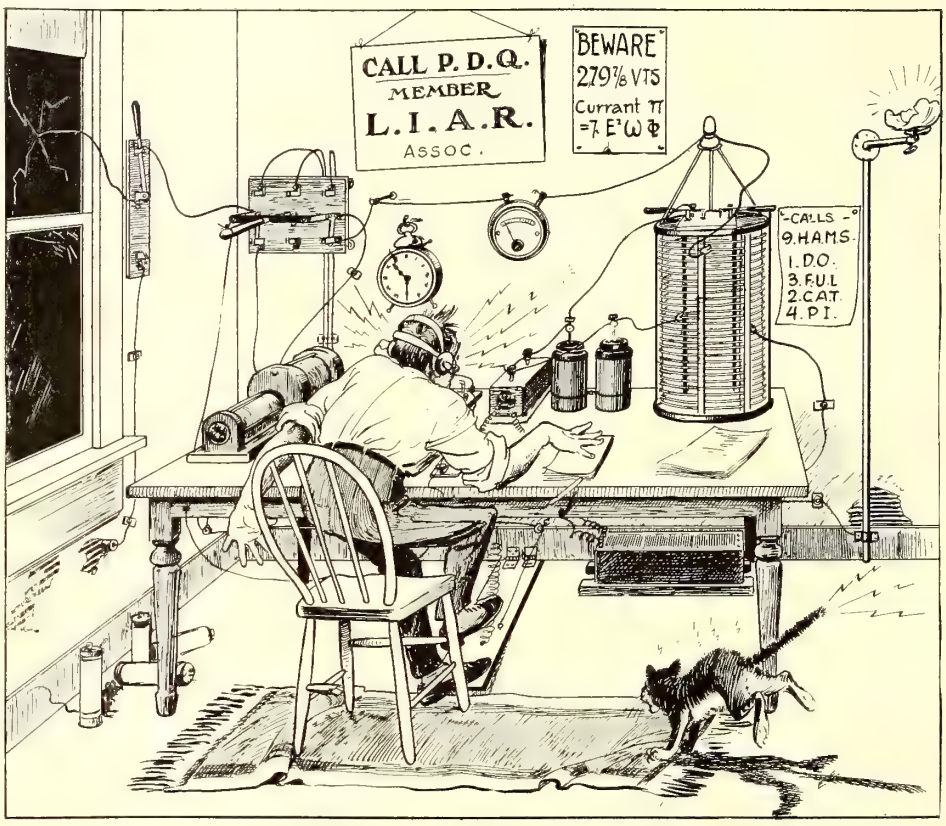
The preamble gave the office of origin as 9 B.U.G., and as I copied it down I hastily scrawled in "Received at 3 N.U.T. Boy! That message sure looked like the real article.

Jimmy said he'd wait around until I found out whether there was to be an answer or not, and I heard him wailing C.Q. plaintively in an effort to find company as I tore off the 'phones and prepared to hop to it.

I hastily donned an overcoat, pulled a muffler around my neck, clapt a derby on my turret (I may say right here that I hatted in haste to regret at leasure), jammed the received message in my pocket together with a few blank forms, in case there was to be a reply, and hied me forth to deliver the thing to its consignee.

It was SOME evening. It was January overhead and January under foot. About two inches of damp treacherous snow covered a coating of inherently fickle ice. Little two-inch blocks of snow collided continually with my face.

I guess I had walked—or rather slid—about two blocks at a rapid pace before the great white light broke thru my shell-proof skull. Skunkton is a town of about 30,000 souls, men, women, and politicians. The telegram was addrest to H. Peck, Skunkton. For the first time it struck me that the sender might have been a trifle more explicit. A gentle hint, you know, as to what end of the city we might reasonably hope to locate H. in, at least.



". . . . Jimmy Did His 'Ether Blasting' With a Full, Round Kilowatt, and a Kilowatt At Half a Mile Gives Forth an Easily Readable Signal, Brother! It Is In Fact, Quite Audible. Jimmy Told Me That He Had Just Received a Relay Message From Ashheap, Ohio, and Would I Deliver it? Would I? Well——"

I stopt and leaned against a wall. This problem merited consideration. I was sure up against it. Vainly I sought for a logical starting point. Here was a situation that called for a Sherlock Holmes.

Thinking of Sherlock Holmes brought a ghost of an idea—a mere wraith of one. Deduction—that's what this called for. Very well, I'd deduce.

Deducing at midnight in a temperature of only a few scrawny degrees above zero is rather more difficult than the uninitiated might imagine. Eventually I got the case boiled down to the following elements. Here was a telegram from Maria Peck to H. Peck. Both surnames the same. Evidently related. Sister or wife, no doubt. I eliminated the former as being unlikely and arrived at the conclusion that Maria and H. were joined in matrimony. Then, too, there was the fact that Maria was in Ashheap while H. was, supposedly at least, in Skunkton.

Now, when a man's wife is away does he hang around home? He does not. Where— It was then that I got my brilliant idea. I headed straight for the nearest saloon. Sticking my head in the door I called in loud tones, "Telegram for H. Peck."

And without a second's hesitation four gentlemen stept toward me with outstretched hands.

When I had sufficiently recovered I looked over the four that stood before me. "Good Lord," I gasped, "It can't be for all of you. What are your first names?"

And in rotation I got the following: Henry, Horace, Horatio, and Hannibal. And the worst of it was that any one of them might be the sendee.

Once again inspiration came to my assistance. "Do any of you belong to a wife named Maria?" I demanded. The quartette pleaded "Not guilty" in a breath, and I stept outside to do a little more deducing.

Under the awning, partially sheltered from the blinding snow, I made futile attempts to warm my ears, and gave the Sherlock Holmes stuff another hitch. Ah, I had it! The city directory.

Ten minutes later I handed the directory back to the bored drug - clerk, and gazed about me helplessly. The city directory was evidently a very complete work and must have been very carefully compiled. Anyhow, it listed just forty-seven Pecks whose first name began with an H., any one of which might be my quarry, and four of which were certainly not. For Horatio, Henry, Horace, and Hannibal were duly accounted for.

It looked like a war of elimination. I aroused the drug clerk from his trance and asked his advice. After some thought, he advised one of two things: use the telephone on such of the Pecks as possest the accessory, or go home and go to bed, preferably the latter.

At exactly one A. M. I stood once more on the exterior of the drug store. Out of the forty-three Pecks remaining after barring Horace Horatio, Henry, and Hannibal, I had succeeded in reaching forty, all in various stages of irritation, the last being the worst, as he had been called from the warmest bed.

But I hadn't been able to hang the accursed dispatch onto any of the forty to which I was playing Ali Baba. There remained three H. Pecks—one on Chestnut St., 1024 East; one on Center Ave., No. 4 West; and one on Brown St., 413 North. To

those of you who are familiar with the topography of Skunkton the difficulty will be apparent on a little thought. For the benefit of those who have never been in our burg let me say that Chestnut Street is one mile from the spot on which I stood, the Brown Street address about a half a mile from that, and No. 4 Center Avenue approximately one mile and a half from the Brown Street outfit. About three miles of real icy going in the face of a snow storm, and a temperature of about ten degrees above.

I selected my first try by the simple but effective "counting out" of boyhood days. "Eeny, meeny, etc." And the lot fell on the Chestnut Street entry.

Having thus decided, I drew my overcoat more closely about me, and started.

1024 Chestnut Street was discouragingly dark. Long and continuous ringing, however, eventually brought this particular beslippered and bathrobed Peck to his very cold front door. There was about six feet of him, every millimeter of it very cold and very angry. "Well," he demanded.

"Is your wife in Ashheap, Ohio?" I inquired, politely.

"Well, you three-plyed, hog branded, triple expanding fool! Have you gotten me out of my warm bed at this hour to ask me that? Well—"

"I have a telegram from her to you," I said, hurriedly, trying to stem the rising flood.

"You have like—cinnamon!" he roared. "It was my wife that woke me up and told me there was an idiot ringing our door bell."

I stood staring blankly at the closed door—which had closed, by the way, with quite some momentum. Anyway, that eliminated 1024 Chestnut Street. I wended my way doggedly toward Brown Street.

I will not dwell on the harrowing details of the interview at 413 Brown. I will draw, as the novelists say, a merciful veil. There are many ladies among the readers of this magazine, and—oh, well—. Suffice it to say that the H. Peck who resided at 413 Brown Street was NOT the H. Peck I was looking for. And he told me so. Explicitly!

Persistence will win, and eventually I stood at No. 4 Center Avenue. I rang the bell. The response was gratefully and astoundingly rapid. Before the sound of the bell had died away, a window on the second floor flew up, and a scared little man in a night-cap peered down at me. "What is it?" he asked in trembling, apprehensive tones. "Are you H. Peck?" I mumbled through cold stiffened lips. "Yes, sir," came the quavered affirmative. "Is your wife in Ashheap, Ohio?" "Yes, sir," more quavery and much more apprehensively.

"Thank God," I said fervently. The little man fairly beamed. "Yes, sir," he said.

"Telegram from her for you—wireless message, you know," I said. The scared look returned to the face of the victim above. "Be right down," he said, hurriedly.

Two minutes later, after a preliminary rattle of drawn bolts and dropt chains, he opened the door and scrutinized me closely. Standing still to be scrutinized at the existing temperature brought my already badly strained temper to the rupture point. I was about to say something, calculated to bring action of some sort quick, when the little guy spoke. "So you are a telegraph man," he said.

"Telegraph man is right," I retorted. "Substituting for Dr. Cook. If you're a human being ask me to come in."

"Certainly! Certainly! Come in, it's cold." Which was the first sane remark I'd heard for hours.

Once in the scrupulously clean parlor into which he led the way, I handed over the white elephant of a message with a sigh of relief, and took a slant at my host as he read.

He was a little man, with a head as bald as a billiard ball and scrubby side-boards. Hen-pecked was written on his countenance as plainly as tho it had actually been branded on his hide. You know, the type cartoonists use as models. As he read the message from his better three-quarters, he paled visibly, and for a long time he continued to study it with perturbed countenance while I sat patiently twirling my accursed derby.

Finally he lowered the message and looked at me. "Excuse me for a moment," he said, hurriedly. "I must attend to something at once." And without waiting for a reply he left the room.

I waited patiently. In about ten minutes Mr. Peck reappeared. He was apparently very much perturbed. He looked at me thoughtfully for a moment before he spoke. "How much does this wireless service cost per word? I would like to send a reply to my wife." I assured him that there was no cost attached, that by these little services we amateurs justified our existence. "And how many words am I limited to?" he inquired.

"Go as far as you like," I invited, carelessly. Then with more caution, "That is, within reason, of course. I don't know that I'd care to transmit the story of your life, or anything like that. Be as brief as possible and be explicit. Use your judgment." I pulled a couple of forms from my pocket and handed them to him. "Go get 'em."

Mr. Peck trotted obediently from the room. I reckon obedience was a habit with him. Judging from appearances, marriage had been more of an enlistment to the poor little animal than anything else, and he looked and acted as if he had had lots of what the U. S. Army officers call good, healthy discipline.

After some little wait Peck came into the room and handed me a folded blank. He was profuse in his thanks. Assuring him that a world of thanks and a mint of money could never repay me for what I'd been thru that night, I made my get-away.

The return trip was practically without incident. It was so cold that the policemen could not sleep, and I encountered two or three of these restless knights who seemed to possess inherently suspicious dispositions. I satisfied these minions of the law that I was what I didn't seem, i. e., a peaceful and law-abiding citizen, and eventually arrived at my home. As I mounted the steps I reflected on my innocence of a few hours before. Adam must have had much the same thoughts after he had gotten outside of the historic apple.

I entered my apparatus room, threw off my coat, hat and muffler and lit the gas. Then I sat down to wait until my fingers had thawed out sufficiently to give a fairly decent imitation of continental.

It was four-thirty. I had quite a few doubts as to whether Jim was still holding the fort at the other end. So as soon as I possibly could I sat down to the table with H. Peck's reply unopened in my hand. Throwing down the antenna switch, I jerked forth three rather unsteady 3 F. U. L.'s. Then I listened. Right back at me came faithful old Jim's —. —. When it came to sticking to his post, Jim had out-Binnsed Binns!

Down went my antenna switch, and I tore off the preliminary call while opening H.'s little composition with my left hand. Then I paused, as the full force of the tragedy bore home on me. Henry had obeyed instructions like a soldier. He had been both brief and explicit. He had evolved a regular one of those "we have met the enemy and he is ours" things. It follows:

To Mrs. Maria Peck,
Ashheap, Ohio.
I had already lit the fire. Billy was in the oven. I am burying him in the garden.
Henry Peck.

My spark buzzed and jumped as I sen this brief account of the tragedy winging along on the first leg at twenty per. For tragedy it was doubtless fated to be for Henry Peck when the common carriers succeeded in filling their contract with Mrs. Peck and dropt her on the station platform at Skunkton. And I strongly doubt if Billy enjoyed the performance any too well.

In conclusion I've got just this to say. If that feline Billy had, during his career on this vale of tears, strayed from the paths of righteousness, I'll bet a 5 K. W. transforming tool against a piece of unimproved real estate two inches by four that he tobogganed into the Sweet Bye and Bye without the least fear of what was to come. At a Methodist camp meeting I once heard a select quartet sing, "Oh what a foretaste of glory divine." Foretaste!! Billy got a mouthful!

The February "E.E."

The February issue of the ELECTRICAL EXPERIMENTER *will contain over one hundred articles treating on Electrical, Mechanical and Radio matters of supreme interest to our readers, both young and old. The Wireless Department will contain several timely and important articles, and all those interested in this subject should not miss them. There will also be a number of highly interesting scientific articles, as well as the usual complement of "How-to-Make-It" and Constructional articles. And while we are on the subject, readers, do not forget to read the "re-mailing notice" on the front cover, whereby you can help to provide good reading for our brave soldiers at the small cost of 1 cent.*

"How Jimmy Saved the Troop Train"—a real live electrical tale, mixed with patriotism, that will hold you spell-bound—by John T. Dwyer.

Baron Münchhausen's New Scientific Adventures, by Hugo Gernsback.

New Substitute for the Selenium Cell—A remarkable Light-Sensitive Electrical Device.

How One Patriotic American Concern Is Teaching the Blind to Make Electrical Apparatus.

"New Radio Wrinkles," by H. Winfield Secor.

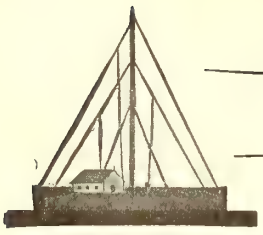
"Experimental Mechanics," Lesson II—describing the "Lathe," by Samuel Cohen.

"High Frequency Phenomena and Experiments," by Frederick Von Lichtenow.

"The Home Treatment of Tuberculosis by High Frequency Currents," by Dr. Frederick Finch Strong.

"The How and Why of Radio Apparatus"—describing Tuning Coils, Loose Couplers, Variometers, Etc., Part VI.

"A Wonderful New Electro-Musical Orchestra," by H. Hartman, C. E.



RADIO DEPARTMENT



Notice to All Radio Readers

As most of our radio readers are undoubtedly aware, the U. S. Government has decided that all Amateur Wireless Stations, whether licensed or unlicensed, or equipt for receiving or transmitting, shall be closed.

This is a very important consideration, especially to those who are readers of THE ELECTRICAL EXPERIMENTER, *for the reason that we desire to continue to publish valuable articles on the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have publisht in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools thruout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment. Remember that you must not connect up radio apparatus to any form of antenna.—The Editors.*

"Electrician—Radio U. S. N."

By WILLARD CONNELY, Chief Yeoman, U. S. N. R. F.

IT is easy to understand why electricity is one of the two or three most popular courses of training chosen by youths who enlist in the Navy. The intense modernism in electricity, yet the persistent mystery of it, its new discoveries which seem unlimited, and the unusual chances it offers for frequent promotion—all these forces are so many magnets to the bluejacket who feels within him the steel of ambition.

Since America surged into the War hundreds of college men have enrolled in the ranks of the naval apprentices. So have hundreds of students who quit high school to become sailors. Still, with the personnel of the Navy numbered in hundreds of thousands it is not surprising that a majority of the enlisted men have not completed high school education. Uncle Sam, however, treats them all impartially. Unlike a college, he is not so particular whether or not an electrical aspirant knows Ohm's law at the time he signs up. Soundness of body is the prime requirement.

If a man has learned something of physics at school, often he is fascinated by his experiments in static electricity. If a man has left school to work in an electrical shop and learn the business, often he is kept at primary work, such as armature winding, for months and months before he is allowed to get a broader grasp of the craft. Both these types of men would like to know more about electricity, to study it, to learn something new every day, to get ahead faster, so to rely upon it for a life competence. But they lack the money. Right there is where the Navy comes forth with the needed boost—feeds the apprentices, furnishes all clothes free, teaches thoroly the trade, and good pay for every man starts from the day of enlistment. With this splendid liberal opening which invites young men to serve their country with honor as well as immeasurably to better themselves as expert craftsmen, every amateur electrical enthusiast in the United States should know just what can be had for the enlisting. Then will he meditate.

Too many American youths, indeed thousands of them wedded to electricity, begin at the bottom and—stay there. A dozen insurmountable obstacles may prevent their getting ahead. Unlikely surroundings may stifle initiative. Irregular habits may impair efficiency. But Uncle Sam sees that his bluejackets go forward. He produces—make no mistake about this—he produces electricians.





Three Interesting Views of the Radio and Electrical Students at the Unsaltiest Naval School in the Country—Dunwoody Naval Training School, Minneapolis, Minn. The Future "Blue-jackets" Are Given a Very Thoro Education in the Theory and Practice of Electricity and Mechanics. Top Photo Shows Class in Welding and Brazing.

Development of the mind through disciplinary training will follow. Uncle Sam takes a chance on that, and he seldom loses out.

One of the purposes of this article is to make plain the circumstance that a sailor is not always detailed to the coast or to

(*Continued on page* 633)

THE "SMALLEST AUDION"

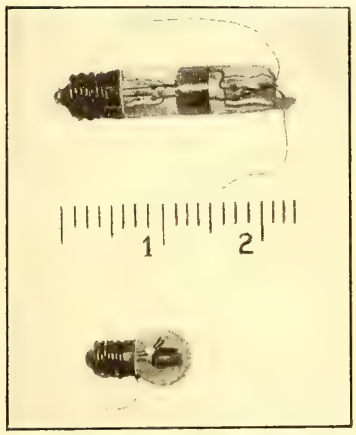
The very rapid strides in the making of electronic receiving devices has rendered possible the production of some very small ones. When the Audion was first made, its size was very large as compared with the present type, but as developments in the art changed this, it was found that the smaller types of the same instrument would perform the same functions as that of the large size.

We show herewith two types of electronic devices which have been made especially for certain experimental work for Mr. Samuel Cohen, a Brooklyn, N. Y., radio experimenter. The Fleming valve is seen at bottom of the photograph, and it consists of the standard miniature 3½ volt filament lamp and the evacuated chamber is $^{5}/_{16}$ of an inch in diameter. The cold electrode is made from tungsten, and is made in semi-circular form in order to receive the maximum electronic discharge from the hot cathode or filament. The connection from this cold plate is obtained by the means of a copper wire which protrudes from the glass chamber, and is seen to the left of the tube in the photograph. With this tube, favorable results have been obtained from nearby signals; the standard Fleming valve circuit was employed.

The de Forest Audion tube is illustrated at the top of the illustration, and it contains all of the elements which are in the standard tube, namely—*filament, grid* and *wing*. The vacuum chamber of the device in which the various elements are enclosed, measures 1½ inches by ½ inch in diameter over all. The *seal-off* is made at the end of the bulb as indicated.

The filament consists of a specially made spiral tungsten filament and this is enclosed in the grid, which consists of another spiral made from copper, the same being kept in position by means of a platinum wire which leads from the lower end of the tube. The wing of this device is composed of a very closely meshed tungsten cylinder.

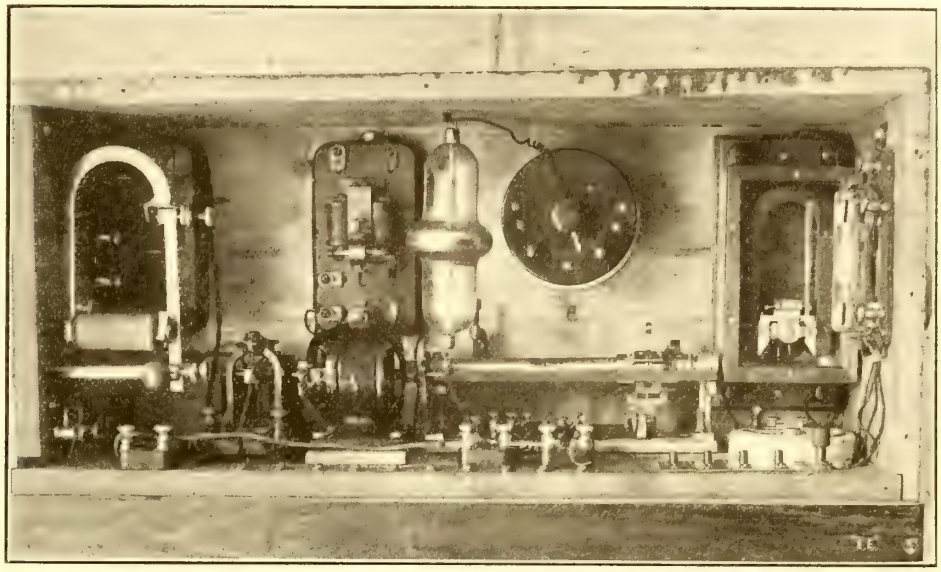
Quite remarkable results have been obtained from this instrument in conjunction with a portable radio receiving outfit. Long distance reception has been obtained with this tube, it having been possible to produce undamped oscillations for the reception of distant stations employing the undamped wave generator. The tube has also been utilized with great success in the making of a "fountain pen" radio receiver, and very interesting results have been obtained therefrom.



Radio Men Are So Accustomed to Seeing Large Sized "Audions," That These Tiny Specimens Might Appear to Be Mere Watch-fobs. But Such Is Not the Case. The Smaller One, at the Bottom of the Photo, Has Done Very Creditable Work Indeed, Even Tho It Is No Larger Than a Flashlight Bulb. The Larger Bulb Contains "Filament, Grid and Wing."

RADIO CONTROLLED MINES

A California genius, Mr. Hyder, has perfected a new radio controlled mine which can be detonated at will by sending out a prearranged radio signal or series of signals. The photograph herewith shows the selective mine construction invented by Mr. Hyder, which cannot possibly be interfered with by any sending device other than the controlling machine, so the inventor claims. This has been tried and tested thoroly under various conditions, and with a number of different radio plants and sending stations, using various wave lengths. It is further claimed that the device has been put to almost every known test condition by the inventor, and so far no person has been able to operate the apparatus except the inventor, nor has any one been able to interfere with the action of the device. Such a device should prove of great value.—*Photo from G. W. Geiger.*



Radio Receiving Apparatus, Including Selective Relays, Wave Filters, etc., Used in Californian's New Radio Controlled Mine. It Is Claimed to Be Non-Interferable, Enemy Waves Having No Effect at All Upon It.

MEASUREMENTS OF RADIO ANTENNÆ ON SHIPBOARD.

In the October, 1917 issue of The Electrical Experimenter, on page 391, Mr. F. A. Hart gives a table of constants for radio antenna. This table is of practically no value unless the spacing of the parallel wires in the antenna is given, says Mr. F. H. Kroger, Chief Engineer, National Electric Signaling Co.. With this additional data the table would, indeed, be of considerable value.

Mr. Hart, in reply, says: I do not agree with Mr. Kroger that the data previously given are valueless without the spacing values, as practically everyone engaged in radio work is familiar with the average spacing between wires. However, with this additional data the table should now be very complete. (Every radio reader should procure a copy of the table previously publisht in The Electrical Experimenter, as it contains data obtained from actual tests.)

Spacing between Wires.

No.	Horizontal Ft.	in.
2-Wire		
1	12	0
2	10	0
3	12	6
4	10	0
5	12	0
6	10	0
7	13	0
4-wire		
8	3	4
9	3	4
10	3	4
11	3	4
12	3	4
13	3	4
14	3	0
15	3	4
16	3	4
17	3	4
18	3	4
19	3	0
20	3	0
21	3	6
22	3	4

No.	Horizontal Ft.	in.
6-Wire		
23	2	3
24	2	3
25	2	3
26	2	3
27	2	3
28	2	3
29	2	3
30	2	3
31	2	3
32	2	3
33	*	
34	2	0
35	2	3
36	2	3
37	2	3
38	2	3
39	2	3
10-Wire		
40	1	4

In 33 spacing forward is 2 ft. 3 in., 80 ft. *in* to centre spacing between three wires (set each side) 12 in., spacing between two inside wires at centre 19 ft. Aft end 85 ft. from centre spacing graduates to 2 ft. 3 in.

Vertical lengths are identical with horizontal at junction of wires graduating to a point approximately 2 ft. at bottom.

MOUNTING TINFOIL ON GLASS CONDENSER PLATES.

A good shellac for fastening the foil to the glass in transmitting condensers may be made by dissolving as much powdered rosin as possible in one ounce of turpentine and thinning the mixture by the addition of one-half ounce of alcohol. Only a very small amount of rosin will be needed.

About three drops of shellac should be put in the center of the surface of the glass and rubbed around well. Place the foil on the glass and roll it fast with a photographic print roller. The foil must be placed on at once, as the mixture dries quickly. When this varnish is used the plates may either be stacked or placed in an open rack.

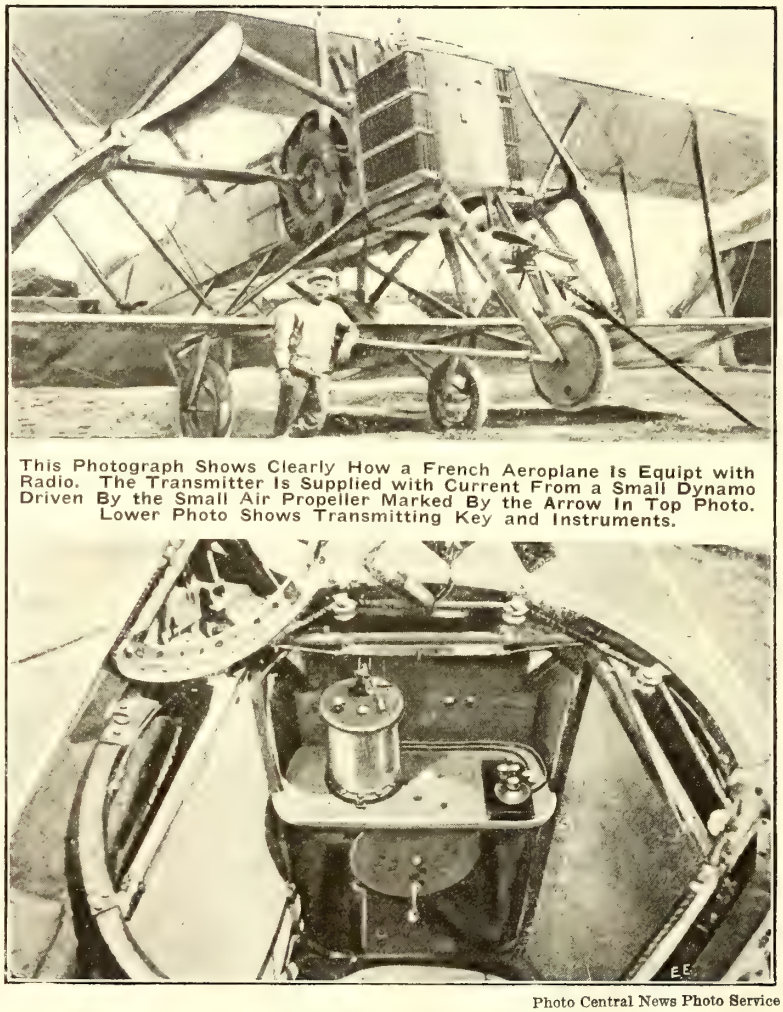
RADIO WRITERS — ATTENTION ! ! !

Can you write radio articles dealing with the practical problems of wireless operating? We can use some good papers on such subjects as "the tuning of radio transmitters"; "the use of the wave meter, including its application to measuring the frequency, wave length and decrement"; "operation of commercial transmitting and receiving sets"; "the operation of army trunk sets"; "improved ways of receiving undamped wave signals," also new ideas and short-cuts for learning the codes. We pay well for all articles accepted. Help yourself, your magazine and your country.

French Aeroplane Radio Great Aid to Artillery

ALTHO wireless experiments in connection with aeroplanes were made in 1910, it was not until the beginning of the war that it was put into actual use. All aeroplanes used for the directing of artillery are now equipt with wireless outfits which are powerful enough to transmit a distance of ninety miles if necessary. They can both transmit and receive, the sounds being perceptible in spite of the humming of the motor.

The electrical energy for the transmitter is supplied by a small dynamo which receives its power from a screw placed in front of the machine and actuated by the motion of the air. The aeroplanes keep in touch with their batteries at all times. It is the observer in the aeroplane who controls the gun fire. He sights the objects, gives the signal and reports where the shell has fallen. The top photo shows a French aeroplane fitted with wireless. The small propeller on the right drives the dynamo. The bottom photo shows the wheel or drum upon which the antenna is coiled; also the wireless telegraph set mounted inside the aeroplane cab.



This Photograph Shows Clearly How a French Aeroplane Is Equipt with Radio. The Transmitter Is Supplied with Current From a Small Dynamo Driven By the Small Air Propeller Marked By the Arrow In Top Photo. Lower Photo Shows Transmitting Key and Instruments.

Photo Central News Photo Service

HIGH-POTENTIAL BATTERIES FOR AUDIONS

By Frank Horton, SC.D.

The difficulties attending the use of a high-potential battery capable of supplying a current of a few milliamperes are familiar to all who have experimented with the discharge of electricity thru gases. The type of battery very often employed for this purpose consists of a number of small secondary cells with lead plates. The chief trouble is the "rotting" of the lead of the positive plate at the point where it passes thru the cover of the cell, says Dr. Frank Horton in the *Philosophical Magazine*. The rotting consists in the formation of a white powder which analysis shows to consist mainly of lead sulfate; in a few months, or even weeks, the rod may thus be separated into two pieces. The rapidity of this action depends on the quality of the lead used.

This type of small storage-cell was originally provided with an indiarubber cover, but the contact of the rubber and the lead was found to be the cause of rotting which occurs. The lead rods of the electrodes were therefore covered with short glass tubes to prevent this contact; this device generally lengthens considerably the life of the cell. More recently wooden tops well soaked with paraffin-wax have been substituted for the rubber and glass tubes; but these appear to be quite as bad as the old indiarubber ones. About 20 per cent. of the positives of a new battery of 320 such cells recently rotted thru in the course of three months. The remaining positives, and the new ones replacing those spoilt were therefore covered with glass tubes where they pass thru the wooden covers; but tho as usual, this increased the length of service of the plates, after a few months broken positives were continually being found and the battery was never reliable to any degree.

The rotting of the positive plate is due to electric conduction across the lid of the cell when wet with sulfuric acid. In the case of the wood and indiarubber covers which fit tightly round the lead, the action goes on more rapidly than when the rods from both plates pass loosely thru glass tubes. The rotting may be prevented altogether by doing away with the cover, but some other device is needed to keep the plates in position and prevent the splashing of the acid when the cell is being charged. It would be convenient to have the glass cells made with ridges to keep the plates vertical, but such cells cannot be obtained at the present time. In a long row of cells in series the connecting wires can be made to keep the plates in position, but a safer device is to cut a strip of thin celluloid of width equal to the distance apart of the plates and to bend this into a ∩ and place it between the plates of the cell. The top of the celluloid separator should be below the level of the acid in the cell and a small hole should be made in the top of it to allow the gases to escape when the cell is being charged. The splashing of the acid can be prevented in the usual way by covering the surface with a thin layer of oil. A battery of secondary cells arranged in this way has been working satisfactorily for several months.

The advantage of a battery which does not require periodical charging is obvious. Several types of primary cell have been used and are usually satisfactory for electrometer work and for experiments where potential only (or only a very minute current) is required. They are often troublesome to fit up, but require no further attention if treated carefully. For currents of the order of 0.01 ampere dry cells may be used, and the writer has found these very convenient for this purpose. These cells have the advantage of being small, thus enabling a large number to be packed into a small space, and their E.M.F. falls but slowly when current of only a few milliamperes are taken from the battery.

One such battery is for supplying potentials up to about 200 volts. The cells are contained in a wooden box 61 cm. long, 18.5 cm. wide and 11.5 cm. high. This has a hard rubber plate on the top which insulates the plug-keys by means of which the cells are arranged in series. The cells used give about 4 volts. It is advisable not to have too many cells connected in series when the battery is not in use, and the box therefore contains three sets of 10 small batteries (each set giving about 40 volts), and five sets of five small batteries (each set giving about 20 volts). The sets are insulated by micanite, and they can all be connected in series by means of the plug-keys. The required potential is tapt off by inserting special plugs into holes in the insulated brass pieces connected to the cells.

In the other arrangement of cells which has been found useful the box contains 25 separate dry cells and gives a total E.M.F. of about 35 volts. The cells are connected in series inside the box and by turning a handle in the centre, the difference of potential between the two terminals can be increased by aproximately equal steps from 0 to 35 volts. A convenient feature of the battery-box is the ease with which the cells can be removed and replaced by new ones. The cells are cylindrical in shape, the outside being of zinc which is the negative pole of the cell. A small brass cap connected to the positive pole protrudes from the centre of the top of the cell. The cells are each about 5 cm. high and 1.4 cm. in diameter. They are arranged in a circle between two sheets of hard rubber, one of which forms the top of the box and the other is inside the box and is supported from the top by four hard rubber rods. Each cell is held in position by two copper springs.

Inside the box a radial arm makes a rubbing contact with the brass clips pressing on the central projecting positive poles, and the position of the arm is indicated by the pointer which moves over the dial on the top of the box. This arm is connected to a left-hand terminal; the other terminal is connected to the zinc of the first cell in the series. It has been found convenient in practise to have one position of the pointer in which there is no connection between the terminals ("off"). This forms a simple method of breaking the battery circuit. It is also convenient for some purposes to have a position in which the terminals are connected, but with no difference of potential between them ("0"). The next position

(*Continued on page* 652)

A Short-Cut to Code-Learning

By THOMAS REED

The main difficulty in learning the telegraph or radio code, lies in the fact that the code-signs (composed of dots and dashes) cannot be exprest in spoken words. They are symbols to the eye only, and the mind cannot talk to itself about them, lacking names to call them.

One can, of course, translate them into sounds by using the words "dot" and "dash"; but the repetition of these words, in varying order for the different letters, soon destroys their distinctiveness. To illustrate, imagine the difficulty of recalling the names of six men called respectively "James Henry Albert," "Albert Henry James," Henry Albert James," "James Albert Henry," "Albert James Henry," and "Henry James Albert."

The idea is already in use, I believe, of representing the dots and dashes by alphabetical letters, using capitals for the dashes and small letters for the dots, thus: F = ffFf; G = GGg, etc. This helps recognition by the eye, but still does nothing toward converting the signals into spoken words which one can repeat to himself and memorize.

Furthermore, the sounds made by the actual telegraph instruments themselves bear no resemblance to the appearance of the dots and dashes, the spoken words "dot" and "dash," or the sound of the alphabetical letter. Leaving out the "sounder" of land-lines, and confining ourselves to "radio" signals, we find that they are heard in the form of *long* and *short buzzes;* and the mind is required by a dead-lift effort to associate these buzzes with the dot-and-dash symbols and the corresponding alphabetic letters.

But, as heard in the radio receiver, each signal has a distinctive cadence of its own, which is instantly recognizable as a whole and not as a series of dots and dashes; just as a word is recognized as such and not as a series of syllables. In fact, the signal sounds almost like a little word or phrase, pronounced in a lisping language. Take the letter "Y," for example; the receiver says, "Siss-a-siss-siss"; and all of us, after gaining familiarity with it, cease to call it "dash-dot-dash-dash," but express it to ourselves as "tah-de-dah-dah," using the phonetic equivalent imitating the cadence we actually hear, if not the sound itself.

Reasoning from this unconscious habit, I have thought it would assist in learning the code if we could select for each letter-signal a certain word (disregarding its sense) resembling the sound of the signal in the number of its syllables and in its accent. Such words could be more easily memorized than could arbitrary arrangements of marks; and each word would carry in itself not only the audible sound of the signal in the receiving instrument, but an index of dots and dashes composing it.

I have selected a list of phonetic catch-words which can be used in this way. The initial letter of each one corresponds to the alphabetic letter which it represents. The accented syllables (usually with long vowels) correspond to the dashes, while the unaccented syllables (usually with short vowels) correspond to the dots. To assist still further, the dash-syllables are printed in capitals and the dot-syllables in small letters, the syllables being separated by hyphens for greater clearness.

The student, having memorized the list of words, is now provided with a reference-index in his head. He is not obliged to remember the arbitrary fact that "L," for instance, is "Dot-dash-dot-dot." The word "la-Bor-ri-ous" occurs to him because it begins with "L," the letter wanted; and, on analyzing it, the long, accented syllable indicates a dash, and the shorter ones dots, correctly placed. But even without analyzing it, the sound of the word itself gives him the clue to the signal.

The pronunciation of the catchword also gives the correct *spacing* between the dots and dashes, a thing sometimes quite hard for a beginner to comprehend.

Further, in receiving, the broken buzzes of the signal "L" form a sound resembling the word "Laborious," and by associating the two he will learn more quickly to recognize the signal as a whole, instead of first having to resolve it into its component dots and dashes.

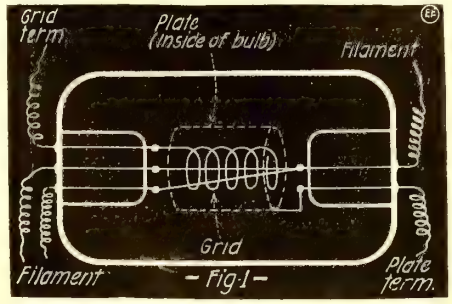
Following is the list of phonetic catch-words. They are the best I have been able to find in the limited time I have been able to give to the matter, and for some of the more difficult letters I have had to use short phrases instead of single words. However, among the great mass of words in our language, a set should be found accurately fitting the requirements. Only familiar words should be used, and such as are not variable in pronunciation. The ELECTRICAL EXPERIMENTER might open a competition in such lists, with the idea of combining the best words into a perfect set, which could thereafter be used as a standard. [*We shall be pleased to hear from any of our readers on this subject.*—EDITOR.]

Alphabetic Letter	Tel. Code Sign	Graphic Sign	Phonetic Catchword
A	.—	aA	a-WAY
B	—...	Bbbb	BLUE-ber-ry-ing
C	—.—.	CcCc	CO-ca-CO-la
D	—..	Ddd	DRA-per-y
E	.	e	etch
F	..—.	ffFf	fil-i-PI-no
G	——.	GGg	GAL-VAN-ic
H	....	hhhh	hel-ter-skel-ter
I	..	ii	in-ner
J	.———	jJJJ	ja-PAN-NOW-OWNS
K	—.—	KkK	KAL-so-MINE
L	.—..	lLll	la-BO-ri-ous
M	——	MM	MA-LAY
N	—.	Nn	NA-vy
O	———	OOO	O-HI-O
P	.——.	pPPp	par-TAKE-FREE-ly
Q	——.—	QQqQ	QUITE-HARD-to-SAY
R	.—.	rRr	re-LA-ted
S	...	sss	sau-sa-ges
T	—	T	TAME
U	..—	uuU	un-a-WARE
V	...—	vvvV	ve-ry-re-MOTE
W	.——	wWW	with-OUT-WAR
X	—..—	XxxX	X-cel-lent-MEN
Y	—.——	YyYY	YEO-man-NO-MORE
Z	——..	ZZzz	ZO-OL-o-gy

INSTITUTE OF RADIO ENGINEERS' OCTOBER MEETING.

The regular monthly meeting of the Institute of Radio Engineers held at the Engineering Societies Building on October 3, 1917, was attended by a very large number of Radio men.

The paper to be presented was on the subject of "Radio Telegraphy in competition with Wire Telegraphy Overland," but owing to a censorship at the last moment, this paper had to be set aside for some future time.



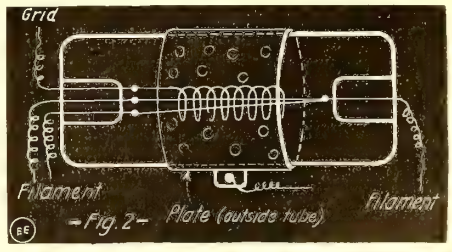
Type of Vacuum Tube Described in Mr. Moorehead's Paper Before the Institute of Radio Engineers at New York. Filament Grid and Wing Are All Inclosed in Evacuated Vessel.

Two other interesting papers were read instead. The first described a new type of Edison storage battery for the "B" current of Audions by Miller Reese Hutchinson, and the second the "Manufacture of the Moorehead Tube" by Prof. Moorehead.

Mr. Hutchinson's paper covered principally the development of a unit of storage batteries which would supersede the use of "flashlight batteries" for the high voltage circuit, which would be compact, reliable and capable of withstanding all forms of abuse and still have a long life on each charge.

Mr. Moorehead's paper dealt with the development of his vacuum tube, the various manufacturing processes, experiments, etc. In Figure 1 is shown the structure of the tube, the grid consisting of a copper wire coil and the plate of platinum, while the filament is of tungsten. Various claims were made for the success of this tube. Another type is shown in Figure 2, which was brought out to get around Dr. de Forest's patents evidently; the construction being the same, except that a strip of perforated brass gauze is placed around the outside of the tube for the plate terminal, instead of inside the tube.

Both papers were read by members of the Institute, the authors not being present, and therefore queries were not answered.



Second Type of Vacuum Tube Described in Mr. Moorehead's Paper on the Manufacture of This Class of Radio Detectors. Wing Terminal Outside of Bulb.

Very little discussion took place, altho some members took occasion to state that the Moorehead tube had not been found, in their experience, to be as sensitive as the Audion in actual tests.

"Ham" Aerials

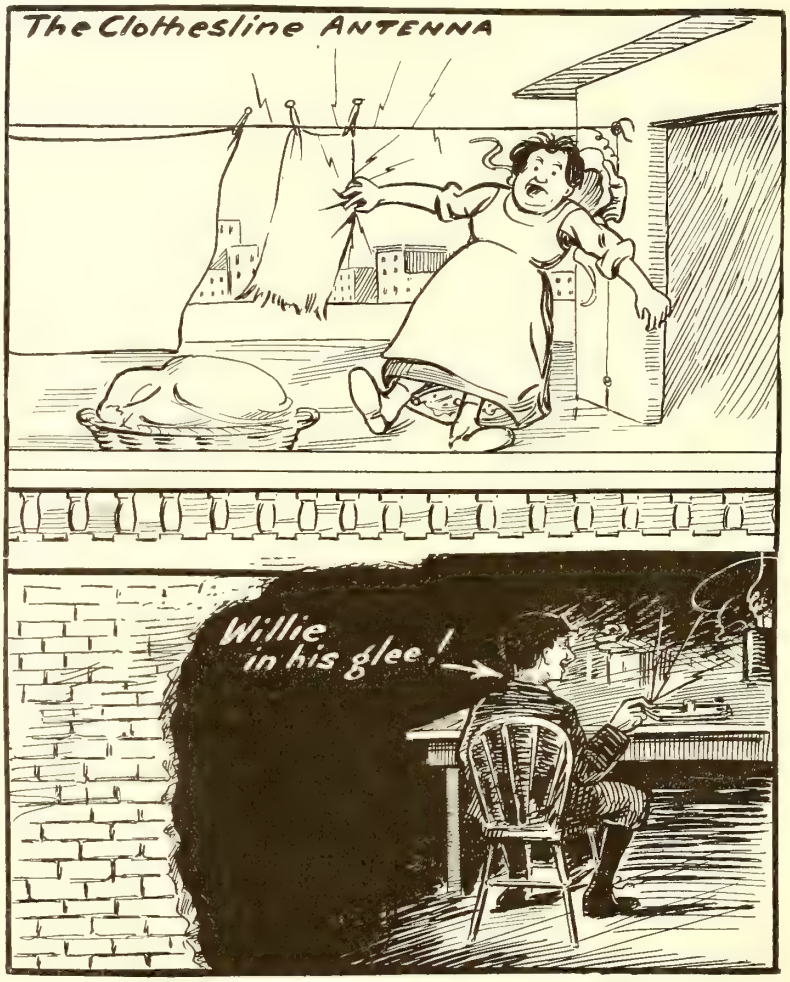
By W. J. HOWELL

AERIALS? Sure we know what they are, you mean those wires strung up in the air on top of the house, and that in some way or other send and receive electro-magnetic waves, or at least did before the order to remove them which makes the top of the house look respectable now, but say, between you and me and the lamp-post, an aerial is the cause of more funny business and trouble that ever was visited on the poor lads that take up wireless. How so? you ask. Well, it happened this way, at least in my experience, and believe me, it has run from anything to everything.

To start this line of chatter right, I should say that I started in the "Ham" class somewhere along the middle of the year 1909, and of course put up an aerial of two aluminum wires forty feet long on two poles ten feet high, nailed to the chimneys. But it so happened that I had nailed said poles to the type of chimneys that have a nice heavy granite block on the top, three feet by one and one-half feet, and of course, desiring to have the aerial up as high as possible, I had only allowed the pole to over-lap about a foot.

The reason for this long description is apparent when things begin to happen, and things did start with a wallop. It began the Saturday afternoon that Teddy returned from Africa and took the form of a beautiful storm right in off the old Atlantic. Barnum and Bailey's Circus was flooded while it was up at the Polo Grounds and it seemed the animals were raising the dickens because of all the things Teddy did to their friends at home. The wind blew and the New York City College had a bill for a new flag pole the very next day. By all the laws of Hamville my poles should have stayed up, but I guess they wanted to do a little celebrating on their own hook, and they certainly did, for one pole goes over, and from the previous description it will be seen that the pole acted just like a big lever, thereby prying the granite block off, letting it drop a mere distance of five feet, gaining speed and weight and ending up by putting a hole in the tin roof, which, of course, let the rain in and our ceiling looked like a sponge.

Lots of fun, that finished off with an order from the owner of the house that Willy should not erect any more aerials on the house top. Things looked gloomy alright till the time when the roof was fixt and the owner discovered that the house needed a chimney of tin for the main smoke outlet. This was put up and stood some ten feet tall with plenty of guy wires, which of course did not worry me in the least, for I took the wires off of the nails and put tape on the nails before putting the wires back in place, and signals came in just about the same. But the joke of the whole thing was that the owner lived on the ground floor and shortly after the smoke stack was put up, said owner looks up the airshaft, sees the wires from the chimney, gets excited and sends the janitor up to cut Willy's aerial that hung in the well—I mean airshaft. He was one of those rare specimens of stupidity and cut the wires as ordered with the result that the house blame near needed a new chimney.



"... Speaking of Using Phoney Stunts for Aerials Reminds Me of One Stunt I Tried. This Was to Put Insulators in the Wire Clothes Lines on the Roof and Use Them for Sending and Receiving. All Went Well Till the Maid Got the Surprise of Her Life. Willie Was Calling His Pal—Via Wireless."

This was my clue to ask the owner if he would be so kind as to let me fix the same and of course Amateurs will not need to ask why.

Another stunt I tried was to have a curtain roller mounted on the house about six feet above the fire escape and let it take up the aerial of four wires that I had rigged up, to pull out on the clothes line when it was not being used. This worked, but the aerial was only about twenty feet long and so the signals did not come in very well at that time, altho I suppose that if I had had the "real sets" of today, I should have had "phenom" results. After this idea I tried a wire forced into the space between the porcelain coping on the top of the brick walls of the house and was able to receive a fair amount with it. These experiments all took place during the days of old W. A. and N. Y. which gave us amateurs plenty of juice for testing purposes, if you lived anywhere in the vicinity of said stations.

Later on I was able to put an aerial on the house next door and it was some antenna, believe me. Forty feet long, spreaders four feet and had four wires, these being strung about ten feet above the roof, one end hooked to a sky-light and the other to the top of a dumb-waiter shaft. I was in luck when I could get "Key West" on galena with home-made instruments and seventy-five ohms built into the craziest pair of ear-laps you ever saw. Things went along fine until something happened and the aerial pulled or tript one of the Navy Yard's messages and I had a fanlight to pay for. Oh, it's a great life if your aerial don't come down.

After a while I became acquainted with a chap who lived about four hundred feet away and we put up a wire for telephone and telegraph work. The results were fine and the wire also acted as a great aerial; in fact, we even went so far as to be able to both receive at the same time and talk about the way the fellow was sending by using the telephone, altho situated two blocks apart. Along about that time Sayville began sending press at fifteen words per minute, which was then about the speed limit of *yours truly*, while my friend was right there when it came to copying WHB at about twenty to twenty-five per minute. Now both stations had the dodgasted habit of sending at the same time and generally the stuff was different, so by sticking a variable condenser in the ground wire my friend was able to tune to 600 meters for WHB and I got Sayville on about 1800 meters, and if I remember rightly, at the same time, so nothing was mist. Of course, if either of us varied our tuning arrangement, it threw the other fellow out a little, but this was easily overcome by trial and then leaving the set tuned. One advantage at the time was that the other chap could not tune up to Sayville, so if he wanted to copy the stuff, I used to receive it on my set, still using the 'phone wire and then hold the receiver to the transmitter for him to hear. Talk about duplex working and phoney stuff, we had the time of our lives monkeying with that wire strung along the edges of the roof.

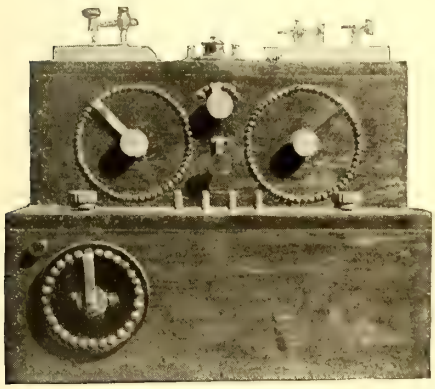
Putting up aerial masts seems to be my middle name and I have gone thru the stages of the game where Willy goes up on the roof every *five minutes* to look at his wires (and the more he has the better), to the point where one lonely wire constitutes the antenna and the only time I've looked at it was when stuff didn't come in.

(*Continued on page* 651)

A Mechanical Inductance Changer

By FREDERICK J. SCHLINK

WHEN listening for various radio stations we find that it is necessary to continually shift our tuning coil sliders or switches, so that we may hear the different wave length signals. This manipulation is necessary since the law requires that



Front View of Motor-Driven Inductance Tuning Switch as Fitted in Lower Left Corner of Standard Radio Receiving Cabinet.

the transmitting apparatus radiate sharp waves and we find that each station "comes in" at sharply defined points of the tuning coil; the usual "stand-bi" being of little or no use and resort is had to the continual changing of the tuning coil switches or sliders.

This operation soon becomes tiresome and will never give the satisfaction that is to be had by the use of a mechanical inductance changer. The following plan has given far more satisfaction than was really expected of it.

A tuning coil was made separate from the usual receptive apparatus and was tapt off in the usual manner, making 30 points to three (3) turns each, using wire of size No. 22 or larger. The cylinder on which the wire was wound is four inches in diameter and fourteen inches long, and this amount of wire and method of tapping has proved ample for the usual amateur and commercial stations. There is of course no unusual difficulty presented in adding more wire or switch-points or conforming to any other method of tapping.

This tuner, while incorporated in the case of the regular receiving apparatus, is not connected to form a permanent part of the receiving circuit for the reason that it would offer some difficulty to the manual changing of the inductance, in that it does not partake of the advantages to be had by the use of the "dead end" arrangement. This device is used only for the purpose of finding the various stations after which the apparatus is disconnected by the switch A, Fig. 1, and found again on the regular receiving apparatus. This change is very quickly accomplisht and one soon learns just about where a particular point on the auxiliary coil can be found on the regular receiving coil, if calibrated or simple numbered scales are used on the tuners and condensers.

The tuner was connected in the usual manner to the switch points and the hour-hand shaft of an ordinary eight-day clock was projected thru the front of the case, the switch arm having been mounted directly on it by soldering. It is suggested that the current be lead to the switch-arm thru the washer upon which the switch-arm moves; this precaution is for the purpose of obviating any imperfect contacts that might result if the current is brought to the switch-arm thru the clock-work and hence thru the bearings to the arm; it is quite easy to solder the lead to the washer and also to the clock-work.

The clock was dismantled and the unnecessary mechanism was removed, that is to say, the alarm movements, the small spring on the balance wheel and the escapement movements. A small vane or windbreak was constructed of a piece of number 20 or 22 B. & S. wire, bent as shown in Fig. 2. This vane was then covered with silk. The vane is for the purpose of making the clock-work unwind slowly and steadily and if after constructing the apparatus it is found that the switch revolves too fast or too slowly the remedy lies in making the vane larger or smaller.

It will be necessary to bore a small hole in the switch face thru which the winding stem of the clock-work will project; this hole should be a little larger than the winding stem so that the key may be inserted.

It will be noticed that in most clock-work mechanisms that the shaft of the balance wheel projects beyond the brass frame of the work and to this protruding shaft the vane must be soldered. This soldering may be accomplished by forcing a sheet of thin paper over the little shaft projection and then soldering the wire of the vane to the shaft using a drop of acid, a bit of solder and a small soldering iron. The purpose of the sheet of paper is to prevent the solder from joining the frame, vane and shaft together which it will do if this precaution is not taken. It may be possible in some clocks to mount the vane within the works, which method is to be preferred. In some types of clock-work the winding stem is on the opposite side from the dial side and some ingenuity must be displayed so that the clock-work may be wound up.

Some kind of a motor stop must be provided and here again the method of construction will differ with the various types of clocks; a light lever arrangement that will slip between the revolving blades of the vane may be sufficient.

The operation of the apparatus is simplicity itself: Have all inductances of the regular receiving apparatus at zero unless your aerial has a small natural wave length,

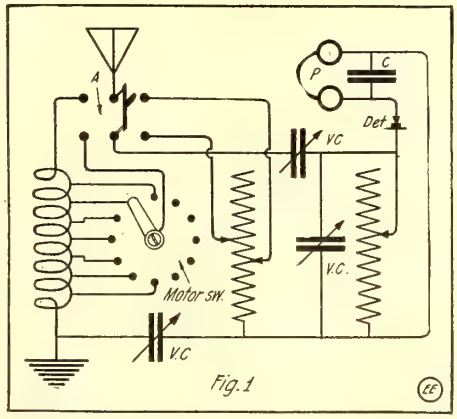
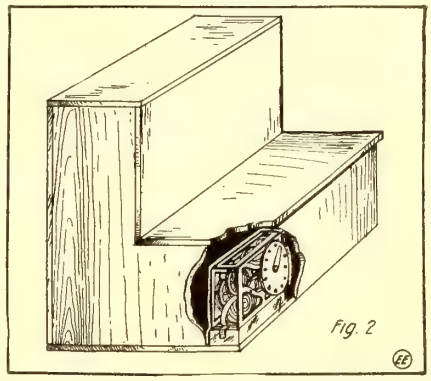


Diagram Showing How the Motor Switch Is Connected for Broad Wave Tuning in Picking Up a Station; Once the Station Is Heard, It Is Tuned in Sharply on Usual Instruments.

in which case it will be necessary to leave in some inductance of the loading coil, the amount of which will have to be determined by experiment. The condenser capacity will also have to be determined experimentally. Start the motor (clock-work) and "listen in" when any station or some desired station is sending, close switch (A), stop motor, and tune in station on regular receiving apparatus.



This View of Mechanical Inductance Changer Shows How Clock-Work (or Other Motor) Is Fitted Inside Cabinet.

ANENT THE HELMHOLTZ RESONATOR AS RADIO AMPLIFIER.

The application of the Helmholtz Resonator to radio work as described on page 266 of the August "E. E." had occupied some little of my time before the declaration of war, and in addition to its use as an amplifier as described, I found that even more important and useful is the effect that it has on interference of any kind.

The resonator transmits and amplifies sound waves of its own frequency, only. Hence any sound waves in the radio receiver differing in frequency from that of the resonator will not pass thru it. For example: say we have a resonator responsive to sound waves having a frequency of 500 cycles; we put this on a radio receiver in which a number of stations, including a 500 cycle set, are coming in, and in which, as well, considerable static is present. Static having a low, scratchy pitch will be excluded from the ear by the resonator, and signals of any station which does not have a spark tone frequency of 500 will also be excluded. The 500 set which you desired to copy will be all that you will hear thru the resonator and his signals will be somewhat louder than in the 'phones, due to its amplifying property.

I have been able to receive a friend's station excellently thru the worst QRM and static by having him vary his rotary until his spark pitch was in tune with, or at the same frequency with the resonator I was using. The only disadvantage is that the combination of 'phone and resonator can not be clasped to the ears as receivers are, but must be set on a table; making it a very uncomfortable position for the listener. Now who will make some practical improvement of this scheme so that the resonator and 'phone may be made in one unit and fastened to the head, receiver-fashion; and so cause it to be of real value to the wireless field?

Contributed by H. O. BIXBY.

RADIO EXPERTS WANTED!

To write up your new ideas and apparatus which have proven efficient and practical. Send us a short, clear write-up with sketches and photographs when possible. We pay good rates for all articles accepted. Address the Editor "Radio Department."

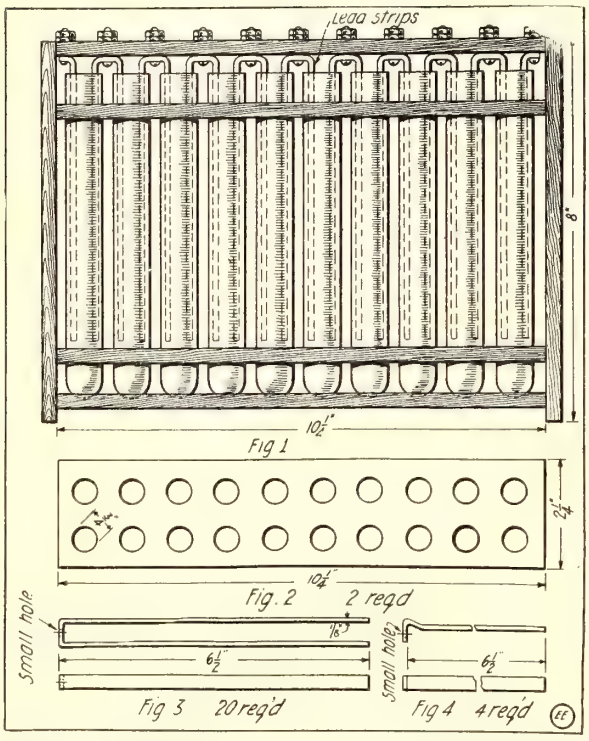
A HIGH POTENTIAL STORAGE BATTERY.

By Thomas Lewis Herren.
(University of Chattanooga.)

The chief drawback of the vacuum valve detector to the average amateur is the cost and upkeep of the high potential battery, which usually consists of 10 or 12 flashlight batteries. The writer here describes a high potential storage battery which has proved to be very efficient when used in connection with a vacuum valve, for testing purposes. The material required for it is as follows:

(20) 3/4 inch × 7 inch test tubes
18 strips of lead shaped as shown in Fig. 3
4 strips of lead shaped as shown in Fig. 4
1 rack or frame as shown in Fig. 1 and 2.

Enough solution of 25% sulfuric acid and 75% water (by bulk) to fill the tubes within ½ inch of the top. In mixing the sulfuric acid and water always pour the acid into the water, stirring vigorously with a glass rod meanwhile. The lead strips are fastened to the top strip of the frame by means of brass machine screws and nuts. Taps are taken from there to a multi-point switch conveniently located. The rack may be put together with small brass screws and glue. After the battery is assembled, it is ready for charging, which may be done by a small dynamo of about two amperes output. With a charging current of two amperes, the charge will be completed in about 15 minutes; with one ampere in about thirty minutes. It can also be charged by means of an electrolytic rectifier. This battery with usual care will give very efficient results and will last a number of years. It is only necessary to charge it about every three or four months, and sometimes less than that.



For Those Who Do Not Have Available a Direct Current Source For Operating Audions on, This Small High-Voltage Storage Battery Will Prove of Valuable Service. It Can Be Charged from a Small D. C. Dynamo or from Gravity (Blue-stone) Cells.

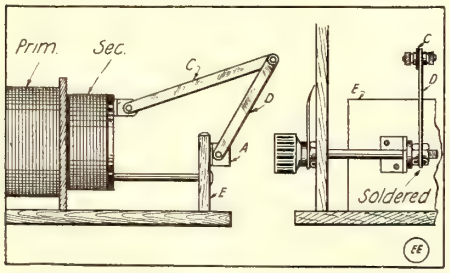
ROTARY ADJUSTMENT FOR SECONDARY OF COUPLER.

Many amateurs wish to make cabinet receiving sets, but hesitate to do so because there is difficulty in the coupling adjustment of the secondary.

As every amateur knows, the method of bringing the adjusting rod thru the end of the cabinet is not satisfactory, as it bends easily and causes no end of trouble. If they build their couplers as shown they can have rotary adjustment and it is very simple.

But little explanation need be given, as the sketches explain everything. This much may be said, however; make the angle bracket A out of very heavy brass, as this must stand all the strain. A scale may be placed on the outside of the panel and very close adjustment is possible.

Contributed by HOWARD STORCK.



With This Simple Lever Attachment Any Loose Coupler Secondary May Be Controlled from a Rotary Knob.

METHOD FOR INCREASING SENSITIVENESS OF SILICON AND GALENA.

I have found that silicon may be rendered considerably more sensitive for use as a radio detector when treated as follows:

Place the piece of silicon in a boiling solution of caustic soda (sodium hydroxoid) and boil for about five minutes. The solution should be about 10% strength. Remove from the soda and wash well, in five or six changes of BOILING water. Place in a solution of hydrochloric acid, made by mixing one part of strong acid with one part of water. Boil for about fifteen minutes. If the liquid is strongly colored repeat the operation. Wash the silicon well with hot water several times, then rinse with pure alcohol and dry. The pieces of silicon so treated should be kept in a closed bottle and should not be handled more than is necessary. I have treated silicon that would not work as described with excellent results.

To render galena more sensitive and also to resensitize a piece which is no longer useful, boil a piece of the mineral in a strong solution of ammonium acetate [$NH_4_2 C_2 H_3 O_2$] for about fifteen or twenty minutes. Pour off the liquid and boil several times with water, pouring off the water each time, then wash with alcohol and dry. Keep in stoppered bottles. To make ammonium acetate solution, take one ounce strong ammonia water and one ounce of water and add to it acetic acid in such amount, stirring constantly, until the odor of ammonia has gone.

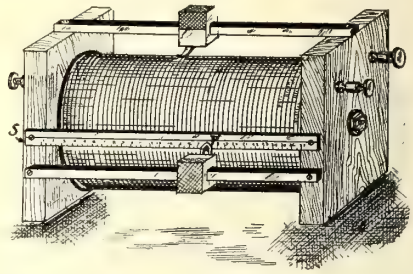
Contributed by ROBERT W. JAEGER.

THE SIMPLEST SPINTHARISCOPE.

Herewith is a description of a simple spinthariscope. It is composed of a "Radiolite" watch and a microscope. Focus the microscope on one of the numbers on the dial and you can see the emanation from the radium in the letters, striking the zinc sulfid. The stronger the microscope the better it works, but it must be in the dark. Contributed by BURLEIGH GARDNER.

SCALES FOR TUNING COILS.

Finding that a scale on a tuning coil is of great advantage in locating stations, I am submitting the idea for the benefit of some other amateurs.



This Precision Slider Indicator and Graduated Scale Will Enhance the Value of Any Tuning Coil Many Times.

The scale may be made of thin sheet brass covered with white paper and should be about half an inch wide and as long as the tuner. It is fastened at the side of the slider rod and the slider is equipt with a pointer, also made of brass, to move over the scale. The paper scales are very well pasted on tin strips to hold them rigid. The slider indicator is unique, the point itself being drilled and filed to leave an opening as shown—giving a precision form of needle, similar to that used on commercial instruments. When a station is tuned in, and after listening a while, the operator desires to tune in others, the number at which the pointer points is noted, and after listening to others, if the operator wishes to tune in the first one, all that is necessary is to move the pointer back to the number it pointed to before and the station is in tune, without waste of time in relocating it.

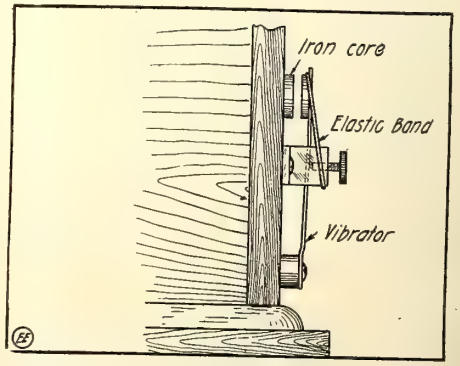
Contributed by SCOTT E. VANCE.

MAKING A SPARK COIL MORE EFFICIENT.

A novel way to make your spark coil give a much larger spark than usual is described below and can be done very easily.

Secure an elastic band and wind it around the top of the vibrator and the other end of the band around the thumb screw (the band should be tight). It will be found that the vibrator has been pulled back toward the thumb screw, thereby making a larger and more musical spark because the spring is stiffer.

Contributed by AN EXPERIMENTER.



To Obtain a Higher Pitch from Ordinary Spark Coil Vibrators, Simply Snap a Rubber Band Over End of Vibrator Spring and Bridge.

Useful Hints on Electric Motor and Dynamo Testing

By SAMUEL COHEN

UNDOUTEDLY many of the readers would like to know how small electric motors and dynamos are tested. It is the purpose of this article to show how it is done. With small machines it is not practicable to test the same way as one would a large machine. This article will deal with generators or motors below ¼ H.P. capacity.

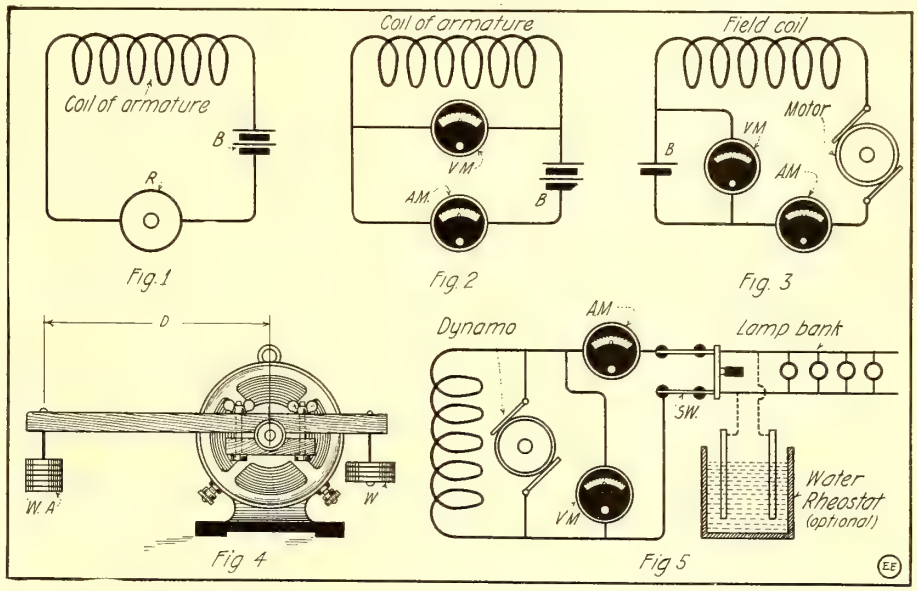
The first procedure is to test the armature and field windings for *continuity*. This is done by means of a galvanometer or telephone receiver. The indicating device is connected in series with the coil and batteries as shown in Fig. 1. If the coil is not broken, the galvanometer needle will deflect to one side, when the circuit is completed. Next, we have the test for *leakage*, that is, whether any part of the winding touches the frame. Join the wire from the galvanometer or receiver to the frame, while the other wire of the battery connects to the coil; if there is no movement of the needle when the circuit is closed, there is no leakage and the insulation of this particular winding is perfect. But if a *very* slight click or movement of the needle is observed, this may be due to the dampness in the insulation, which cannot be helped.

The commutator should now be tested with the battery and indicating instrument, in order to see that each segment is not short-circuited with its neighbor. This is best done by attaching one wire of the battery to one segment and the other wire of the galvanometer to the adjacent one; watch for any movement of the needle. If none occurs, it indicates that the segments are not touching. Each and every one of them should be tested in the same manner. It is advisable to test the resistance of each coil in order to find out that they have the same amount of wire, providing that they are wound with the same gage. If the commutator and the brushes are clean, their resistance will be infinitesimal in comparison with the coils and therefore it may be neglected. The general method is to connect each coil thru its corresponding segment to a Wheatstone bridge, either of the arm or box type. Instructions for the use of this instrument are to be found in any up-to-date electrical book. If a bridge is not at hand the volt and ammeter method can be successfully employed and connections for using them are given in Fig. 2. Connect as shown and take simultaneous readings on both instruments. After the readings are obtained, they should be next substituted in the equation $R = \frac{E}{I}$ (Ohm's law) where R is resistance of winding in ohms, I current in amperes and E voltage drop across winding. Two values of I and E are known and the third R is obtained by solving the equation. Every coil should be tested in a similar manner.

The various parts having been tested, the next step is to test the complete machine. In the first place it should be firmly screwed or bolted down and the bearings well oiled, the belt tightened, the brushes properly placed and making good contact with the commutator and see that all connections are firmly and properly made. The field coils should be tested for their proper polarity with a compass needle. If it is found that they possess the *same polarity*, one of them must be oppositely connected or else remagnetized by passing a powerful current thru them.

In testing motors, a volt and ammeter will be required and also a *prony brake*, a frictional device for testing the horse-power developed by a running machine. The instruments are connected as indicated in Fig. 3. The speed is also taken in these tests and this can be obtained by using a speedometer, which can be obtained at any hardware or machinery supply store. Fig. 4 illustrates a simple prony brake. It consists of two wooden blocks clamped on the motor pulley by means of two small bolts. The small weight "W" on the right is to counter-balance the longer arm, and should be adjusted until the brake is perfectly balanced on the pulley. This is very important. When the perfect balance is obtained the two bolts must be tightened, by turning the hand nuts, until the brake begins to clamp the pulley. When the machine is running, the nuts are tightened, and a weight "W A" is then added. This weight is increased in order to keep the brake balanced. As soon as the brake is balanced during the maximum run of the motor, the brake absorbs the power developed by the motor. A lamp bank, made up of miniature incandescent electric lamps or a water resistance will be needed for the absorption of the current. An ammeter should be connected in series with the lamp bank or water resistance, a voltmeter shunted across the dynamo brushes and a double-pole switch as indicated in Fig. 5. Now run the machine up to speed and then close the switch and regulate the resistance until the meters indicate the maximum output at which the machine is rated. If the machine is of unknown output then regulate the speed and load to the point where the maximum watts output is obtained with only slight heating of the machine. It should be kept running for one-half hour and the speed recorded every five or seven minutes.

If the machine fails to generate, altho connections are properly made, the direction of rotation should be reversed or the position of the brushes altered. If all these



The Present Discussion, With the Aid of the Accompanying Diagrams, Aims to Bring Out the Fundamental Tests to be Made On Motors and Dynamos, Both Large and Small. Every Radio Operator, Electrician and Experimenter Must Be Thoroly Familiar With These Principles, For They Are In Daily Application In Every Branch of the Art.

horse-power is then obtained just by multiplying the R. P. M. of the speedometer reading, by the distance "D" in feet, times the weight in pounds (W A) and then by the factor .000194. The horse-power can also be measured directly by means of the prony brake, by first loading the arm with a weight and clamping the brake on to the pulley firmly, then gradually increasing the speed of the motor and the longer arm placed upon a spring balance or scale. The former method is more practical for smaller machines as the power developed by them is very small.

The efficiency of a motor can be readily obtained by knowing the input in watts; that is, volts times amperes, and the power developed in watts. Then divide the latter by the former and the result obtained is the efficiency of your machine.

The result obtained in the prony brake test is in *foot-pounds per minute*, and to convert it into watts, it is necessary to divide the quantity obtained by 44.24.

In the case of testing a dynamo, some means must be made for absorbing the power generated, the same as the prony arrangements do not help, the only remedy is to remagnetize the field with some separate source of current until they are partially magnetized. Sparking at the commutator should be eliminated as much as possible; there are several causes for this, such as loose connections, dirty brushes, short-circuits, over-loading of the brushes, over-loading the machine and worn-out bearings.

The efficiency of a dynamo can be obtained in the same manner as in the motor. The efficiency equals the electrical output divided by the mechanical input. To illustrate this, let us take a typical example: suppose that a dynamo of 150 watts capacity requires a motor of ½ H.P. to drive it. What is the efficiency of the generator at its maximum load? The solution is as follows:—there are 746 watts in one H.P. therefore, ½ H. P. 373 watts; divide this into 150 watts which result is .42 and in terms of percentage, (*i, e.,* multiplied by 100) 42 per cent is the efficiency of that particular dynamo. The larger the machine the higher is the efficiency. The electrical output is obtained from the volt and ammeter readings.

THE CONSTRUCTOR



Experimental Mechanics

By SAMUEL COHEN

LESSON I.

THE mechanical and electrical amateurs of today are far better off than their ancestorial fellow amateurs who have bitterly strived in building their models without real tools. This of course was a great drawback in respect to rapid developments of certain devices which they were working with. However, the present day experimenter has the greatest mechanical facilities which he can utilize in the making of his various models. It is often found, however, that the experimenter with the greatest facilities on hand is unable to go forward with his ideas because of lack of proper equipment as he is unfamiliar with the tools, and the kind that he is required to purchase. On the other hand, many amateurs who possess a number of tools and other equipment are unable to obtain best results therefrom on account of lack of ability to handle them.

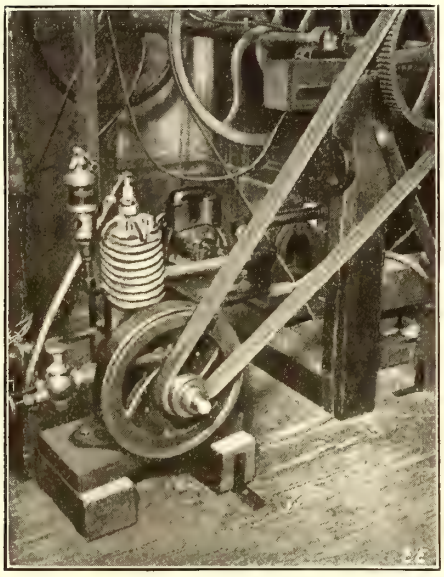


Fig. 2. A Very Satisfactory Work-shop Power Unit, Comprising An Air-cooled Gasoline Engine Rated At ½ H.P. It Is Belted to the Line Shaft. Two Small Dynamos Can Be Seen Just Back of the Engine.

Another great drawback which the amateur had to contend with is with the improper layout of shop and laboratory equipment and which case was noticed in the Amateur Contest page of this journal, and the various inquiries which the Editors have received. For the above reasons the author has endeavored to bring forth this series of lessons in order to indicate to the reader how to rig up a shop and laboratory so he can acquire the best methods of handling the more important tools.

The first and most important thing that the novice should consider is to obtain a fairly large room with plenty of light and sufficient ventilation. A room with the dimensions of 20 feet deep by 10 feet wide is just the size which would prove an ideal room and Fig. 1 shows a general layout of the various parts.

Of course, it is not compulsory to follow exactly the same layout since each one will be controlled by his resources and location. The lighting of the various portions of the shop should be either by electricity or gas; electric light being usually found in most of the homes of amateur mechanics.

It is presupposed that the reader has a fair knowledge of carpentry thus enabling him to construct the various shelves and benches. The most important one is the *shop bench* which is made from 1 inch stock and measures 7 feet long by 2 feet wide. The legs should be made of heavy square timber and 3x3 inches is quite ample. Nails should not be used in joining the various sections; use ample large size wood screws. Shelves should be placed in convenient locations. The tool cabinet may be of the drawer type which can be utilized for holding various measuring tools and different sizes of drills, taps and dies, etc.

In selecting the various tools necessary to carry on the shop work it is advisable for the novice to write several of the best toolmaking concerns for catalogs, in order to obtain the best idea as to prices and quality of the goods.

Let us consider that the reader has acquired a good judgment as to the company from which he would purchase his tools. The first tool he should obtain is a good vise, which should be of the parallel jaw type and its size may vary from 2 to 5 inches. It will be found that the 2 inch size is excellent for light work while the 5 inch variety is suitable for heavy work. The former type should be fitted with auxiliary lead jaws and the latter with copper ones. It is advisable that the vises be so mounted that the operator can work with the smaller one while sitting down.

The next important tool is the lathe and in this case great care must be exercised since several factors control the selection. First, you may decide to start with a plain lathe of good quality, so constructed as to admit of conversion to screw-cutting at a later date, or the experimenter may get one of the several low priced screw-cutting lathes on the market.

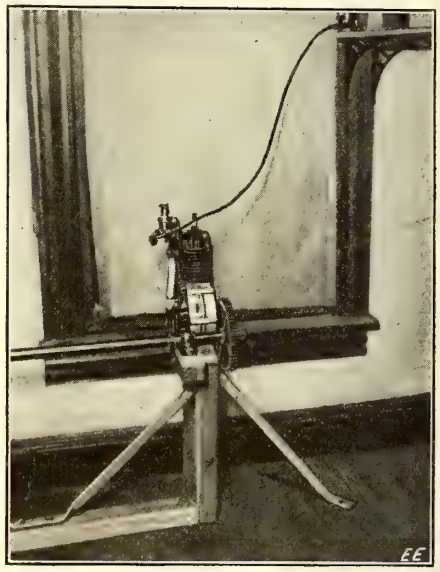


Fig. 3. This Form of Drive for An Experimental Work-shop Makes Use of a 3½ H.P. Motorcycle Engine. It Is Geared to the Line Shaft. A Rawhide Or Comprest Paper Pinion On the Engine Will Reduce Any Noise.

In the first place and before purchasing the lathe, some form of motive power should be considered so that undue trouble may be eliminated when the necessary equipment arrives. The author at first utilized a foot-operated lathe, which he has found to be entirely satisfactory for beginners and for handling light work. However, he has found that for doing actually good work on a lathe some other form of motive power is required and a small gasoline engine of ½ H.P. was utilized with great success in driving a 9-inch swing screw-cutting lathe. In Fig. 2, this engine is shown coupled to a countershaft by a one-inch belt. The exhaust pipe is led out thru the window and the whole engine is substantially secured to the floor as noted.

In opening our new department, "Experimental Mechanics," we do so with the full conviction that it will be welcomed enthusiastically by the majority of our readers.

Mechanics and electricity are so closely interwoven today, that neither can possibly do without the other. Too many experimenters and amateurs are dependent these days upon machine shops, cabinet makers, tinsmiths, etc., when wishing to build certain new apparatus or instruments. Every amateur experimenter should be able to build his entire "rinktum" right at home, without outside help.

And by studying the lessons of our new course, he will be placed in a position whereby he will accomplish this end—and much more. Thousands of very lucrative positions are open to the man who knows how to handle tools and how to build models from the base to the last gear. And such experience can only be gained by doing the work with one's own hands. The time spent and the money invested in the necessary equipment will most assuredly pay handsome dividends, and rapidly at that.

It runs very quietly in this manner and the consumption of fuel is very small. A 3½ H.P. motorcycle gasoline engine was also utilized at times which is illustrated in Fig. 3.

This was an old discarded engine which was overhauled and repaired and then utilized for power purposes. The countershaft was geared to the engine as shown. It is advisable that the prime mover be in the form of either a gasoline engine or electric motor; the latter is more advisable since it is very steady and noiseless and further, its power can easily be utilized for driving the various machines by individual drive, which will be treated on in a later article.

Many readers, of course, will not want to secure an expensive lathe and for them the author advises a treadle operated, small speed lathe, and the amateur today can obtain a fairly accurate one for about $25.00. The beginner will find this type of lathe very satisfactory, and for the first several months he should become familiar in handling ordinary *hand* turning tools for both wood and metal. He will then be in a better position to manage his more complicated lathe, and he will never regret the time spent. Later as he becomes a master in handling the ordinary lathe with hand tools, he should then proceed to purchase a more expensive one, and it is an excellent plan to keep the cheaper one for wood turning and metal spinning.

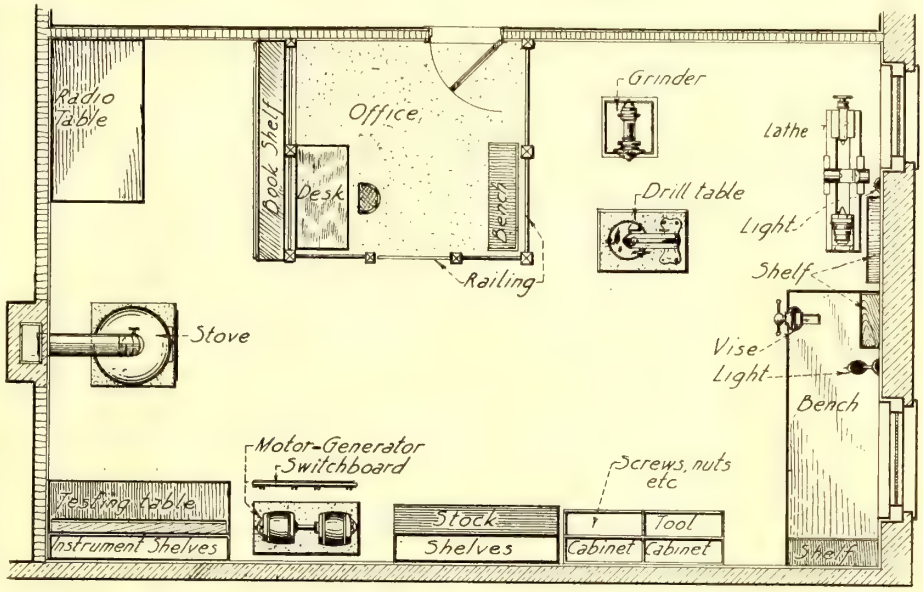


Fig. 1. A Very Efficient Arrangement of the Various Machine Tools, Benches, Shelves, Etc., Is Shown in the Plan Herewith of the Author's Work-shop.

When procuring a lathe the following accessory tools will be found necessary: A face-plate, driver-plate, two centers, and a hand tool rest, together with a dozen or so ¼ inch bolts and nuts for clamping purposes. One of the most valuable tools for the lathe will be found to be a chuck, which is not usually furnished with the lathe, and this device is very essential, especially when metal turning and drilling is to be done. A self-centering three or four-jaw chuck can be purchased for a nominal sum and it will repay the purchaser in a short time.

The operation and the handling of the lathe will be fully treated in the second installment of this series. Having obtained the lathe the following list of tools will be found very useful and the writer suggests that the beginner should not purchase the complete list at one time, but gradually until the set is completed.

The first thing is the hammer and two are sufficient, one about 4 oz., with a cross pene, and one 2 lbs., with the ball pene. The smaller should be purchased first since much work can be done with it. A copper or brass as well as a raw-hide hammer is useful for finishing up work. This of course is optional to the amateur.

A hack-saw is most essential and it should be one of the best make; a good one can be secured for about $1.50 and it should be of the adjustable type in order to handle blades ranging from 6 to 12 inches. The tension is adjusted by the handle, which should not come off at the critical moment. The blades should usually have fine teeth (23 per inch), but for certain work such as in cutting cast or wrought iron the "star" coarse pitch blade is the only one to use. Fine pitch blades with many teeth, are good for brass and copper.

The next important tool is the *file* and on its quality and suitability to the job depends the pleasure of one's work. They should, therefore, be very carefully chosen. The following will be found satisfactory for the start:

(1) For heavy work—One 12 inch hand second-cut; one 12-inch half-round, second-cut.

These will be found invaluable in taking off a lot of metal, as a good sweep can be gotten without fear of bruising one's knuckles.

(2) Medium work—One 8 inch hand, second-cut; one 8 inch hand smooth; one 8 inch half round, second cut; one 8 inch half round smooth; one 8 inch three square, second-cut; one 8 inch round, second-cut and one 8 inch square, second-cut.

(3) Very light work—One or two sets of six 4 inch files of various shapes (flat, half round, round, square and knife) will be found most satisfactory.

A metal brush for cleaning the files will be required and it should be seen that the wire bristles are substantially inlaid so that they are prevented from falling out when brisk cleaning is done.

Chisels—These are readily made in the shop as one can select one in whatever shape or size he desires. The general type of chisels used are the half-round, diamond, cross cut and flat.

For center marking holes after having been laid out *center punches* are used. Two are generally sufficient, 4 inch long, one large one, about 3/16 inch in diameter at the end, and one small one about 3/32 inch diameter.

In regards to *drills* it is advisable to invest in a complete set, ranging from numbers 1 to 60, including a drill stand. It seldom happens that the amateur employs drills larger than a ½ inch and for this larger group the following will be found handy:—¼, 5/16, ⅜, 7/16 and ½ inch. If the novice is unable to purchase the complete set, he can at first simply buy the drills which will suit his purpose most advantageously.

The problem of procuring *stock* and *dies* for the amateur work-shop is important and for this reason it is advisable to procure the following:—2-56; 4-36; 6-32; 8-32; 10-32; 10-24; 12-24; 14-20; ¼-20. All these should be of the same diameter, so that a standard holder will suit. The ⅝ inch type was found to be very convenient. For each *die* the corresponding *tap* should be obtained. In stock and die sets, taper and plug taps are usually included. An adjustable tap wrench should be procured.

Pliers and *Nips* are included among the hand tools and for the former the parallel jaw type is recommended. Toggle jointed cutting nippers are advisable. Gas pliers will be found at times very useful.

Scales and Gages—Among the most important tools in the shop this class should be of the finest grade as the accuracy of the finished work will depend a great deal upon the condition of the layout, which naturally is reflected to a certain degree upon the measuring instruments. A twelve-inch steel scale with the following division will be useful:—⅛, 1/16, 1/32, 1/64 inches. There are several good makes and these can be procured at a nominal price. Inside and outside spring calipers of the 10-inch variety are very handy; a tool-maker's spring dividers and combination square with a "V" centering block is very useful and the amateur should not be without it. A protractor attached to the combination square is very desirable if it is required to layout parts at various angular positions. A combination drill-thread and screw gage or a drill and wire gage (a good one is the "Time Saver"), will be found invaluable. As the novice becomes more experienced with handling measuring tools he can then invest in a micrometer.

The various other hand tools which should be among the other shop equipment are the following:—ratchet, screw driver, wood chisels and planes, hand brace, hand drill, augers, awls, broaches, reamers, glass cutters, wood and iron clams, hand vises, center gage of 60 degrees, countersinks for wood and metal, level, and metal shears.

Grinders and *Polishers*—These should consist of two heads, one for grinding work which should have a spindle fitted for two grindstones, one a corundum wheel, while the other side has a carborundum wheel. It will be found that these types of wheel will be most suited for the work which the amateur will meet with. The other, or polishing head, should be of a lighter construction and the spindle ends should be tapered in order to hold polishing wheels. In some of these polishing heads an extra arbor is made on the same shaft, so that a grinding wheel may be attached to the same head. For the one who does not care to employ two heads, the latter is therefore advisable.

The driving power for these heads can either be a motor or foot-power. If the former is used, a ⅛ H.P. electric motor will be sufficient to drive it. However, if the latter form of power is utilized an old sewing machine foot treadle will be found very useful and cheap to procure.

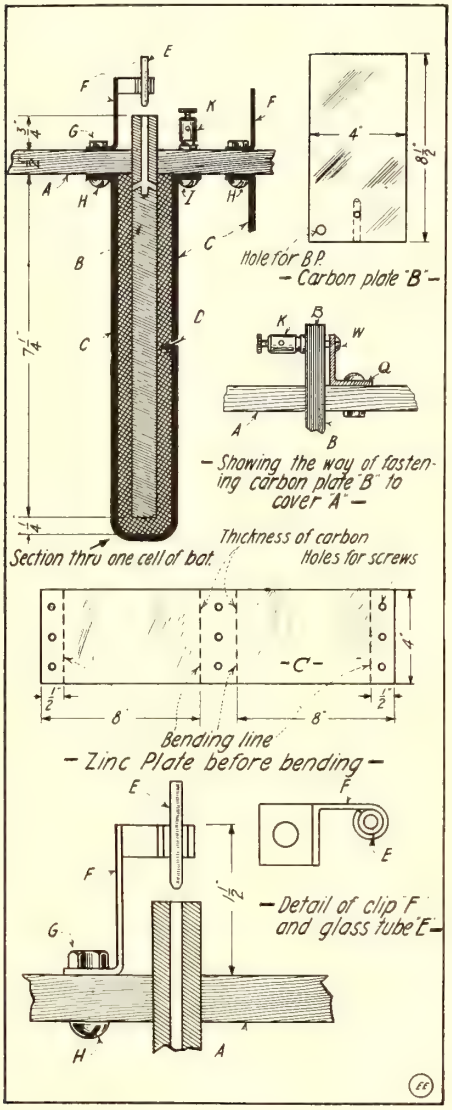
Drill Press—Altho this is not very essential to the beginner, (as most of the

(*Continued on page* 653)

A New Type of Chromic Acid Battery

By C. A. OLDROYD

THE great advantage of all chromic acid batteries is their high E. M. F., namely 2 volts. The voltage drops, however, very quickly if the battery is in use for more than about 10 minutes. Various designs of chromic acid



Electrical Students Are Always Partial to the "Chromic Acid" Battery, Chiefly Because Its Potential Is High—viz., 2 Volts. The Author Here Describes How to Build a Very Ingenious and Improved Form of This Useful Battery.

batteries have been brought out, at different times, to overcome the inconstancy and the author will describe in detail the construction of a modified chromic acid battery that will supply a constant current as long as the exciting liquid lasts.

This battery can be built very easily and cheaply and is "just the thing" for spark coils, small motors, electro-magnets, etc. The battery described here consists of five cells; thus giving a total voltage of 10 volts when connected in series. A battery with any number of cells can however easily be built from the directions given.

Each cell consists of a carbon plate B, which is fixt to a wooden cover A. A strip of zinc plate C, bent as shown, encloses the carbon plate B and between B and C is a thin layer of "glass wool" D; that is spun glass, which is used for pocket accumulators and many other purposes. The zinc plate C is fastened to A by means of screws H and I. The latter carries a binding post K, while H is fitted with a nut G.

A small hole is drilled on the center-line of the carbon plate B and two holes are drilled from the sides of the plate to meet the hole first mentioned. The chromic acid is fed into the vertical hole and passes thru the two holes out of the carbon plate B into the glass wool layer D. After passing to the bottom of D the chromic acid leaves the cell thru some holes in the zinc plate C.

The chromic acid is fed into B thru a small glass tube E, which is connected to a container M by means of rubber tubing. The end of E is drawn to a fine point, so that the exciting liquid enters the hole in B in a very fine stream or only as drops, as the amount required is very small. The tube E is held in position by a small clip F which is fastened to A by the screw H and nut G. After leaving the cell, the chromic acid collects at the bottom of the battery jar, as shown in the general arrangement, and is finally drained away thru a glass tube S into a storage bottle R.

To build this battery procure first the carbon plates B; as all the other dimensions are fixt by the size of B. These plates should be about 4" wide by 8½" long. Drill a hole in the right hand top corner of B to suit the screw W. Then drill a vertical hole about ⅛" dia., on the center-line of the plate 1½" deep and from each side a similar hole to meet the vertical hole. The carbon plate B is now finished and we turn to the zinc plate C. The zinc used should be at least 1/16" thick. A strip of the length required is obtained and bent as shown in the sketch. After bending, and not before, amalgamate the zinc plate C.

We can now assemble one cell. A slot is cut thru the cover A to allow the carbon plate B to pass thru and B is fastened by means of a small clip Q made from brass strip about ¾" wide. A screw W is now past thru Q and B and fitted with a binding post K.

We now fit the zinc plate C to the carbon plate B, so that a clearance of at least ⅛" exists all round between the carbon plate and the zinc plate. This clearance is now filled with glass wool and the easiest way to do this is to take a few strands of glass wool at a time and to push them into place by means of a steel rule or a knife.

Now comes the tube E. Take a short length of glass tubing, such as used for chemical experiments and heat it in the middle in the flame of a Bunsen burner till it becomes quite soft. Then remove it from the flame and taking one end of the tube into each hand, pull the ends apart and you will find that the tube is now tapering to a fine point in the center. Break it there and grind the ends down till the opening is big enough to admit an ordinary pin.

The clip F, for the tube is made from thin brass plate and bent as shown. A hole is drilled thru the foot of F to allow the screw H to pass thru. Now adjust the clip so that the outlet of the tube is directly over the hole in the carbon plate. In this way all the cells required, in our case five, are completed and a battery jar of sufficient size to allow at least 1" clearance all round is procured and the cover A fitted to it. One of the rectangular jars used for storage batteries will do very well.

Near the bottom, a hole has to be drilled thru the wall of the jar and this is done best by a glazier, who will do this for a nominal sum. A glass tube S, fitted with a cock U, is fixt into the jar by means of a rubber stopper T. A small glass tube V is fixt into the cover A, after having been bent as shown. A container M of about ¾ of a gallon capacity and tubulated near the bottom is procured and fitted with a cock N. To this cock a branch-piece, having five branches, is joined by means of a short length of rubber tubing and each branch is connected to the tube E of each cell. The container M is now filled with chromic acid and the cock N opened. The exciting liquid travels now thru the branch piece and tubing to E, thru B into the glass wool D and thru the holes at the bottom of the zinc plate into the jar and from here thru S into a bottle R. Adjust the cock N in such a way that the liquid leaves E in drops. To clean the battery after use, close cocks U and N and connect tube V to the watermain; fill the jar with water, allow to stand for a few minutes and drain the water off and the battery will be quite clean.

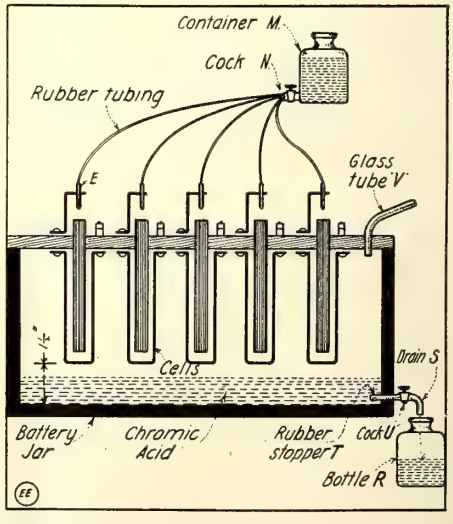
TO KEEP DRY BATTERIES FROM SHORT-CIRCUITING.

When a number of dry batteries are placed closely together in a damp place, the moisture is apt to soak thru the paper covering, making an electrical connection between the zinc casing. To avoid this, remove the cardboard casings and wrap a double layer of friction tape (ordinary bicycle repair tape) around each dry cell near the top and near the bottom. Also stretch two layers of the tape along the shelf about an inch and a half apart. This will insulate the cells from the shelf in case the latter gets wet or damp, while the tape bands will keep the casings from coming into contact with each other even if set close together.

Contributed by PETER J. M. CLUTE.

PRESERVING CORKS FROM ACIDS AND OTHER ALKALIES

I had considerable trouble with the corks which I used in the bottles in my laboratory, from being corroded by acids and other alkalies, so I used the following process to preserve them:—I boiled them for some time in paraffin; they must be kept under the surface of the hot wax and should be heated and allowed to cool, re-



Diagrammatic Arrangement of 5 Cell, 10 Volt, "Chromic Acid" Battery Provided with Means for Circulating the Electrolyte and Cleaning the Container.

peating this several times, so as to get all the air out of the pores. When they are treated as above they cut easily and make very close joints.

Contributed by EDWIN MOTZEL.

The Ultra-Microscope and The Underworld of Infinitesimal Small

By FRANK M. GENTRY

"WHAT is the ultra-microscope and what has it bequeathed to science?" is a question that can be answered by scarcely one person in five thousand. If you must know of this little known but very interesting and vastly important scientific instrument, sharpen your imagination and let us travel into the underworld of infinitesimal small and roam midst molecules and atoms.

When salt is placed in water, it immediately disappears; that is, it dissolves or goes into solution. Just what happens when a substance goes into solution fooled the chemists for many years and, for that matter, has them puzzled yet. Some say it is a case of the mere mixing and intermingling of the molecules, others say it is a case of chemical combination, still others believe it to be an aggregation of the former theories, while many uphold the theory of electrolytic dissociation or ionization. However, it is not our purpose to argue the points of the several hypotheses but rather to study the properties of solution.

If we pass a salt solution thru filter paper we obtain no residue. Again, if we force the liquid thru animal membrane (which has no visible pores) the salt is not yet removed from the water. Salt cannot be removed from solution by any process of filtration. Conversely, if a little starch be dissolved in water, it presents all the characteristics of a true solution until the mixture is forced thru animal membrane, when the starch is recovered from solution as the residue. These mixtures were called by Prof. Graham, of London, *hydrosols* or simply *colloidal* solutions.

Prof. Bredig of Heidelberg prepared metals in the colloidal state by placing two wires of the desired metal in a shallow dish of water and forming an arc, until the solution became saturated, by passing an electric current of forty volts between the electrodes. Colloidal platinum is a deep brownish black color, the gold is a beautiful ruby and the silver is a splendid yellow.

The beautiful ruby glass prepared at Jena and used in church windows and photographic dark-rooms is produced by the introduction of minute quantities of gold into the glass. The state in which the gold existed was long a subject of bitter controversy. Was the color due to gold in solution or was it due to particles of finely divided gold suspended in the glass? Was it a case of true solution or of colloidal suspension? It was this question that led Siedentopf and Zsigmondy to develop the ultra-microscope.

The ultra-microscope consists essentially of an especially constructed microscope of high magnifying power and lenses which serve to bring a powerful beam of light to a sharp focus within the object, perpendicular to the line of vision. There are two theories regarding its operation.

The older explanation, based upon the law of sympathetic vibrations, assumes that since the smallest particle discernible by the ordinary method is about 0.0002 mm., or about 1-127,000 of an inch, which is very near the value of half a wave-length of visible light,—the only way in which a particle of greater minuteness could be made visible is by causing it to emit a light of its own, that is, become self-luminous. Accordingly, a great amount of energy in the form of light is brought to bear by means of powerful lenses upon a comparatively small region of the object under examination. This great concentration of vibrating energy causes the small particles to vibrate in unison with itself and these vibrations, being radiations of visible light, cause the particles to become self-luminous and visible thru a powerful microscope. This beautiful theory, altho romantic, is far fetched and has given way to a later explanation.

The second theory, based upon "Tyndall Phenomenon," is the one generally accepted by science today. It makes use of the principle that dust suspended in the air, while invisible in the open sunlight, is easily seen in a dark room under the illumination of a beam of light. If a beam be past thru a beaker of water it is invisible, but if the same beam be past thru a colloidal solution it is easily traced by a diffused streak. Thus when the submicroscopic particles are illuminated by the coaxial method, employed in ordinary microscopes, they are invisible, since they are encircled by the light waves themselves. But when illuminated by a thin plane of light not exceeding eight wave-lengths, the sub-microscopic particles become visible, on account of diffraction, as bright objects upon a dark field.

But whether this or that theory is correct, is of no concern compared with what has been learned by the use of the ultra-microscope. In former times the limit of direct observation with the best compound microscope was 1-8333 of a millimeter with the aid of a special immersion. Today the limit of visibility of the ultra-microscope is directly proportional to the specific intensity of illumination. With the aid of intense sunlight sub-microscopic particles of 0.0000039 mm., or about 1-6,777,685 of an inch have been detected. The magnification of the present instrument with the most powerful beam obtainable is approximately,

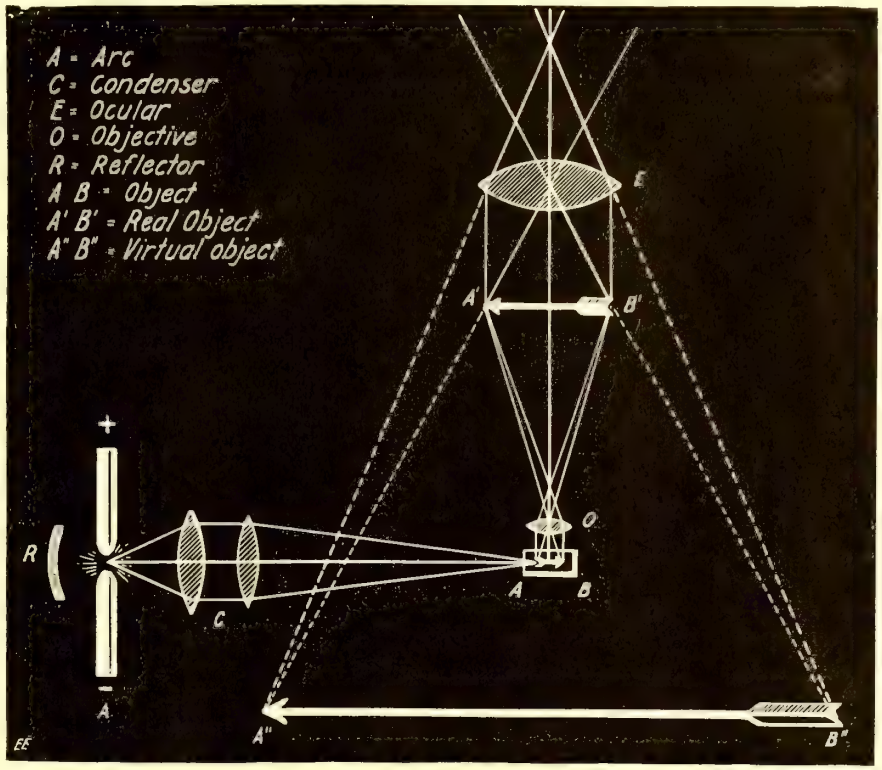
$$\left[\frac{1}{1/600 \div 1/6{,}777{,}685}\right]^2 = 127{,}602{,}778.8996$$

times; where 1/600 is equal to the limit of the unaided eye's resolving power in inches. The hypothetical diameters of the larger molecules are: hydrogen 1-10,000,000 mm., ethylalcohol 5-10,000,000 mm., chloroform 8-10,000,000 mm., and starch 5-1,000,000 mm. Thus we see man on the verge of distinguishing the molecules and atoms, things which scientists dared not dream, and in fact, "the large molecules of albumen and of certain fluorescent substances have actually been seen!"

Gaidukov has shown that the protoplasm, the nucleus of a cell, the starch grains, and the chlorophyll grains consist of a thousand sub-microscopic particles. So far, however, not a single sub-microscopic organism has been discovered which has not led to a disagreement between the investigators themselves. The ultra-microscope has found its greatest use in determining the condition of solutions. It has been shown that coloidal solutions contain minute particles of varying size; that there is no distinct difference between true solutions and hydrosols; and that it is possible to pass gradually from one to the other. The particles of finely divided gold have been seen suspended in ruby glass. Since the size of the beam of light could easily be calculated, the particles counted and, knowing the specific gravity of gold and the weight introduced into the glass, it was an easy matter to arrive at their average size. The gold dust in ruby glass averages 1-6,000,000 of an inch in diameter.

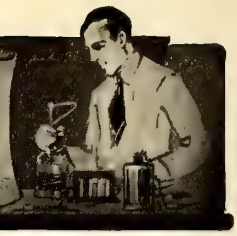
The lack of exact reproductive power is the chief defect of the ultra-microscope. It is impossible, however, to eradicate this fault at the present, since the particles are made visible by the interference rings caused by diffraction.

(*Continued on page* 653)



The Finest of Scientific Researches Are Made Possible Only by the Application of the "Ultra-Microscope." This Remarkable Yet Relatively Simple Device Consists Essentially of an Especially Constructed Microscope of High Magnifying Power and Lenses Which Serve to Bring a Powerful Beam of Light to a Sharp Focus Within the Object Perpendicular to the Line of Vision.

HOW TO MAKE IT



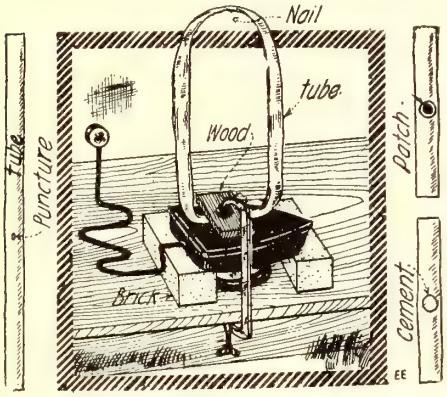
This department will award the following monthly prizes: **First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.**
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

AN ELECTRIC IRON VULCANIZER.

All Bugs and Buglets who own flivvers, etc., may find this wrinkle of some value in saving a small part of the vulcanizer's bill which is always large, by following these instructions closely. First clean the tube around the puncture thoroly with gasoline, now apply some quick cure cement by smearing it on with your finger (don't lick your finger), covering a space about the size of a quarter, next cut out a piece of raw rubber or gum about the size of a dime and cover the hole, but be sure that the cement has dried perfectly before doing so; now all is ready for the cooking.

Hunt up an old electric iron and clean off the smooth surface so there is no rust or other dirt and heat it to about the temperature that is used for ironing and clamp the tube down firmly, then let it cook for five minutes. When you take it off you will have a patch that will not readily come off.



If You Possess or Can Borrow an Electric Sad Iron, It Then Becomes a Simple Matter to Vulcanize Tires in a Few Moments.

And as for the cement and gum you can obtain that at any rubber supply house or vulcanizer.

Contributed by
THEODORE F. LITER.

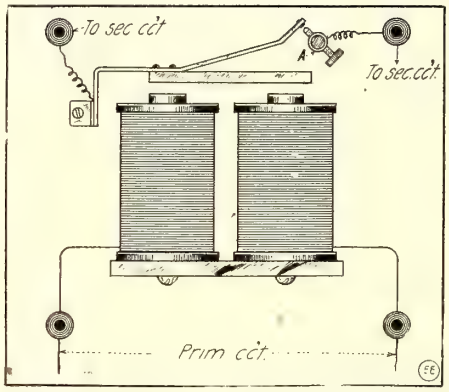
APPLICATION OF RADIO-ACTIVE SALTS TO BATTERIES.

A recent French patent, due to M. H. G. C. Thofehern, is concerned with the use of radio-active material for the purpose of facilitating the chemical action taking place in accumulators. For this purpose radium barium sulfate is suggested. The material is insoluble in the electrolyte, and does not appear to enter into chemical combination with the lead oxid or the metallic lead of the plates. Its presence, however, is assumed to render the chemical action more complete during charge and discharge; otherwise the process is normal. About 0-2 microgrammes of radium per pound of lead oxid is used, the radium compound being merely incorporated in the oxid used on the plate grid.

SECOND PRIZE, $2.00

SIMPLE RELAY MADE FROM BUZZER.

The relay here shown is made from an old bell or buzzer and is fairly sensitive. Twist the adjustable contact screw around as at (A) and bend the circuit-breaking contact spring as shown.



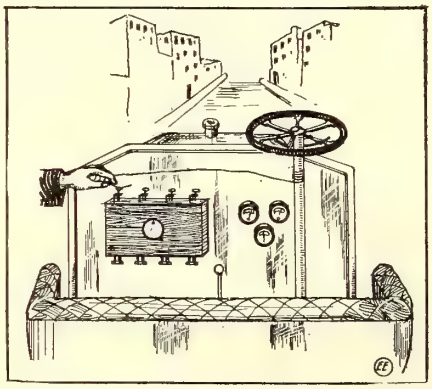
The Simplest Relay Is Made by Twisting the Contact Screw Post on a Bell or Buzzer to the Position Shown, Also Bending the Armature Spring a Trifle.

A wire from (A) is run to a binding post and another from the armature to a binding post.

Contributed by
EDWARD M. WYLAND.

ADJUSTING AUTO COILS.

To adjust the spark coils on an automobile, without leaving the car and turning each cylinder circuit to contact on the commutator, a wire may be grounded on the steering wheel shaft, the switch closed and the top of each vibrator screw touched with the end of the wire until the proper buzz is heard.



Easy Method For Testing and Adjusting Auto Ignition Coils.

Contributed by JOHN SCHMITZEIS.

TEST PAPERS

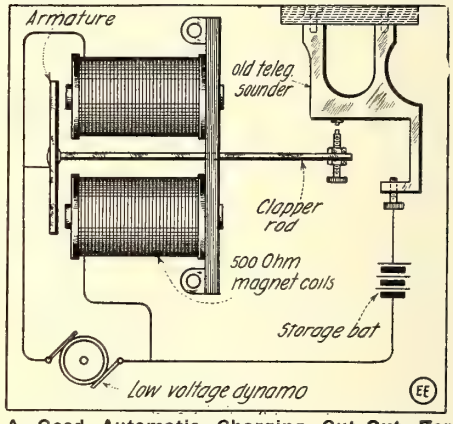
The following are some test papers which I think the experimenter will find useful.

THIRD PRIZE, $1.00

HOME-MADE BATTERY CHARGING CUT-OUT MADE FROM POLARIZED BELLRINGER.

Having some storage batteries I wanted charged and being unable to watch them all the time, I thought of the plan shown in the drawing and it has worked successfully so far. The operation is as follows: When the dynamo generates the proper current, the 500 ohm magnet coils (polarized telephone ringer) are energized, which closes the contact attached to the clapper rod. The storage battery begins charging now and continues to charge until the dynamo stops or something happens, whereby the contact is broken; thus shutting off the battery "juice" from the line.

Contributed by ERNEST JOHNSON.



A Good Automatic Charging Cut-Out For Batteries Is Readily Made From a 500 Ohm Polarized Ringer As Shown.

Use the best filter paper cut in strips, immerse in the solution, and dry in an atmosphere free from ammonia or hydrogen sulfid.

Ferrous sulfat Fe_eSO_4. Dip in solution and dry; test for hydrocyanic acid cyanides. Gives a blue color.

Iris paper. Make extract of the roots of the Blue Iris (Iris versicolor). Dip paper in solution. Dry.

Neutral solutions give blue; acids red; alkali green.

Lead Acetat. Dip in solution and dry. Sulfides give black.

Pole test paper. Dip in a solution of phenolphthalein and dry. Then in a solution of sodium sulfate.

Negative pole gives *red* spot.

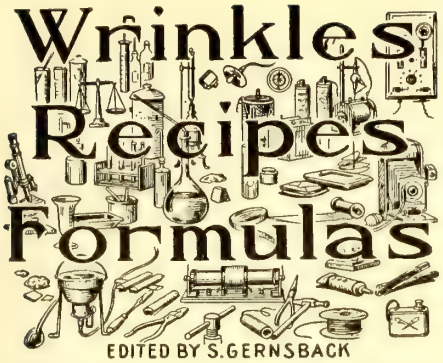
Potassium bichromat. Same as other papers. Lead salts give yellow. Silver salts red.

Silver nitrat. Keep in a dark bottle. Lead gives black; Arsenic yellow; Chromates red.

Dry in air free from H_2S.

Potassium ferrocyanid. Ferric salts give blue. Cupric salts red.

Contributed by F. G. HOPPER.



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

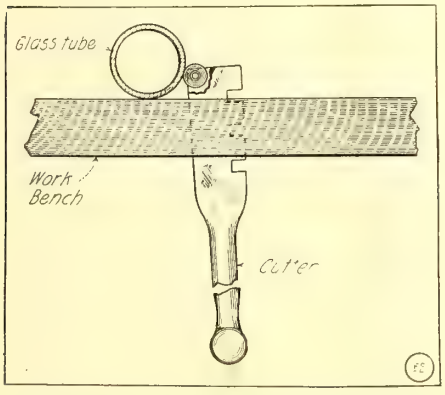
HOW TO MAKE A CHEMICAL GARDEN.

Place a quantity of sand in a wide mouthed bottle or fish aquarium to a depth of about three inches. Slightly imbed a few pieces of copper sulfate, aluminum sulfate, iron sulfate, chrome alum, lead acetate, calcium chlorid, magnesium and manganese sulfates, in the layer of sand (all these chemicals can be purchased at any drug store). Make a solution of water glass (sodium silicate) one part water glass and three parts water, pour this solution carefully over the sand and chemicals. In about a week a dense growth of the silicates of the various bases will be seen, in various colors and fantastic shapes. Now displace the solution of the water glass with clear water, by conveying a small stream of water thru a small rubber tube into the vessel, which will gradually displace the solution of water glass. Care must be taken not to disarrange or break down the growth with the stream of water. Other sulfate such as chromium, nickel, cobalt, etc., may also be used. When successful this produces a very beautiful scene.

Contributed by ALBERT W. PUTLAND.

HOW TO CUT GLASS TUBES.

A good way to cut glass tubes with the ordinary glass cutter is to bore a hole in your work bench and fit a glass cutter in it with the handle down, so that the wheel is about one eighth of an inch above the level of the bench. Lay the tube to be cut against



Cutting Glass Tubes Is Always a Problem to the Amateur. Here's a Simple Method Using an Ordinary Glass Cutter.

the cutting wheel of the glass cutter and turn with the hand as shown in the illustration. This scores the glass so that the tube may be easily broken with the hands.

Contributed by LAVERNE WISE.

SIMPLE TESTS FOR LEAVENING CAPACITY AND PURITY OF BAKING POWDERS.

To ascertain the leavening capacity, place as many glass tumblers in a row as you have baking powders to test. Measure half a teaspoonful of each baking powder into a tumbler by itself, and fill two-thirds full of clear, cold water. Set the tumblers between yourself and the light, observing which throws off the larger amount of tiny gas bubbles. The one that liberates these in the greatest abundance, possesses the highest leavening power, as these tiny globules developing in the dough, cause it to rise and become light.

To test for purity place as many teacups in a row as you have baking powders to test. Deal a teaspoonful of each into its separate cup. Pour a very little boiling water from the teakettle into each and in about two minutes fill with boiling water. After they have stood half an hour to cool, pour each into a separate glass tumbler and set aside to rest. The baking powders that are pure and free from stuffing will be completely dissolved and the water will be as clear as crystal. The cloudiness and precipitate at the bottom of the impure ones will tell the amount of adulteration and of impurity. The tumbler with its solution as clear as crystal contains pure cream of tartar and no adulterants. The tumblers containing turbid solutions and yielding small precipitates contain little cream of tartar but phosfates of calcium and stuffing. The tumblers containing very turbid solutions and yielding heavy precipitates contain no cream of tartar, whatsoever, but plenty of alum and stuffing.

Baking powders containing pure cream of tartar are recognized to be the best by experts while those containing phosfates and alum are regarded to be unwholesome and detrimental to our stomachs.

Contributed by
FRANK BECHTOLD, JR.

BLUE PRINTING

To obtain *white* lines on a *blue* ground:

SOLUTION No. 1.
Ammonia Citrat of Iron.....1 oz.
Water .....4 oz.

SOLUTION No. 2.
Ferricyanid of Potassium.....1 oz.
Water .....4 oz.

COATING SOLUTION:

Directions—Mix equal portions of solution No. 1 and No. 2. Coat the paper with a camels hair brush (like painting) or rub on solution with a tuft of absorbent cotton. Any good bond paper will do, a mat surface writing paper is good. Paper should be dried after coating in a dark room, develop in water.

Contributed by
JOHN BLACKHURST.

TIN PLATING

To tin-plate a small article like a copper penny or a copper statue proceed this way. Put a half teaspoon of tartaric acid in a bright and shiny tin cup. Put the article in the cup and fill the latter about three-fourths full of water and set on stove to boil. Boil till water is nearly all driven off. The article is now tin-plated and a little polishing will make it shine as bright as a new dime. In this experiment the tartaric acid dissolves the tin and plates the object which is in the cup.

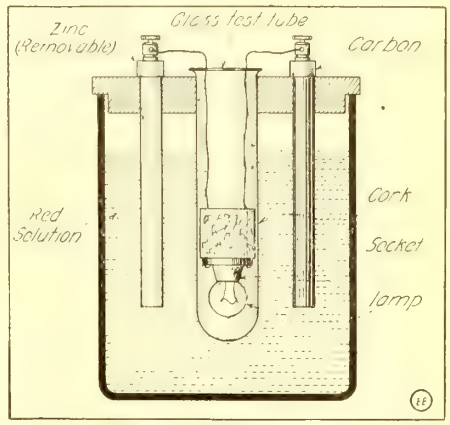
The object to be plated must be clean and free from dirt or it will plate unevenly. To clean the article dip in weak sulfuric acid and dry.

Contributed by
MANSELL SARGENT.

IMPROVED BICHROMAT DARK-ROOM LAMP FOR PHOTOGRAPHERS.

Some time ago you publisht a description of the above type lamp which shows a battery and rheostat connected in the external circuit to light the lamp within the red solution of Bichromat of Potash.

I desire to describe an improvement which is more convenient, less expensive and yet one which will give good service. Place a carbon and zinc within the bottle and connect them to the lamp. Put the following solution in the bottle; dissolve 24 ounces of Bichromat of Potash in 1 gallon of water



Improved Idea for Making a Photographer's Dark Room Lamp Which Incorporates the Battery, Lamp and Red Coloring Solution All in One Jar.

and then slowly add 72 ounces of Sulfuric Acid. If only one-quarter of solution is desired use one-quarter of the above amounts. For the lamp procure one of the lamps now used in operation with a one or two cell dry battery flash-light; they can be bought in the 5 and 10 cent stores for a dime. This battery will give about 2½ volts and can be used for constant service. The zinc will last much longer if first dipt in sulfuric acid solution and rubbed quickly with mercury. To open the lamp circuit remove the zinc rod.

Contributed by THOS. APPLEBY.

BROWN OR SEPIA TONES ON BROMID AND GASLIGHT PAPER

Photographic Printing Paper:—

SOLUTION No. 1.—Bleaching Solution.
Bromid of Ammonia.....1 oz.
Water .....16 oz.

SOLUTION No. 2.
Ferricyanid of Potassium.....1 oz.
Water .....12 oz.

SOLUTION No. 3.—Browning Solution.
Sulfid of Soda..... 1 oz.
Water .....12 oz.
(Do not confuse *Sulfid* with *Sulfite*)

Directions for Brown or Sepia Tones on Bromid or Gaslight Photographic paper:—Take a print from the negative in the usual manner, develop and fix; when thoroly washed, place in developing tray, and develop till image becomes faint in:—

Solution No. 1.....4 oz.
Solution No. 2.....4 oz.

Mix together in container bottle; label bleaching fluid.

Wash once only, (too much washing will spoil the work); the solutions will keep indefinitely. After washing the print, fill the developing tray with water, placing the print in the tray with the water, and add a teaspoonful of (browning solution).

SOLUTION No. 3—Develop till the desired tone is acquired, and wash well in running water.

Solution will not keep.

Contributed by
JOHN BLACKHURST.

Experimental Chemistry

By ALBERT W. WILSDON

Twentieth Lesson

VALENCE.

DOUBTLESS many readers of previous installments have wondered how to determine, how to write symbols for certain compounds in order to write an equation. For instance, how are we to know whether to write the symbol of a given compound with 1, 2, 3, or 4 atoms of either of its elements?

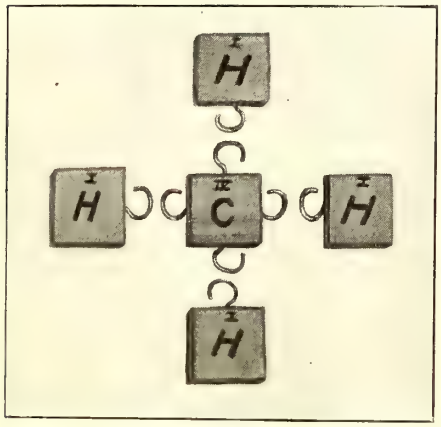


Fig. 1. Illustrating Graphically the Tetravalent Element Carbon (C) In Methane.

For example, shall we write Sodium Chlorid NaCl, Na_2Cl, $NaCl_2$, $NaCl_3$, or $NalCl_4$, etc.? It is evident that one of these is correct; the others must be wrong.

The object of this installent is to ascertain in what way the atoms of the elements combine. In the last paper we took up the study of certain laws of chemistry with respect to the balancing of equations, and the ration with which elements combine.

SYMBOLS OF ELEMENTS AND COMPOUNDS.

When expressing the composition of various chemical substances which are made up of various elements, as a matter of simplicity, an abbreviated form of chemical language is employed.

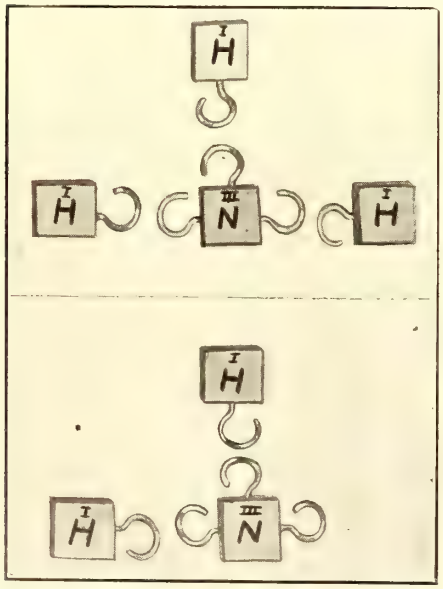


Fig. 4. The Upper Line Illustrates Graphically a Trivalent Or Triad Element—Nitrogen (N) in the Ammonia Radical (NH_3); Lower Line Shows Why Ammonia Could Not Be Written NH_2.

An atom of copper is the smallest particle of copper that is found in any compound. The symbol for an atom of copper is Cu; that of an atom of Oxygen, O; of Sulfur, S, etc., etc. For the symbols of the other elements, together with their atomic weights reference to the table given in the last lesson should be made. Every element possesses a symbol which stands for its atom. If more than one atom of an element is indicated, a co-efficient or sub-exponent is used as 2Cl or Cl_2, which means two atoms of Chlorin.

A symbol is usually the initial letter or letters of the Latin name of the element, which does not in every case correspond to the English name. In some cases several elements possess the same initial letter. It is then the custom to assign the single letter to the most important, abundant or earliest discovered member of the group and to the others another letter contained in the name of the element. Thus, ten names of elements begin with C. This symbol was selected for Carbon as the most important then Ca for Calcium; Cd for Cadmium; Ce for Cerium; Cl for Chlorin; Co for Cobalt, etc.

A few names in which the Latin names differ from the English, are: Fe from Ferrum (Iron); Sb from Stibium (Antimony); Cu from Cuprum (Copper); Pb from Plumbum (Lead); Hg from Hydrargyrum (Mercury); Ag from Argentum (Silver); Na from Natrium (Sodium); K from Kalium (Potassium); Sn from Stannum (Tin); Au from Aurum (Gold).

Symbols possess a *quantitative significance.* Each one represents one atom of the element in question, this being the smallest quantity of an element which is present in the molecule of its compounds. Thus Na does not represent any indefinite quantity of Sodium, nor does Cl represent any amount of Chlorin, but each represent a definite mass, one part by weight. Thus we see that the symbol not only is an abbreviation of the name of the substance, but also signifies a definite amount or quantity of the Substance. Na means one atom of Sodium, also 23 parts by weight of Sodium.

The formula of a molecule is formed by grouping together the symbols of the atoms composing it. The molecule of Hydrochloric acid is found to consist of one atom of hydrogen and one atom of chlorin, expression of which formula is:—

$$\underset{\text{Symbols of elements}}{H + Cl} = \underset{\text{Formula of compound}}{HCl}$$

This formula (HCl) means:

1. One molecule of hydrochloric acid.
2. One molecule of hydrochloric acid containing one atom of hydrogen and one atom of chlorin.
3. One molecule of hydrochloric acid composed of 1 part by weight of hydrogen, and 35.46 parts by weight of chlorin.
4. One part of hydrogen plus 35.46 parts of chlorin equal 36.46 parts of hydrochloric acid by weight.

EQUATIONS:

What is an *Equation?* What is a *Reaction?* These are questions which have probably come up to numerous readers.

When we speak of a Reaction, it is meant for some definite chemical action which takes place between two or more molecules, but the term is also used for an Equation. *An equation stands for a reaction.* It represents a chemical experiment.

As stated before, symbols and equations, together with certain algebraic signs are the shorthand of chemistry. An equation gives the substances that are put together in an experiment, and those which are

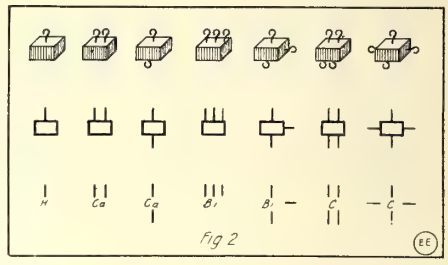


Fig. 2. The Several Ways of Representing "Valence." The Usual Method Involves the Use of Blocks With 1, 2 Or More Hooks Arranged As Shown in the Upper View.

obtained as a result, together with the right ratio of those used and of the ones obtained.

FACTORS AND PRODUCTS:

The substances put together for a given experiment are called "factors," and those obtained the "products."

If one contemplates advancing himself in chemical knowledge, it is imperative that he know how to write equations. There are three essentials to be mastered by the student. (1) to know the *factors* and their symbols; (2) to know the *products* and their symbols; (3) to balance the equation.

(*Note*:—A list of the elements, together with their symbols with atomic weights was given in the last lesson, page 559).

(1) FACTORS:—The first thing to do is to write down the symbols of the substances which were put together to obtain the result. Thus, in making Iron sulfid, we must first write down the symbols for the substances to be put together, namely, Fe and S. These two substances compose the first half of the equation and should be written: Fe + S =.

The symbols of the factors are always written on the left hand of an equation,

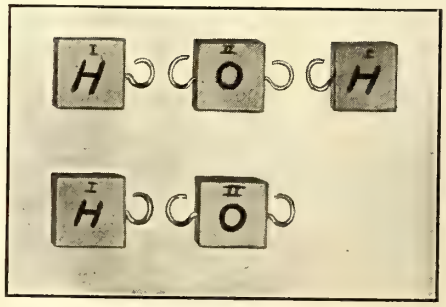


Fig. 3. Upper Line Shows a Bivalent Or Dyad Element—Oxygen (O) in Water H_2O. Lower Line Shows Why the Symbol for Water Could Not Be HO. There Would Be a "Free" Hook Or Bond.

and the number of factors are variable. Sometimes we use only one factor, *i.e.,* breaking up Red Oxid of mercury (HgO); or two or more factors, in an experiment.

(In the preparation of hydrogen, water was employed merely as a solvent of the

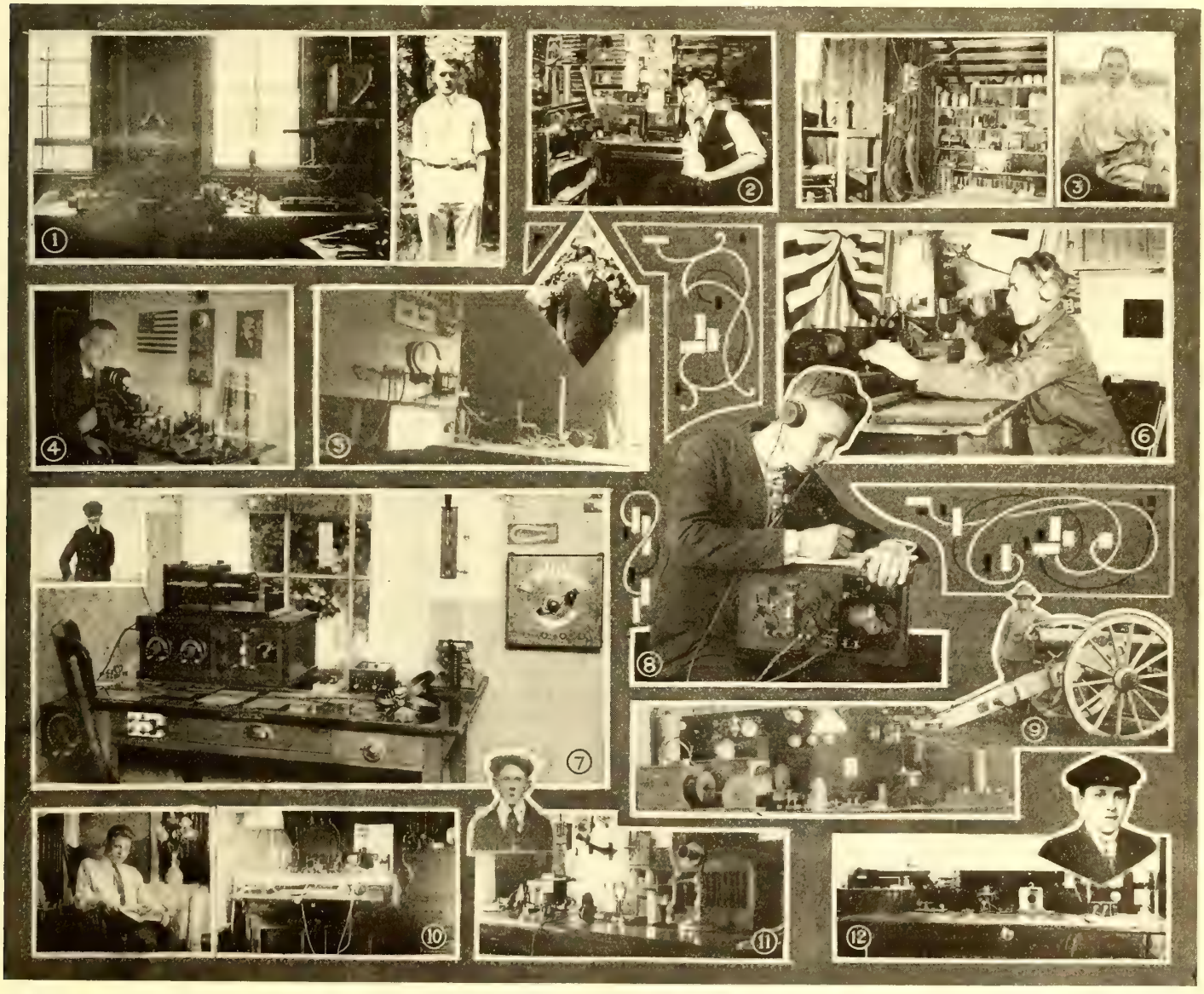
(*Continued on page* 636)

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month $3.00 prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

Send a Photo of Your "Electrical Lab."

"Radio-bugs," just keep up the good work! Send us a photograph of your "Electrical Laboratory" now so that we can judge them for the February prize contest. You might as well take a chance on winning the monthly prize as well as anyone else. Talking about prizes, we want to speak particularly about this month's prize winner—Mr. Edward G. Raser, of Trenton, N. J. Now Mr. Raser has a genuine "Electrical Lab." No mistake—"Bugs." Among other things he owns a Wheatstone bridge, a Potentiometer, two D. C. Galvanometers, Kelvin bridge for measuring extremely low resistances, Millivoltmeter, a Standard Cell, a Pyrovolter, etc. He also has two resistance furnaces which lie on the floor at the right and cannot be seen in the picture. He uses 220 volts and steps it down to 50 volts by means of a large transformer and can melt brass, copper, tin and lead with the aforementioned apparatus. An electric arc run from the same source of supply is used for welding purposes and obtaining high temperatures. Address your "Electrical Lab." photos to Editor "With the Amateurs Prize Contest."



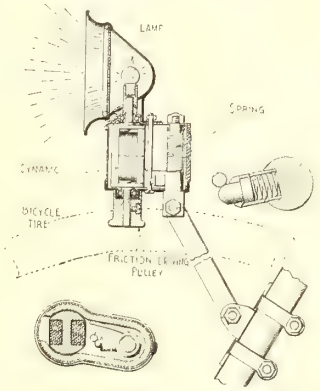
A GROUP OF REPRESENTATIVE AMERICAN AMATEUR LABORATORIES.
Electrical Laboratories of, 1—Edward G. Raser, Trenton, N. J.; 2—Richard S. Owen, Pittsburgh, Pa.; 3—J. F. Freeman, Tucson, Ariz.; 4—Harvey McCoy FitzSimmons, Mansfield, Ohio; 5—Harold Martin, Pasadena, Calif. Radio Stations of, 6—Earl S. Nelson, Cleveland, Ohio; 7—Ted Lively, Morrison, Ill.; 8—Sedric R. Brown, Oceanside, Calif.; 9—D. E. Barthel, Elkader, Ia.; 10—Theodore Gathmann, New York City; 11—Fonda McCook, Sumner, Ia.; 12—C. H. Langford, London, Ont., Canada.

LATEST PATENTS

Bicycle Lamp

(No. 1,244,262; issued to H. R. Van Deventer.)

Those who ride bicycles will be interested in this ingenious dynamo headlight which is arranged to be driven by frictional contact between its driving pulley and the tire on

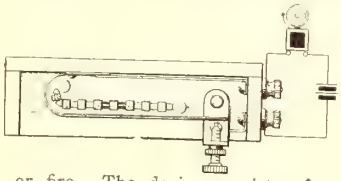


the bicycle wheel. The details are very simple, there being provided a permanent-magnet type dynamo, which can be swung into contact with or away from the bicycle tire. The dynamo shaft carries on its upper end a suitable receptacle for the low voltage lamp, and the latter therefore rotates with the armature, giving a very efficient illumination.

Gas and Smoke Alarm

(No. 1,242,575; issued to Silvestro Milano.)

Many lives have been lost annually from smoke and gas escaping in dwellings. The present device is of great interest therefore, in that it will give an alarm from gas, smoke

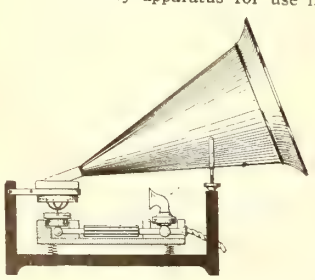


or fire. The device consists of a circuit maker and breaker embodying a thermostatic spring responsive to abnormal temperature changes, together with means sensitive to the presence of illuminating gases, so that when subjected thereto said means will generate heat, as is the case by using for the purpose spongy platinum. If gas happens to escape into the room, this element will become heated to a glowing condition, whereby it will influence the thermostatic spring, and thus close the alarm circuit, which may be either audible or visual.

Telephone Amplifier

(No. 1,243,755; issued to F. C. C. Naeser and N. A. J. Lilliendahl-Petersen.)

An auxiliary apparatus for use in

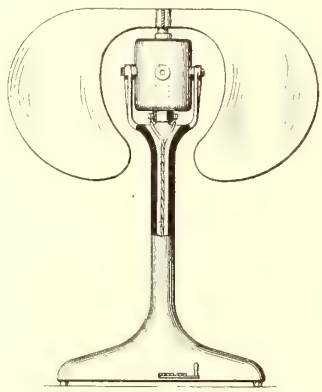


connection with regular telephone equipment, providing amplifying means so that one or more persons may readily hear the telephone speech without placing the instrument to their ear or ears respectively. The device comprises a sounding-box with a suitable membrane and contact member which will rest against the diafram of the telephone, when the latter instrument is properly placed on a spring table as shown. This receiver to accommodate the telephone instrument is made resilient by placing the springs under it, and when this part of the apparatus is properly adjusted, the speech can be heard very plain and strong thru the trumpet, all disturbing sub-tones and by-tones being eliminated by the transmission of the sound waves thru the sounding-box, so the patentees claim.

Unique Electric Fan

(No. 1,243,238; issued to Angelo Adamo.)

An electric fan of the portable type, the object of the invention be-

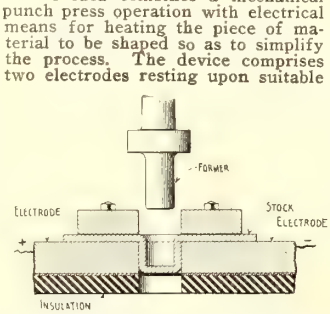


ing to provide a fan which will deliver a current of air from all sides or to all quarters of a room or apartment, whereby a thoro circulation of air may be secured thruout all portions of the room without requiring the fan itself to be oscillated or revolved in the ordinary manner. Further, the patent provides for a vertical motor, and especially devised fan blades of novel form, whereby the air will not only be moved in a circular path, but also forced outwardly for reliable and efficient circulation.

Electrical Punch Press

(No. 1,242,580; issued to T. E. Murray, Jr.)

This idea combines a mechanical punch press operation with electrical means for heating the piece of material to be shaped so as to simplify the process. The device comprises two electrodes resting upon suitable

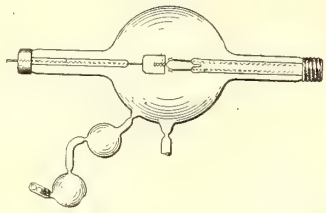


supports from which they are insulated, as the drawing shows. The stock material in which a cup-shaped projection is to be formed, is placed upon the electrodes so as to cover the central opening and is secured by clamping bars and bolts. The punch is supported above the plates in any suitable manner to permit vertical motion. The stock plate being clamped in position on the electrodes, the current is establisht of sufficient strength to heat and so soften the portion of the plate which covers the central opening. The punch is then lowered and caused to force the softened metal into the die opening. When the collar on the punch meets the two die clamps, the current is short-circuited thru the former, so that its heating effect upon the metal then ceases, permitting the metal to quickly solidify.

Electron Discharge Bulb

(No. 1,244,217; issued to Irving Langmuir.)

Electron discharge device suitable for rectifying alternating currents, etc., and having an electrode consisting at least in part of "thorium," and having at a given temperature, an electron emission per unit surface



materially greater than the emission of a refractory metal, such as Tungsten, at the same temperature independently of and in the absence of positive ionization. The patentee provides in the glass envelope a quantity of a vaporizable reagent of low vapor pressure capable of preventing the oxidation of "thorium," using for this purpose an alkali metal such as potassium.

Secret Telegraph

(No. 1,244,477; issued to Patrick B. Delany.)

The patentee has here devised a clever telegraph sounder circuit whereby it is possible to cause the sounder used in public telegraph offices to give "reverse" signals and in this way to prevent any one in the vicinity of the instrument from deciphering the actual incoming message, which is taken from another sounder close to the operator. The sounder which is connected to give the reverse signals is mounted in a wooden resonator, so that they

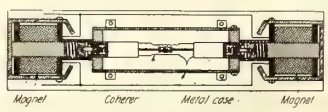


will predominate in loudness over the signals recorded by the main sounder. This is accomplisht by providing a back contact on the line relay.

Coherer-Protector

(No. 1,242,512; issued to Harry D. Betz.)

A clever arrangement for protecting wireless coherers from the powerful currents produced by the local transmitting apparatus or other nearby electrical disturbances. The invention comprises a metallic case for inclosing the coherer to exclude undesired waves therefrom, two contart members normally located within the case and adapted for contacting the coherer terminals and means for withdrawing the contact members from the metallic case a sufficient distance. To insure against the coherer being affected by Hertzian waves or the like during a protective period, the contacting members are operated by means of two electric magnets at either end of the

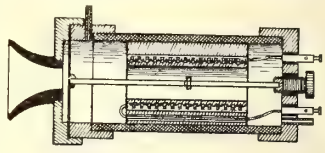


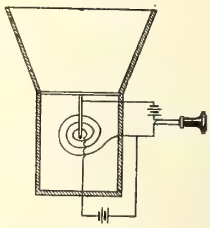
device, and which control magnets may be connected with the local transmitting key, aerial switch, etc.

Improved Microphone

(No. 1,244,150; issued to E. Weintraub.)

A microphone capable of carrying and modulating a much larger current than has been possible in this class of apparatus heretofore. This increase in resistance variation in the present device has been affected by raising the electrodes or current-varying medium to a high temperature, the passage of current between electrodes being facilitated when their temperature, is raised, owing to the greater emission of electrons. These electrodes moreover work best in a vacuum or in a rare gas such as "argon." Concentric with the microphone-members, there is placed a cylindrical coil forming an electric heater. The ends of the microphone electrodes are formed so that one of them may contain granules of carbon for example, or for a high resistance microphone—metallic oxids, and the end of the other electrode is properly designed to hold these granules in place. Variations



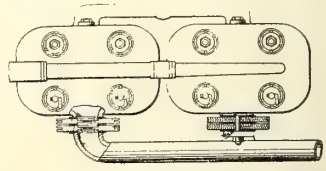


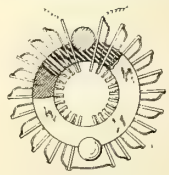
of current thru an external circuit are thus caused by microphonic action at this heated electrode juncture, which current variations may be transformed and made to operate a second circuit for wireless or submarine signaling purposes, etc.

Thermo-Electric Generator

(No. 1,242,499; issued to Hartwell W. Webb.)

The principal object of this invention is to produce a thermo-electric generator which is particularly adapted for utilizing the waste heat of the exhaust gases of internal combustion engines. The patent also provides a thermo-electric generator with automatic electric potential regulating means, etc. Instead of





soldering the two opposite metals of the thermo-couples, which are liable to become loosened in service and thus reducing the efficiency of the device, the present thermo-couples, having for instance iron as the positive elements and an alloy of nickel and copper as the negative elements, are interfused at their joints by electric spot-welding. This form of thermo-couple construction has been found to be very efficient. To form a generator unit of several couples, and to hold the elements in place, a suitable impervious heat-conducting and electric insulating binding material is used, such as a cement.

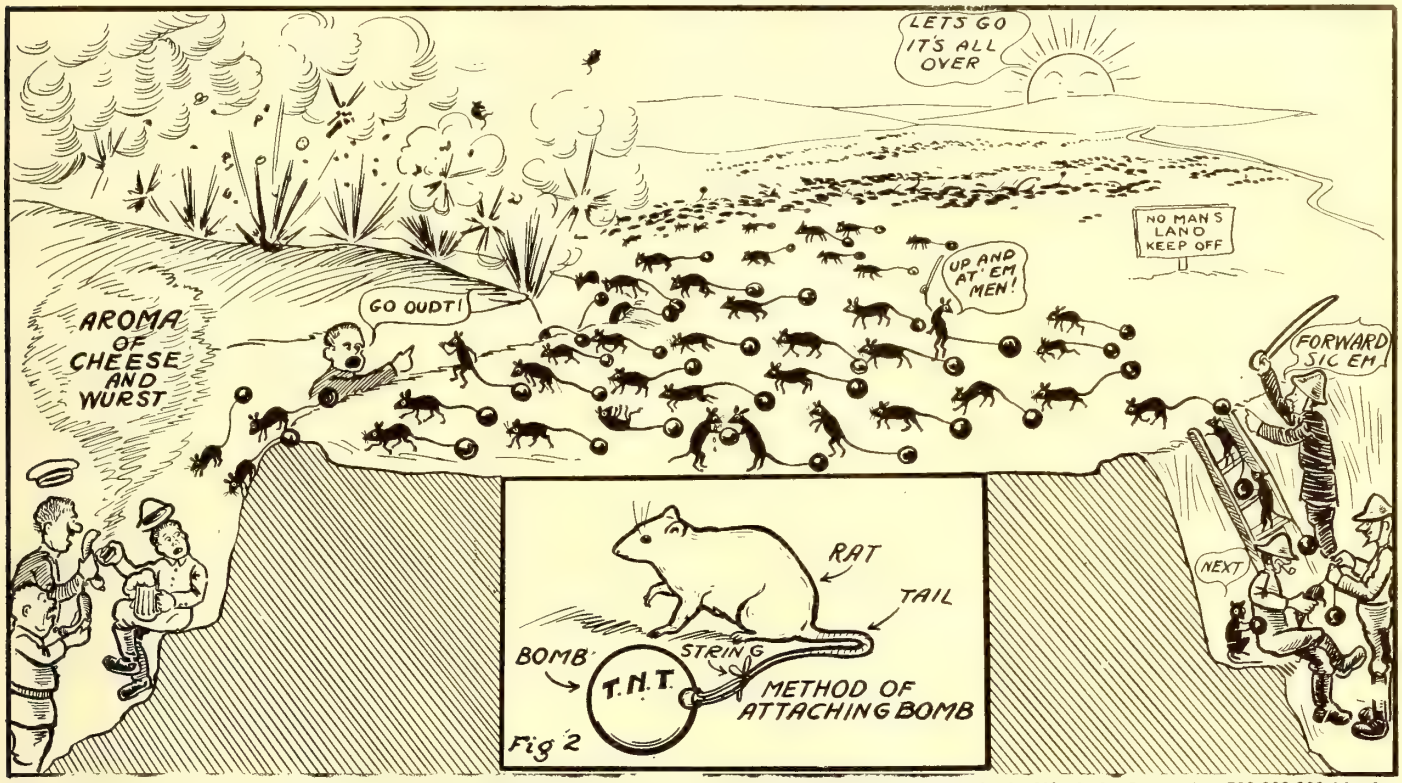
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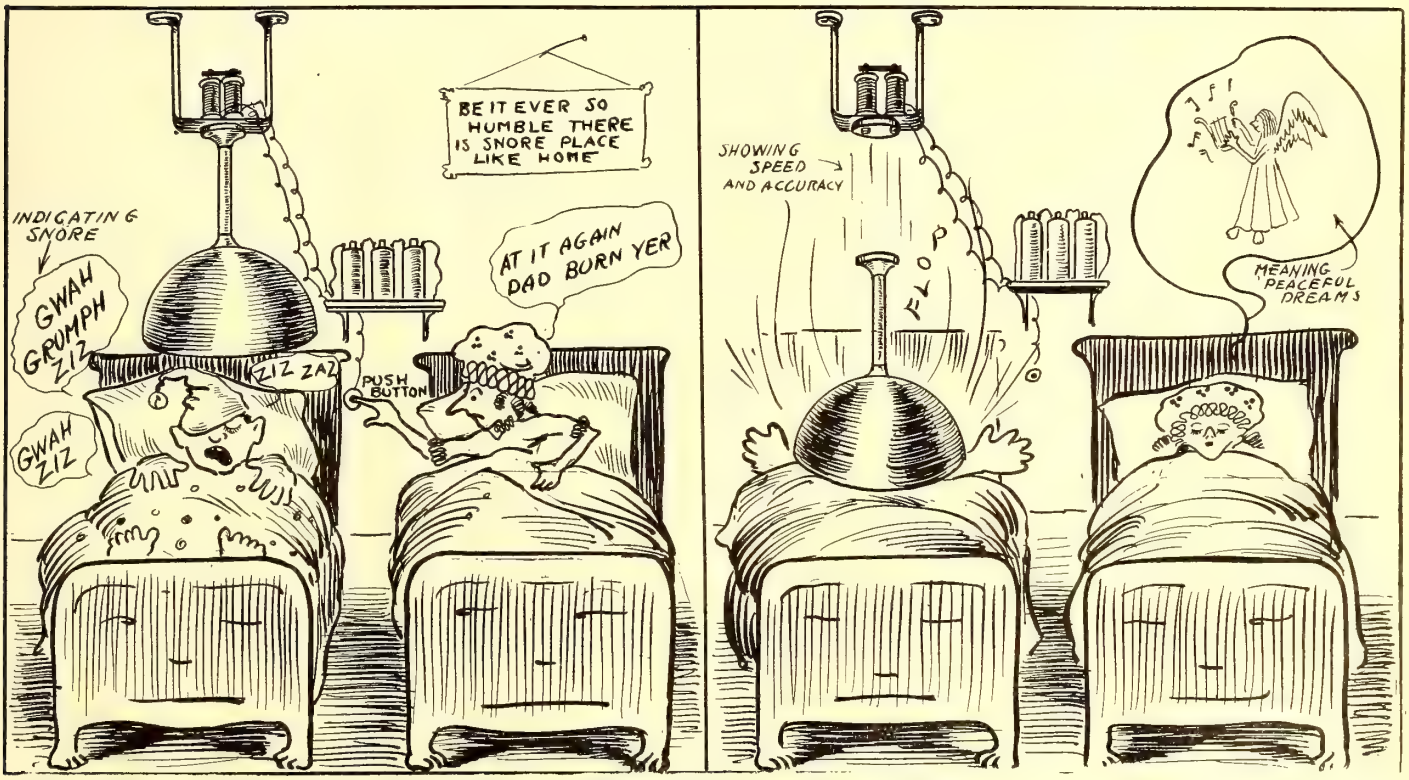
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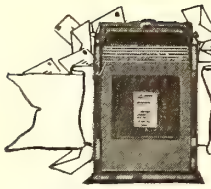
PHONEY PATENT OFFIZZ



Prize Winner. HUN KILLER. My Plan For Finishing the 5,000,000 Odd German Soldiers Positively Works! Conscript 500,000,000 Yankee Rats (100 to a Hun); Then Manufacture 500,000,000 Electric Bombs. Toward Dawn of the Psychological Day Attach a Bomb to Each Rat's Tail. The Aroma of Limburger and Wurst Attracts the Rats; the Electric Time Fuses Let Go; the Bombs Explode Simultaneously; Presto! No More Germans. Inventor, Gust Ekonom, Springfield, Ill.



ELECTRIC SNORE ELIMINATOR. Who Is It Grumbles When the Old Man Snores—Ask Dad, He Knows. To Relieve the Grumble, As Well As the Snore, Waste No Time In Installing This Extremely Simple Electric Device Which Stops the Snore Instantly and Without Pain. The Annoyee Pushes the Button; the Gravity Cell Current Opens; the Magnet Thus Releases the Snore Dome. Simple? You Bet! Inventor, Jack Dodge, Sydney, N. S. Can.



QUESTION BOX

This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

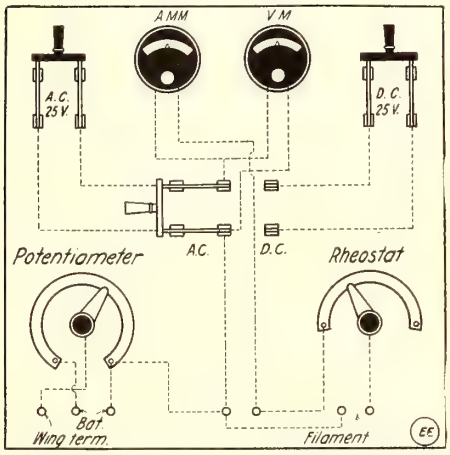
1. **Only three questions can be submitted to be answered.**
2. **Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.**
3. **Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.**
4. **If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.**

WIRING DIAGRAM.

(874.) M. F. Kelley of Meadville, Pa., says:

Q. 1. I wish to connect up the instruments shown herewith to a small switchboard. Will you give me a diagram of the wiring?

A. 1. We give complete wiring diagram of your instruments.



Hook-Up For Audion Testing Switch-Board Adapted to Laboratory Requirements.

RADIUM EMANATION.

(875.) John Alexander of Brownsville, Texas, wishes to know:

Q. 1. How can radium emanation be detected?

A. 1. Radium emanation or that emitted by radio-active compounds are usually detected by means of the *gold-leaf electroscope*, which is a very sensitive instrument for the detection of these minute electronic discharges emitted by such radio-active substances.

Q. 2. What is the construction of a spinthariscope?

A. 2. The general make-up of Crooke's spinthariscope is usually composed of screen coated with a very high-grade phosphorescent zinc sulfid, and a small pin opposite. A short distance away from the phosphorescent screen there is placed a minute speck of radium, the emanations from which cause the zinc sulfid to become phosphorescent. The whole arrangement is placed in a tube, one end of which is fitted with a magnifying lens, so as to intensify the scintillating particles shot out from the screen.

EINTHOVEN GALVANOMETER.

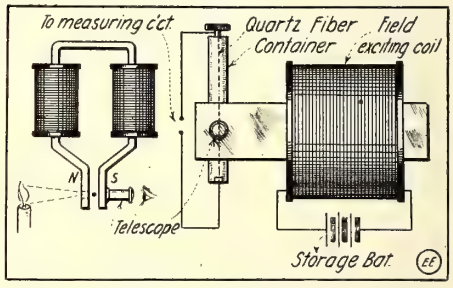
(876.) Arthur Stanley of Flushing, L. I., wishes to know:

Q. 1. The construction and operation of an Einthoven galvanometer?

A. 1. The general construction of an Einthoven galvanometer is shown in the sketch herewith. It will be noted that two strong magnet poles with a very small air gap are used. The magnetic flux between these poles is very high, and is obtained by the use of two powerful electro-magnets as indicated. These are excited by a direct current, usually obtained from a series of storage batteries. The reason for using storage batteries as a source of supply is that of obtaining a powerful unidirectional and constant current. The current obtained from a generator is by no means unidirectional, but contains a series of pulsating peaks due to the commutator action of the machine.

In the small air gap of the magnet a fine silver-plated quartz filament is inserted, the ends of which are properly suspended and connected to the source of current which is to be measured. In one of the pole-pieces of the electromagnet a telescope eye-piece is inserted, which is used for noting the degree of displacement of the quartz wire that takes place.

The principle of operation of this device is solely dependent upon the displacement of the quartz filament in the magnetic field. The degree of displacement of this filament is proportional to the amount of current which flows thru it, and the density of the magnetic field in which it is placed. This type of instrument is very sensitive, and the standard type usually is so sensitive that the filament will be displaced one millimeter for every one-ten-thousandth of an ampere. These instruments are so sensitive that they may be utilized for the reception of radio signals.



General Make-Up of Student's "Einthoven" String Galvanometer.

These galvanometers have also been utilized to a great extent for the study of heart diseases in human beings, and a description of their use for this purpose is thoroly described in the May, 1917, issue of the ELECTRICAL EXPERIMENTER.

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As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 *to* 150 *words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.*

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, *233 Fulton Street, New York City.*

MULTI-LAYER COILS.

(877) D. L. Latley, Westmount, Can., wishes to know:

Q. 1. Are one or two coils used for the construction and use of the Inductances mentioned in the article entitled "Calculation and Measurement of Inductance" in the September, 1917, issue of the EXPERIMENTER? If so, are they the same?

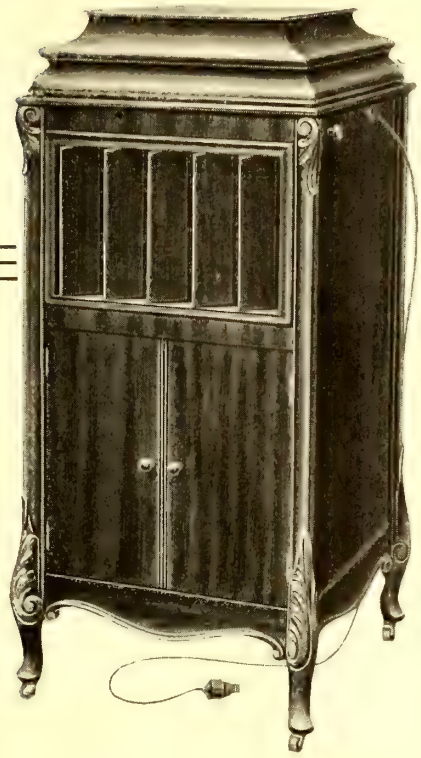
A. 1. You can use as many of these multi-layer coils in the circuit as you wish, as the electrical conditions of these coils are just the same as those of the single layer coils. There is absolutely no difference between these coils and the ones used at the present time.

Q. 2. How is coupling varied?

A. 2. The coupling between two multi-layer coils is varied in the same manner as that of the single layer type, the only difference between the coils, both of the receiving and exciting types, is that the multi-layer coil contains several layers of winding instead of one.

Q. 3. Do all the layers begin at the same side of coil?

(*Continued on page* 632)



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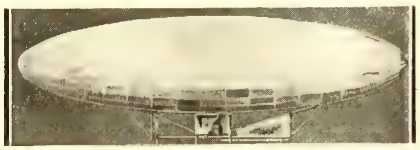
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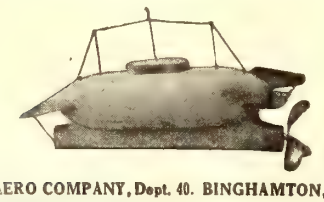
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QUESTION BOX.

(*Continued from page* 630)

A. 3. It is not necessary that all layers of the coil begin at the same side of the winding, but can be a continuous winding, such as those employed in electro-magnets.

GROUND BATTERY.

(878) Mr. L. E. McQueen, Elkhart, Ind., asks:

Q. 1. Please explain to me how I can make an *earth battery,* and what the voltage will be, and can I increase the voltage by laying more than one, and connecting them together, as any other cell.

A. 1. An earth battery can be made by inserting zinc and copper or carbon electrodes in the earth, preferably in a place where the ground is very moist, so that electro-chemical action will take place between said plates; thus producing an electromotive force in the external circuit.

The voltage of such arrangement is very low, usually below one volt. However, the amperage of such a cell can be increased by increasing the total exposed area of the elements. They can be increased by either increasing the size of the inserted elements or by connecting several of these elements in parallel.

This type of cell is very inefficient and very clumsy. However, where currents of small magnitude are required at a cheap cost, you will find that such a cell will be of service.

It is advisable that the space between negative and positive plates should be filled with a layer of charcoal, which should be at all times saturated with a weak acid solution or a saturated solution of salt. This will be found to give satisfactory results.

ELECTRICAL QUERY.

(879) John W. Powers, Dawson, Ill., writes us:

Q. 1. A straight bar of copper, for example, cutting across a magnetic field, has a potential difference established between its ends, excepting a slight displacement current at the start. No current would flow until the electrical circuit was completed. Now the question is: Does it require the same force to move the bar of copper across the magnetic field when the ends are not connected and the electrical circuit was completed?

A. 1. As soon as the external circuit of the revolving copper strip is closed when moving in the magnetic field a difference of opposite potential is established in the circuit which tends to overthrow the originally produced electromotive force. This naturally produces a mechanical strain in the revolving armature which necessitates a greater amount of power to revolve it at a given speed, in order that the desired external electromotive force can be generated.

STEP-DOWN TRANSFORMER.

(880) S. C. Vaughan, Boonville, Mo., sends drawings of a rectifier and wishes to know:

Q. 1. Can this arrangement be successfully used to operate ¾" spark coil and small series-wound motors?

A. 1. The arrangement of employing a rectifier in conjunction with a step-down transformer is possible. The rectified current thru the transformer would again be converted into a sinusoidal current when passing thru the transformer.

Further, you can operate satisfactorily a ¾" spark coil with this arrangement or run a small motor, providing that the step-down transformer is sufficiently large to deliver the proper secondary current to operate the device. About 2 amperes will be required to run either of the two mentioned apparatus.



TELEGRAPHY, by T. E. Herbert, A. M. Inst. E. E.; cloth bound, 985 pages, size 5 x 7¼"; Third Edition thoroly revised and enlarged with 630 illustrations. The Macmillan Co., New York City. Price $3.50.

The third edition of this book far surpasses expectations. The work covers the entire field and the reviewer finds it impossible to describe in detail the many interesting and instructive chapters—a most concise and detailed exposition of the telegraph system of the British Post Office.

Among the subjects treated we find:—Fundamental principles of magnetism and electricity; units; primary cells; calculations in connection with circuits and conductors; the resistance of wires; the measurement of current and E.M.F.; battery testing; potentiometer measurements; measurement of resistance; single current systems and relays; capacity; condensers; the double current sounder; the differential duplex; the quadruplex; the wheatstone automatic system; the bridge duplex; the wheatstone A.B.C.; the Steljes recorder and Rebesi typewriting telegraph; the Hughes; the Baudot; the Murray automatic and Murray multiplex systems; central battery telegraphs and telegraph switching systems; secondary cells; repeaters; the test box and protective devices; telegraph testing and the formation of special circuits; construction of aerial lines; construction of underground lines, etc., etc.

Besides these numerous chapters there is an Appendix covering the theory of Magnetism, a very lengthy discourse on Chemistry; Automatic Printing Machines; Wire Gages, etc.

The author has dealt in a very increasing way with all the subjects and describes each apparatus and its function in the simplest manner possible. The standard method of using these instruments is explained in a most up-to-date manner in each case, and this work should find a ready demand from the student as well as the more advanced worker.

TEXT BOOK ON WIRELESS TELEGRAPH, By Rupert Stanley, B. A.; cloth bound, 340 pages; 5¾ x 8¾"; Longmans, Green & Co., New York City; Price $2.25. Second Edition.

Prof. Stanley's work is one of the best works on the subject of Radiotelegraphy as yet presented to the art. It fills a distinct want and every reader of this book will certainly enjoy the brilliant way in which every subject is handled, and moreover, reap real benefit from it.

The author has done his work well and in writing the work has always held in mind the special requirements of elementary students. Beginning with the rudimentary principles, he carries the student on step by step until he knows each subject thoroly.

All the important radio phenomena, experiments and calculations are carefully explained, a series of questions at the end of each chapter acting as a review and home examination.

Many drawings and photos of commercial apparatus are incorporated in the work with full explanation of each—the appendix contains code charts, call letters, rules and regulations, radio time service and other important data.

Taken as a whole, the work is very complete; especially is this true of the chapters on undamped wave systems, which is of special interest at the present time. Prof. Stanley knows whereof he writes, having been instructor in the subjects he treats on for many years in one of the best English universities.

WIRELESS MUSIC TO ARMY CAMPS.

Troops in many encampments within a radius of about 100 miles from Forty-third Street and Broadway, New York, recently heard the strains of a single phonograph, playing martial airs in a wireless tower at that point.

Among the encampments connected with the phonograph were those at Yaphank, Hempstead, Wrightstown, Sea Girt, Plattsburg, Van Cortland Park, and many small outpost stations where soldiers are guarding bridges and public works.

The experiment was conducted with a phonograph especially constructed for army use by Thomas A. Edison. The idea is to use similar machines in France, where one, placed in a dugout behind the lines can send "canned" music over the telephone to soldiers in front line trenches on a wide front.

"ELECTRICIAN-RADIO, U. S. N."

(*Continued from page* 612)

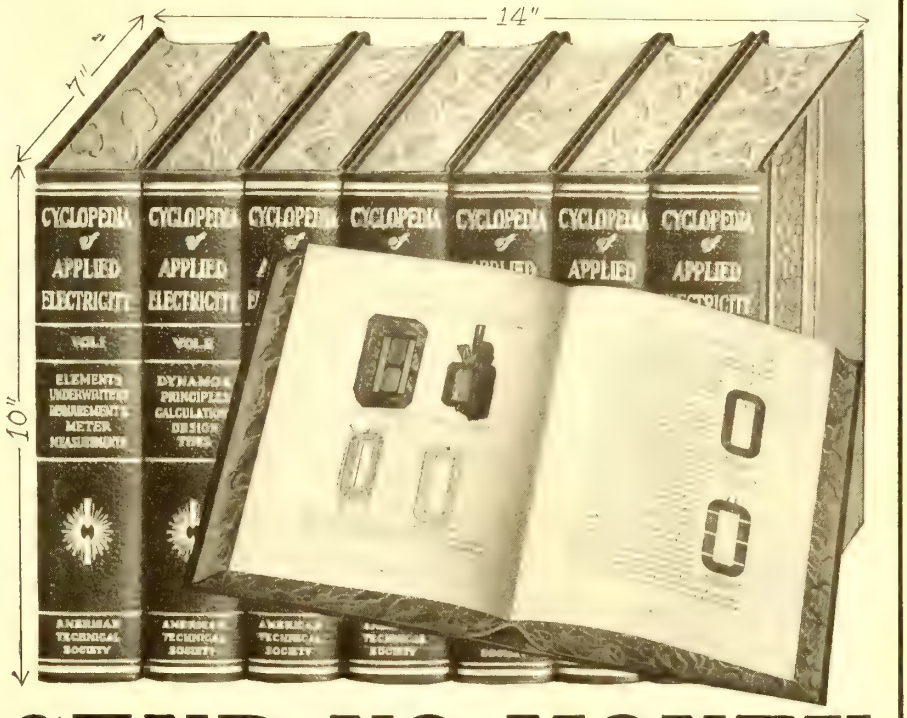
sea to get his training, to serve his apprenticeship. There is no denying that some youths hesitate to join the Navy because they find it hard abruptly to quit home and be stationed three to ten thousand miles distant. Suppose, however, they are sent to a naval training school only a day or two away from their native village, so that at the discretion of their Commanding Officer they may get leave for a brief visit at home —what then? Does not that situation banish all scruples of the reluctant, thus permitting them to break into their new life more gradually? Moreover, a man is never in the service a month before he is ready and anxious to sail to the end of the earth with the fleets. Homesickness makes short headway under the skin.

A training station for sailors is in full operation in the unsaltiest state in the Union—Minnesota. And though the men from the Mississippi valley are especially acquainted with Dunwoody Naval Training School, Minneapolis, bluejackets are there from every corner of the land, and three-eighths of the entire detachment is studying electricity, general and radio. When training is being given in twelve branches, and there are nearly a thousand bluejackets being instructed at a time, the relative consequence of the electrical crafts is at once evident.

Ensign Colby Dodge, U.S.N., Commanding Officer of this remotest naval station from the ocean, has from the outset insisted that the electrical courses be given extreme thoroness, the same as at the old-establisht electrical schools at New York and Mare Islands Navy Yards. When the offer of Dunwoody to train apprentices was accepted last summer by the Navy Department, the first move of this state industrial school was to send its chief instructor in electricity to that very Navy Yard in New York, where after weeks of concentrative observation at the famous electrical school he mapt out a course for his prospective pupils, a plan of work completely in accord with naval stresses, precedents, and regulations. He figured on a wartime schedule of four months' instruction for his electricians-general, and unlike most of the other instructors who have revised their courses to three, five, or eight months, he has found his calculations about right. Now, December, the first company of one hundred Dunwoody-trained naval electricians has departed for sea duty, and the winter quota of apprentices has just begun to wrestle with batteries and generators. Radio operators, besides, have been leaving Dunwoody at the rate of about thirty a week since early in September.

Naturally it became immediately necessary to supplement the equipment already in the electrical shops of Dunwoody with many additional appliances, some essentially naval and some not. The instructor learned at the navy yard that the marine electrician is up against much apparatus and gear with which the landsman is unfamiliar. In order that the reader may obtain a precise idea of what the Dunwoody bluejackets study it may be interesting to recount some of the mechanism which was specially installed by the time the men began training.

Upon reporting the urgent needs to the Bureau of Steam Engineering the following were received at Dunwoody: Motor control equipment, signal devices such as arc lights, incandescent searchlights, yard-arm blinkers and portable tube blinkers; interior communication devices, such as push buttons, connection boxes, bells, ship annunciators and buzzers, gun elevating motors, motor parts, circuit breakers, motor starting apparatus, light and power fixtures such as deck fixtures with globes, ceiling appur-



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THE MICROPHO JUNIOR DEAF-PHONE is a super-sensitive instrument which has been developed to meet the demands for a practical and efficient hearing device at an extremely low price. It is equal to any $35.00 instrument made and superior to most of them.

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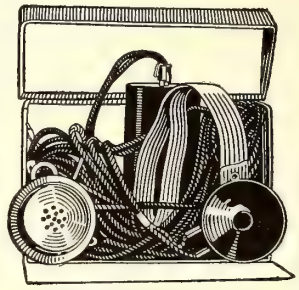
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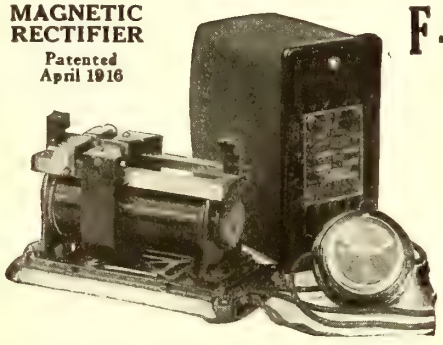
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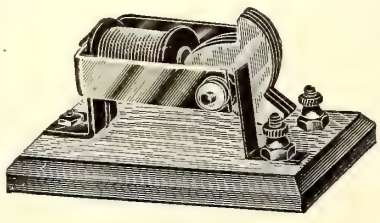
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tenances, distribution and junction boxes, and 5-ampere switches and receptacles.

In the Dunwoody electrical shop a huge instrument board was at once set up bearing all the small instruments and appliances commonly used aboard a dreadnaught. Next to this board was hung a panel six feet square, a white panel with black letters half a foot high—you've guesst it,—the eternally paramount Ohm's Law. That formula, *I equals E over R,* relentlessly stares every bluejacket in the face from six to nine hours each day. When he leaves Dunwoody he knows that cardinal law of electricity in all its ramifications, knows it just as certainly as he knows when pay day comes around, and that's almighty certain. No less intimately is he acquainted with every instrument on the adjacent panel. No bell, no buzzer, no connection box, but he knows its anatomy. He has to, or his coveted rating is denied him.

With the unprecedented rush of war orders during the past autumn it has not been easy to get quickly needed apparatus from manufacturers, even by Government direction. However, in fairly good time for teaching the first detachment of sailor-electricians, Dunwoody managed to obtain a mercury arc rectifier, two two-horsepower shunt motors, two one-eighth kilowatt shunt generations, one variable speed direct current motor, one automatic starting device with push-button control, one variable speed alternating current motor, one 10-kilowatt rotary converter, one switchboard converter, one set of voltage transformers, two seven and one-half K.V.A. alternators, one three--panel switchboard (D.C.), one voltage regulator and four auto-transformers. This additional equipment, together with what was supplied by the Bureau of Steam Engineering, rounded out a shop and laboratory pretty well fitted to train electricians worthy of Uncle Sam's fleets.

The Dunwoody electrical department has been peculiarly fortunate in having among other instructors two broadly trained ex-Navy men. Both enlisted in the Navy as seamen, second class. One came out chief electrician and the other electrician, first class. They know naval indoctrination, how to discipline recruits, the advantage of runing every phase of their courses on prompt schedule.

"It is not hard to get ahead in the Navy," said one of these men, who is now director of the Dunwoody radio classes. "The great mistake many bluejackets make is in trying persistently, obtrusively, to get a "pull" with their superior officers. If a man will just buckle down to his job and forget about bootlicking, recognition will come soon enough. Nothing queers a man so surely as too much 'pull.'

"When the radio apprentices arrive at Dunwoody," he continued, "I give them an entrance examination in common arithmetic and elements of electricity. If a student makes a fair mark he is put in the advanced class. If he is weak on decimals, fractions and square root he is given a few more lessons before starting the related work. The course as outlined covers sixteen weeks, half that period devoted to operating practise and the other half to classroom, lectures and laboratory. The operating room is fitted with tables and head phones to accommodate one hundred men at a time. Related work includes demonstrations and lectures in theory of motors, batteries and dynamos, also the theory, installation, construction, operation and repair of radio apparatus. Each student keeps a 'log' book in which he writes all he learns in class, and answers twenty questions on the work of each week. An operating examination is also given each week, to record sending and receiving ability in words per minute. Unless a man im-

proves steadily he is classed a 'drone' and marked down. If he does not reach a receiving speed of fifteen words a minute after six weeks' training he is relegated to the 'drone division' and gets special instruction for two weeks. If he still displays no signs of ever becoming a radio operator he is send back to Great Lakes station to man a 'deck swab' instead of a wireless key. Under this system only *one or two men in a hundred* have shown inaptitude.

"The men are instructed on the navy type Audion receiving sets, as well as on the measurement of wave lengths and the adjustment of the modern arc and spark transmitters. In the operating room five long tables are divided into sections eighteen inches deep by twenty-four wide, each section equipt with a 'phone, jack, and key. Omnigraphs are used for sending, and keys for hand sending to any or all of the tables are mounted on the master table. Three tables are used for receiving only, two for both sending and receiving. On the sending tables two students sitting opposite can send to each other independently of anyone else. In this way men of equal operating ability can be paired off to work together until they attain ten or twelve words a minute. They are then transferred to the receiving table, and upon reaching fifteen words go to the 'traffic' table.

"Here each bluejacket is assigned a 'call letter,' and is required to carry on traffic with the master table in accordance with the traffic laws. Instead of a buzzer for producing the practise signals in the 'phones a high-frequency generator is used. This generator has ninety-eight poles, and the rotor which is the field is revolved at a speed sufficient to give a clear musical note of about 600 cycles. The head 'phones are connected directly thru the transmitting keys to the stator coils of the generator, which is driven by a one-sixth horse-power motor. The frequency as well as the strength of the signals can be easily varied, so the student gets practise in receiving an exact imitation of the modern radio signals such as are sent out by undamped wave generators and quenched spark sets."

This scheme of instruction and the arrangement of apparatus have been evolved by a man who was formerly a radio chief on U. S. S. Birmingham, one of the first ships in our navy to be rigged with wireless. He has grown up with the craft, the craft which has become literally a science among the most significant developments of this generation. Dunwoody radio men will go to sea ably tutored. After the war, either in the navy or in civilian appointments, their services will continue to be at a premium.

Indeed, not a few radio bluejackets were well-trained operators before they enlisted to aid their country in the present crisis. Such men, altho they gave up no mean "bounties" besides their salaries, realized that the advanced instruction they could obtain free in the Navy would enable them to get even better jobs in later life.

I have said that college men are often discovered amongst the recruits. In the hundred electricians-general sent to Dunwoody from the Mare Island Navy Yard and thru Captain Moffett at Great Lakes station, four have been found, all graduates of state universities—California, Arizona, Nevada, and Iowa. As is common with men who have gone thru college, their lack of information on practical problems has been noticed. But these four students are well versed in theory, they can teach, they can assist excellently in the laboratory, with experiments. It has been found expedient to divide the electricians into four sections of twenty-five each, and over each section one of these college men is to be retained at Dunwoody, each of the four designated assistant instructors for the new arrivals.

That these assistants and some other experienced students who have attained high marks may not cease gaining electrical knowledge, so that eventually they can win better ratings upon going to sea, the chief instructor in the department has set aside Saturday mornings to give them advanced work. As for the preceding five days of the week, all electricians get six hours of training daily, with two two-hour study periods in the Institute at night.

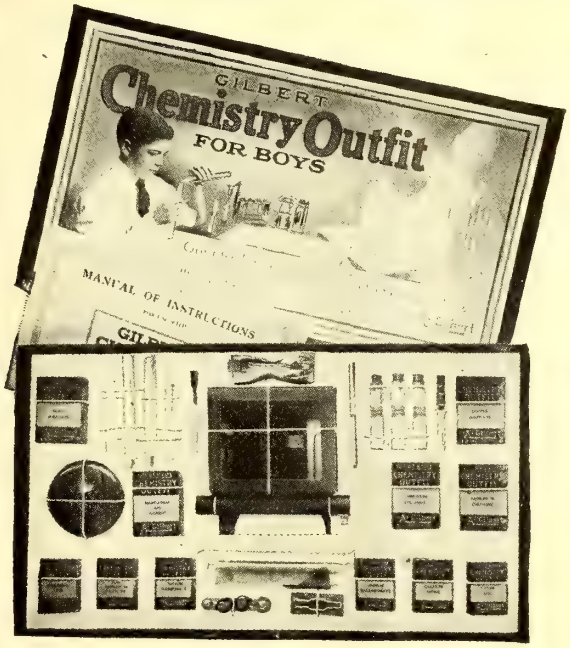
A general survey of the Dunwoody course in electricity indicates that the work comprises six distinctive parts: Magnetism and wiring, motors and generators, instruments and switchboards, storage batteries, lamps and searchlights.

To mention less generally some of the subjects covered, there may be cited splicing, soldering, taping; annunciators, conduits and telephone circuits; micrometers and solenoids; motors and control; galvanometers, dynamos, shunt motors and armatures; candlepower, lighting circuits, Wheatstone's bridge, voltmeters, etc.

Tho in the electrical work-shop at Dunwoody the bluejacket has bench exercises and learns to make small apparatus on drill-press and lathe, it must not be supposed that his instruction is confined solely to that department. Before he leaves for sea duty he is made well acquainted with the machine-shop, gas-engine laboratory, and forge.

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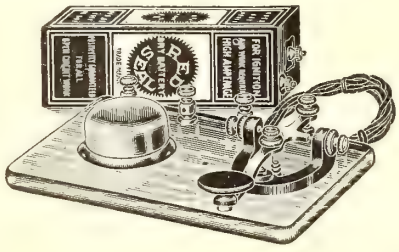
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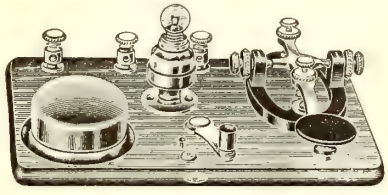


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The new classes of electricians-general starting their training at Dunwoody in December will spend their first two weeks mostly in the machine-shop, learning to operate big lathes, planers, shapers, milling machines and mill-cutters, even to the radial drill-press, the grinder, and the emery wheels.

Later, in the gas-engine department, the bluejacket electricians are familiarized with simple and compound reciprocating engines, with separators, traps, indicators, tachometers, pressure regulators, and the various valves, condensers, pumps, gages and revolution counters. This work, of course, provides for much time to be given to the practical operation, assembly and repair of such mechanism, lining up engines, overhauling pumps and regrinding valves.

In the longer period necessarily devoted to things more intrinsically electrical, it is not possible to give electricians as comprehensive a course in gas and steam engines as the motorboat pilots themselves are getting at Dunwoody, nor in machine tools and appliances as the machinists are learning, nor yet in oxy-acetylene welding and forging as the blacksmiths have, but the general electrical students do master the rudiments, and for that reason they are entitled to the term "general." They are without doubt the all-round handy men on a battleship. In Commanding Officer Colby Dodge of Dunwoody Naval Training Station, they have a mentor and disciplinarian who books no rated man's despatch to service in the first line ships until that man's class record is proven "unqualifiedly meritorious."

THE X-RAY ON THE BATTLE FRONT.

(*Continued from page* 599)

after the first exposure. A stereoscopic plate holder for exceptional cases, in which two exposures are better made upon separate plates, finishes the equipment.

Manipulation:—The distinctive lead marker is fastened to the skin where it will be in contact with the middle of the plate while the picture is made. The position of this is marked upon the skin with an indelible pencil. The plate is laid upon the table and the wire netting covers it. The lead serial number is invariably placed over the lower external corner of the plate. And the same number had better be marked upon the skin with an indelible pencil. Lead markers R and L (right and left), will be of occasional service. For the thigh or any part of the head or trunk, the anti-cathode is set at a distance of 21 inches from the plate, and is displaced laterally three inches after the first exposure. For the forearm or leg, the distance from the anti-cathode to the plate is fourteen inches and the lateral displacement of the anti-cathode two inches. Each $^1/_7$ inch subdivision that the image of the foreign body is displaced in either case, corresponds to ½ inch distance from the plate to the foreign body when the exposures were made. If this distance is considerable, we must bear in mind the fact, that the foreign body is located in a direction from one image to the corresponding position of the anti-cathode. Each exposure should be made of the same intensity and duration as for a single picture, whether the exposures are made upon the same or separate plates.

EXPERIMENTAL CHEMISTRY.

(*Continued from page* 626)

zinc chlorid formed, and for this reason it was omitted. In those experiments where water is employed solely as a solvent, it does not appear in the equation. Heat is also left out from equations).

(2) PRODUCTS:—*The products are the substances obtained as the result of an experiment.* These may be one or several. In the experiment with iron and sulfur, there was one product, iron sulfid. The equation may be written:—

$$\underset{\text{Factors}}{\text{Fe} + \text{S}} = \underset{\text{Product}}{\text{FeS}}$$

In other experiments two or more products may result from a given reaction.

The symbols of the products of an experiment are always written on the right of the equation. The equality sign is employed to separate the factors from the products. It is much more difficult to determine the products of an experiment, than to find the factors. At the outset we have to accept statements that this or that substance is formed, as when we are told that zinc chlorid is the resulting product from pouring hydrochloric acid on zinc. We might, however, as has been repeatedly done, have tested the substance, and have found the statement true.

In all cases where we are certain that a given reaction takes place, the products have been at some time ascertained, and in doing the experiments it is well to apply tests to as many as possible. But in a large number of cases we have to accept the statements of those who have made careful analysis of the results. It thus becomes necessary at first to memorize the factors and the products. It will be found very easy, after a little practise, to calculate the most common reactions. If a double decomposition takes place, the metal (or positive part) of each compound joins itself to the non-metal (or negative part) of the other. On mixing the solutions of silver nitrat and sodium chlorid there are formed sodium nitrat and silver chlorid: $AgNO_3 + NaCl = AgCl + NaNO_3$.

Sometimes one metal sets free another from a compound, the former taking the place of the latter. In a solution of silver nitrat, copper will displace the silver, deposit it, and form copper nitrat: $Cu + 2AgNO_3 = Cu(NO_3)_2 + 2Ag$.

Do not for a moment think that every equation that you can write stands for a reaction. Before an equation is written it must be known whether a given reaction will take place. For example: $2NaCl + H_2O = Na_2O. + 2HCl$ **IS NOT CORRECT,** for on mixing the two substances, *there is no such reaction.*

VARIATION OF EQUATIONS:

There are very few equations that express all that takes place in an experiment. The most they can do is to give the general average of reactions. Difference of temperature, strength of reagents, as well as different kinds of reagents, all contribute greatly to the variation of results. An excellent example is the action of nitric acid on metals. The general equation is $8HNO_3 + 3M'' = 3M(NO_3)_2 + 4H_2O + 2NO_2$ M'' represents any metal, having a valence of two). But this varies greatly with (1) temperature (2) strength of acid, and (3) different metals. Often two equations are given to express results at dif-

ferent temperatures. *Molecular Equations,* as distinguished from *Atomic Equations,* contain no free atoms, but have all atoms combined as molecules. $H_2 + O = H_2O$ is an atomic equation: $2H_2 + O_2 = 2H_2O$ is molecular. As the molecular composition of most elements is not known, it is better to write atomic equations, tho many teachers advocate and even insist on writing H_2, Cl_2, O_2, never allowing the atom to stand alone.

EQUALITY SIGNS:

Sometimes the two parts of a reaction are joined by an arrow (⇆ or ⇋) instead of the quality sign (=) as Fe + S ——> FeS. Often a reaction takes place one way under certain conditions, but under other conditions the reverse reaction results, as 2HI = 2H + 2I, or 2H + 2I = 2HI. The two may, in fact, happen in the same experiment. It is then customary to write it 2HI ⇋ 2H + 2I or, 2HI ⇋ 2H + 2I, which is read, hydroiodic acid in equilibrium with hydrogen and iodin. Consequently the reaction often does not take place completely in either direction, so that all three substances may exist in equilibrium, side by side. The ⇆ or ⇋ signs always indicates a *reversible* reaction. For the present, it is better that the student employ the quality sign (=).

VALENCE:

What is **Valence?** *The valence of an element is the combining or replacing "value" of its atoms.* Valency is not an absolute invariable property of the element, but is dependent on the nature of the element combining and on physical conditions.

Dumas, in 1834, showed that 1 atom of oxygen had the same *replacing value* as 2 atoms of hydrogen, or 2 of chlorin. Liebig observed that hydrogen and potassium had the same value, which was only a third that of antimony. Frankland in 1852 first definitely explained the principle of valence, or the saturation capacity of elements. Frankland's valency theory was accepted by chemists in 1860. In 1864 Wurtz and Naquet establisht the fact that some elements show more than one valence.

If we compare a few symbols of compounds, we at once observe a certain numerical relation among their elements. By way of illustration, HCl, H_2O, H_3N, H_4C. One atom of chlorin unites with one of hydrogen; one of oxygen with 2 of hydrogen, one of nitrogen with 3 of hydrogen, and one of carbon with 4 of hydrogen. For practise compare the following in like manner:—

NaCl,	$CuCl_2$,	$BiCl_3$,	$SnCl_4$
NaBr,	$CuBr_2$,	$BiBr_3$,	$SnBr_4$
NaI,	CuI_2,	BiI_3,	SnI_4
NaF,	CuF_2,	BiF_3,	SnF_4

We see that sodium combines with chlorin, bromin, iodin, fluorin, in the atomic ratio 1:1. If bromin in sodium bromid were to be replaced, by chlorin, only one atom of chlorin would combine with one of sodium; in other words, chlorin has the same replacing value as bromin, or as iodin or fluorin. Sodium also has the same combining *value* as has each of the 4 elements named, and as has hydrogen. Copper (Cu) often has a different value. Its atom combines with 2 atoms of the elements named. Its combining value is twice as great as sodium, or as chlorin, bromin, iodin or fluorin, or hydrogen. It has a value of 2 if the others have a value of 1.

Valence has nothing to do with the strength or power of affinity. It is the combining (or replacing) *value.* An element having a valence of 5 has that combining value in the same way (as an analogue) a 50 cent piece has the same purchasing value that 5 dimes have. It can

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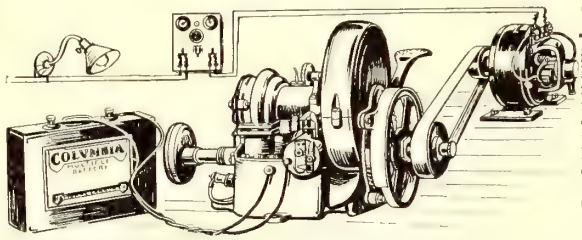
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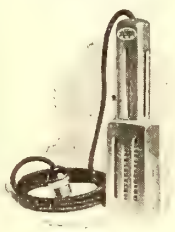
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combine with or replace 5 atoms of hydrogen or chlorin.

The combining value of the hydrogen atom is the unit of valence, as this element has the smallest combining value. Therefore its valence is said to be 1. In the molecule whose symbol is HCl the chlorin atom has the same valence as the hydrogen namely, 1.

If sodium and chlorin were brought together, each atom of sodium would combine with one atom of chlorin; Na + Cl = NaCl. If sodium and hydrogen chlorid (hydrochloric acid) should react, one atom of sodium would displace one atom of hydrogen: Na + HCl = NaCl + H.

In magnesium chlorid ($MgCl_2$) one atom of magnesium cannot combine with a single chlorin atom, but it picks out two atoms. If the compound were to be formed by the action of hydrochloric acid on the metal, the equation would be

$$Mg + \left\{\begin{matrix}HCl\\HCl\end{matrix}\right\} = Mg\left\{\begin{matrix}Cl\\Cl\end{matrix}\right\} + \left\{\begin{matrix}H\\H\end{matrix}\right\}$$

or, $Mg + 2HCl = MgCl_2 + 2H$. The valence of magnesium is therefore 2. In the chlorid of bismuth ($BiCl_3$), the bismuth atom cannot combine with one or two chlorin atoms, but is not satisfied with less than three. Formed from the elements, the equation would be $Bi + 3Cl = BiCl_3$; if made by the action of hydrochloric acid, $Bi + 3HCl = BiCl_3 + 3H$. Hence the valence of bismuth is 3. Now carbon requires four atoms of Cl to satisfy its attraction, and carbon chlorid is CCl_4. If the two elements could unite directly, the following would be the equation: $C + 4Cl = CCl_4$. If hydrogen could be obtained from carbon and hydrochloric acid, $C + 4HCl = CCl_4 + 4H$ would represent such a reaction. The valence of carbon is 4.

Any element which replaces hydrogen atom for atom, or any element which combines with hydrogen atom for atom, has a valence of 1, is said to be *univalent,* and is also called a *monad.* Thus the valence of chlorin in hydrochloric acid is 1. Note the valence of each of these elements, which are united with H: HBr, HI, HF. Any element combining atom for atom with one of these elements, F, Cl, Br, I, is also a *monad.* Note the valence of the first written element in these: NaBr, KI, AgCl, AgI, NaF. Elements which require two of these atoms to make a molecule of a compound have their valence 2, and are called *bivalent* elements, or *dyads;* for example, calcium in calcium bromid ($CaBr_2$). Note the name and valence of these metals: $CuCl_2$, HgI_2, $MgBr_2$. Write symbols for chlorids, bromids, and iodids of these *dyads;* Cd, Fe, Ca, Sr. The elements whose atoms select three atoms of a monad are *trivalent,* or *triads,* or their valence is 3; for example, As in $AsCl_3$. Write symbols of chlorids, bromids, and iodids of these triads: Sb, Bi, P, Fe, Cr, Al. A *tetrad,* or *tetravalent* element, has its valence 4. C and Si are the most important tetrads. A few elements are *pentads,* that is their valence is 5; for example, P, Bi, Sb. Try and write symbols for their *pentachlorides.* A higher valence than 5 is rare, though *hexads* and *heptads* are known.

DOUBLE VALENCE:

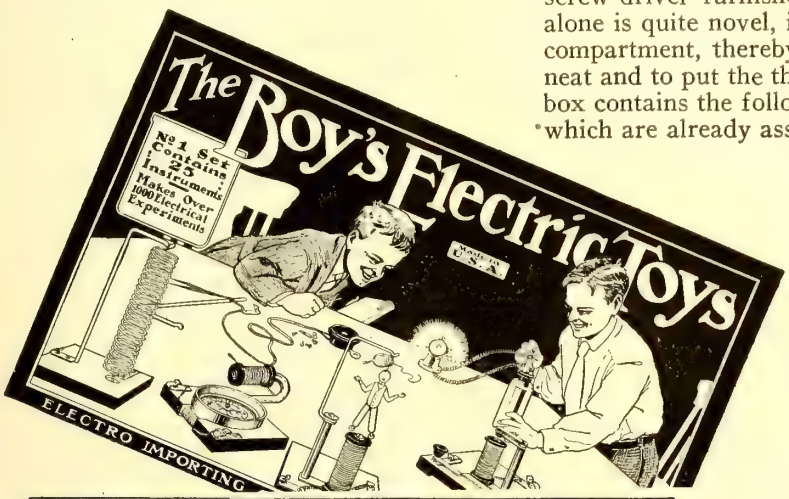
Elements quite often have more than one valence; for example, phosphorus sometimes combines with 3, sometimes with 4, atoms of chlorin. In the first case it is a *triad* (PCl_3), in the second a *pentad* (PCl_5). The iron atom under some conditions selects 2, under others 3, atoms of chlorin; as $FeCl_2$, $FeCl_3$. These are called,

(*Continued on page* 640)

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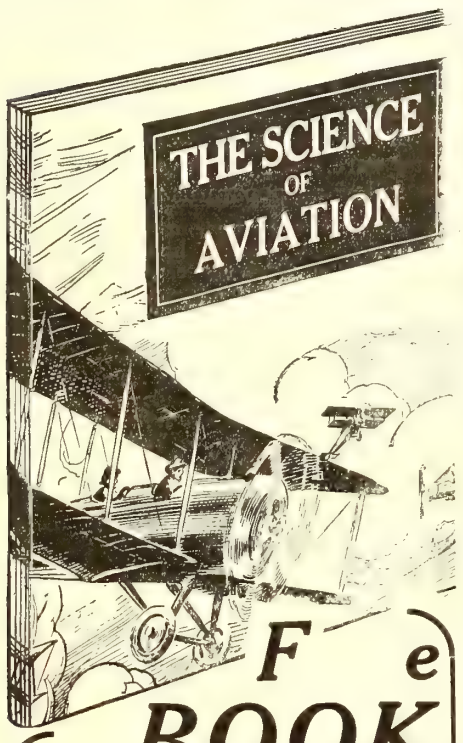
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EXPERIMENTAL CHEMISTRY.

(*Continued from page* 638)

respectively, *ferrous* and *ferric* chlorids. *Ferrous* always indicates the lower salt, while *ferric* always indicates the higher, that is the combining value is 2 and 3 respectively. Occasionally elements have a certain valence towards one element and a different one towards another, but usually varying conditions of formation govern this peculiarity. When hydrogen and oxygen combine to form water the molecule is H_2O, and oxygen is a *dyad*. This valence of oxygen must be regarded as being as invariable as that of hydrogen. It is the standard of valence for negative or non-metallic elements.

HOW TO DETERMINE VALENCE:

How can I determine the valence of an element from the symbol of one of its compounds? What, for example, is the valence of Mg in MgO? Oxygen always has two bonds, and hence Mg must have the same number, as there is one atom of each in the symbol. To verify this, write the number of bonds above the element, with plus sign for that over the metal, and minus for the other.

$$\overset{+2}{(Mg''}\ \overset{-2}{O'')}.$$

In any symbol there must be as many "plus" bonds as "minus." A plus element may not necessarily be a metal, so long as it is plus with reference to the element it is combined with. There must be no free (or unsaturated) bonds; in order to form a stable compound all must be attached. This is imagined to explain why atoms of elements usually exist only in pairs; two hydrogen atoms, for example, attaching themselves together to form a stable molecule, H-H, or H_2. Now HO *is not* a correct symbol, for this would leave one bond free, H-O-, which attracts another H atom to saturate it, as H-O-H, or H_2O. The valence of N in N_2O may be considered 1, (N'_2O''), that is, 1 oxygen atom with 2 bonds is equivalent to 2 nitrogen atoms with 1 bond each. In N_2O_3 it is 3, since 3 atoms of O with 2 bonds each equal 6 bonds (N_2O_3''); and since 2 atoms have 6 bonds, 1 will have 3 bonds $(N_2''O_3'')$, or N is here a *triad*.

$$\overset{+2}{N_2}\overset{-2}{O}$$

$$\overset{-6}{O_3}$$

$$\overset{+6}{N_2}\overset{-6}{O_3}$$

Another good way to determine the valence of an element in a compound, such as Mg in MgO is as follows: We know that in water hydrogen has a valence of 1, but an exponent of ₂ is used to indicate that 2 atoms of hydrogen are required to combine with 1 of oxygen, therefore oxygen has a valence of 2. This being the case Mg must also have a valence of 2 in order to combine with the oxygen. Likewise it can be remembered that Chlorin has a valence of 1, because it combines with 1 atom of Hydrogen as in HCl. Many other analogues may be found very useful for determining the valence of any element in a compound.

VALENCE OF RADICALS:

Radicals as well as elements have valence. In the compound HNO_3 the NO_3 radical has a valence of 1, because it combines with 1 hydrogen atom. In KNO_3 and $NaNO_3$, K and Na are each monads, as they replace H atom for atom, and the radical NO_3 is likewise univalent. Copper is a dyad, hence when it reacts with nitric acid, and displaces the hydrogen, it must displace 2 atoms, or combine with 2 NO_3 radicals, and the symbol of copper nitrat is $Cu(NO_3)_2$, as that of copper chlorid is $CuCl_2$. Silver nitrat is $AgNO_3$ and lead nitrat $Pb(NO_3)_2$, because the valence of silver is 1 and of lead is 2, while that of NO_3 is 1. Suppose lead were to replace silver in a solution of silver nitrat, the equation would require twice as many $AgNO_3$ molecules as of lead atoms.

$$Pb + 2AgNO_3 = Pb(NO_3)_2 + 2Ag$$

$$Pb + \left\{\begin{matrix}AgNO_3\\AgNO_3\end{matrix}\right\} = Pb\overset{NO_3}{\underset{NO_3}{\Big\}}} + \left\{\begin{matrix}Ag\\Ag\end{matrix}\right\}$$

EXERCISES:—In H_2SO_4 the SO_4 radical is united to 2 hydrogen atoms, and hence has a valence of 2. Potassium has the same replacing value, and hence the molecule of potassium sulfate is K_2SO_4 not KSO_4. The radical NH_4 has the same replacing value as H, hence ammonium sulfate is $(NH_4)_2SO_4$. Zinc is a dyad, and so 1 atom replaced 2 of hydrogen. Zinc sulfate is $ZnSO_4$. The reaction of zinc with sulfuric acid is $Zn+H_2SO_4=ZnSO_4+2H$. Triad elements uniting with dyad radicals give symbols as follows:

Al''' and $(SO_4)''$ is $Al_2(SO_4)_3$. Verification: $\overset{+6}{Al'''_2}\ \overset{-6}{(SO_4'')_3}$. Write symbols for these and VERIFY THEM: Na' and SO_4, $(NH_4)'$ and SO_4, Ba'' and SO_4, Mg'' and SO_4, Fe'' and SO_4. Fe''' and SO_4, Cr''' and SO_4, (The little characters like $(''')$ means the valence of the element is 3, etc.)

In phosphoric acid (H_3PO_4) it is evident that PO_4 is a *triad*. Replace the H with Na, and we have Na_3PO_4. Give a reason why it would not be $NaPO_4$. Write symbols for K' and PO_4, Ag' and PO_4, Ca'' and Po_4, Ba'' and PO_4, Mg'' and PO_4. Triads replace 3 atoms of hydrogen, as $FePO_4$, $CrPO_4$. In silicic acid (H_4SiO_4) what valence has the radical? Symbolize silicates of Na', Pb'', Ca'', Al''', and Sn^{iv}.

The principle above given enables us to ascertain the valence of the middle element of a triad, for example $KClO_3$. The valence of K being 1, of O 2, we have $\overset{+1}{K'}\overset{-6}{ClO_3''}$. As there must be as many + as —bonds, Cl will have 5, as $+1+5-6$

TABLE

Metals and Positive Radicals				Non-Metal and Negative Radicals			
Monads	Diads	Triads	Tetrads	Monads	Diads	Triads	Tetrads
H	Mg	As	Pt	F	O	N	C
Na	Ca	Sb	Sn	Cl	S	P	Si
K	Sr	Bi		Br	SO_3	B	SiO_4
Ag	Ba	Au		I	SO_4	PO_3	
Hg	Pb	Fe		NO_2	CO_3	PO_4	
NH_4	Cu	Cr		NO_3	C_2O_4	AsO_6	
CH_3	Cd	Al		ClO	$C_4H_4O_6$	AsO_4	
C_2H_5	Zn			ClO_3			
	Co			Clo_3			
	Hg			BrO_3			
	Sn			IO_3			
	Fe			$C_2H_3O_2$			

$K'Cl^{v}O_3''$. Take $Pb(NO_3)_2$ to find the valence of N. $_3Pb(NO_3)_2 = PbN_2O_6$, $Pb''N_2O_6''$. There are 10 bonds left for N_2 or 5 for each

$$\overset{+2}{Pb}\overset{+10}{N_2}\overset{-12}{O_6}$$

N ($Pb''N^{v}O_6''$). Find the valence of N in KNO_2, in KNO_3; of P in Ag_3PO_4, in $Ca_3(PO_4)_2$.

Opposite is given a "table of valence," which should become familiar to the reader, and it is advised that they should try and memorize the main elements, and especially the radicals. It is indispensable, before proceeding further in the subject, that they be able to apply everything in this lesson. These elements and radicals are arranged according to the USUAL or more stable valence. The valence of most radicals does not vary, but that of many elements does.

STRUCTURAL SYMBOLS: — Molecules of compounds may differ in three ways. (1) In the KIND of atoms they contain. CO_2 and CS_2 are composed of carbon combined in one case with oxygen, in the other with sulfur. (2) In the number of atoms of the same element. CO and CO_2 are composed of the same elements, but with different proportions of oxygen. Hence the properties of the two compounds in this case are very unlike, as they were in the previous one. (3) In the arrangement of atoms in the molecule, *i.e.*, in MOLECULAR STRUCTURE. C_2H_6O is the symbol for either methyl ether or ethyl alcohol, two compounds of very unlike properties. From their similarity of composition, it might be supposed that their properties would be the same, but such is not the case. How can this difference be explained, when an exact analysis shows that the percentage of carbon, hydrogen and oxygen is the same in both? It is believed that the molecules are differently made up —that the carbon, hydrogen, and oxygen atoms are arranged differently in the ether and in the alcohol. That difference of place of atoms in molecules constitutes MOLECULAR STRUCTURE. Why is the symbol of ammonium hydroxid written NH_4OH and not NH_5O? Experiments show that one-fifth of the hydrogen bears a relation to the rest of the compound different from that which the other four-fifths bear. If we add a solution of ferric chlorid ($FeCl_3$) to the hydroxid, there are formed $Fe(OH)_3$ and NH_4Cl, as

(1) $FeCl_3 + 3NH_4OH = 3NH_4Cl + Fe(OH)_3$

A similar reaction takes place with aluminum, chlorid, etc.

A large number of other salts give hydroxids with ammonium hydroxid. It will be seen in equation (1) that Fe combines with OH and displaces NH_4, which unites Cl; that is, one of the H atoms is attached to the O atom, whereas to the four H atoms are joined the N. As this occurs in a large number of reactions, the symbol is written NH_4OH instead of NH_5O. In the reactions NH_4 unites with the negative elements or radical, OH with the positive.

The efforts of chemists to picture molecular structure, or the relative position of atoms in the molecule, has led to structural symbols. The EMPIRICAL SYMBOL of nitric acid is HNO_3. From the VALENCE SYMBOL ($H'N^{v}O_3''$) the valence of nitrogen is seen to be 5. A SEMI-GRAPHIC SYMBOL IS $H\text{-}NO_2$, but the complete STRUCTURAL SYMBOL would be $H\text{-}O\text{-}N\begin{matrix}=O\\ \backslash O\end{matrix}$. The similarity to the symbol of water, H-O-H (in which NO_2 takes the place of the last H), is seen by comparing the two.

(*Continued on page* 643)

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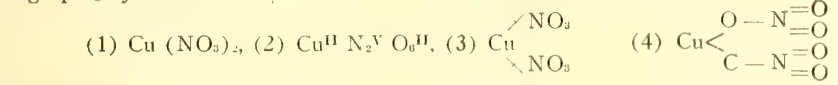
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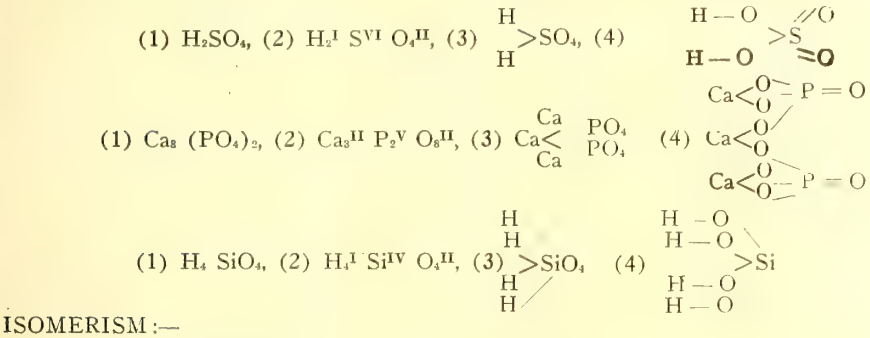
EXPERIMENTAL CHEMISTRY.

(*Continued from page* 641)

In the following examples (1) is the common or empirical symbol, (2) is what may be called the valence symbol, (3) is the semi-graphic, and (4) the structural or graphic symbol.

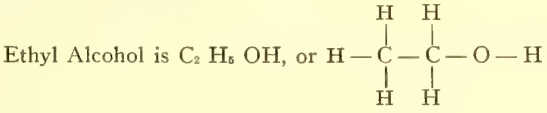


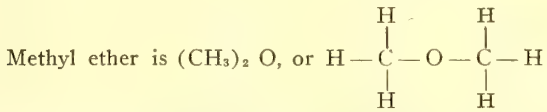
Note that Cu takes the place of 2 H in two molecules of HNO_3.



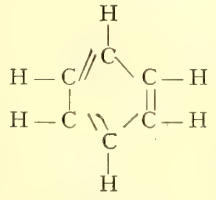
ISOMERISM:—

Two or more compounds, which have the same percentage composition of the same elements, but have different properties, are said to be *isomeric*. Ethyl alcohol and methyl ether, mentioned above, are examples, the latter being an *isomer* of the former. The symbols — empirical and structural — of each are as follows:





Substances like the above, in which atoms are supposed to be placed differently in the molecule, are called METAMERIC. The other main variety of isomerism (besides metamerism) is called *polymerism*. *Polymers* have the same percentage composition, but the molecule of the polymer is a multiple of the other. Benzene ($C_6 H_6$) is a polymer of acetylen ($C_2 H_2$). The percentage composition is the same in both cases, but the molecular weight of the former is three times that of the latter. Structurally they are respectively H — C C — H, and



VALUE OF VALENCE:—

While the study of valence is of great importance to beginners in the science—so much so that symbols, equations, etc., cannot be understood without knowledge of the subject—yet the student must not attach the same value to the principles brought out in this article as he would, for example, to the *law of definite weight*, or the *percentage composition* of a substance. *Valence is only a theory;* structural symbols are pictured explanations, on the atomic theory, of results obtained by analysis—nothing more. They prove nothing—they simply illustrate.

It is suggested that the reader obtain a set of wooden blocks about 2 inches square and fasten eye-screws therein, for the more important elements and then try and arrange them to illustrate graphic formulæ of various compounds as shown in the accompanying photograph (Fig. 1). Fig. 2 shows a method of affixing the eye-screws to a few of the elements.

Different indices have been employed to represent valences as I II III IV V (never 1, 2, 3, 4, 5). These should be placed at the right ofthe atom symbol, as shown in the above examples.

Atoms are often pictured as having hooks, or bonds to attach them to other atoms. *Mounds* have *one* hook each, *dyads* have *two* hooks or bonds, *triads three, tetrads, four, etc.*

MODERN PHYSICS AND THE ELECTRON.

(*Continued from page* 603)

out of these same units, then the total speed which the field will impart must be an exact multiple of the change in speed which the capture of an ion produces. In other words, if electricity is atomic in structure, you cannot get in a given field anything except a definite number of speeds, which will make an arithmetical series, that is, will come up by steps, one, two, three, etc.

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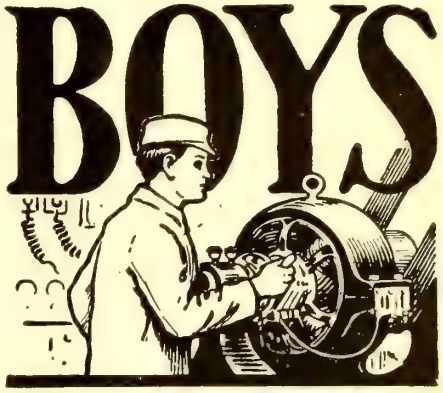
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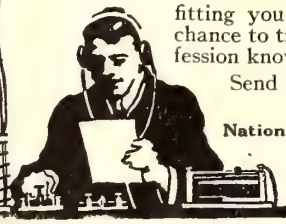
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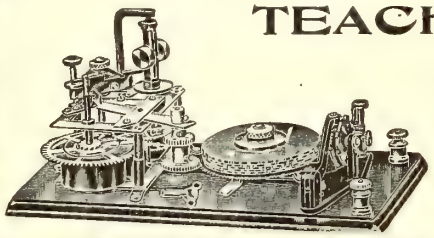
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is nothing but a charge in motion, you have here the proof that the electrical current that goes thru these lamps, for example, is nothing except the motion of a certain number of electrical specks thru or over the filament of the lamp. Add to that J. J. Thomson's discovery made in 1881, that an electrical charge possesses inertia, the only distinguishing property of matter, and you have made it perfectly legitimate to say that an electrical current in a wire is *a definite material, granular something which is moving along that wire.*

This brings me to the next of our discoveries namely *the discovery of the nucleus atom.* Let me give you just a brief statement of how we know that the atom is somewhat like a miniature solar system, with an extraordinarily minute nucleus, the size of the nucleus never being more than 1/100,000 part of the diameter of the atom, with a certain number of subsidiary bodies —negative electrons—which we should liken to the planets, somewhere around the outside. How do we know that is the case? We have this direct evidence. Nature takes a helium atom which is going with a speed of 18,000 miles per second, and nature shoots that atom right thru a glass wall without leaving any hole behind, and without in any way interfering with the structure of the molecules of the glass. I can show you photographs (see Figs. 3 and 4) that make the thing so clear that the wayfaring man can see it, you don't need to be a physicist.

This obviously means that the positive nucleus itself must be extraordinarily minute. Indeed the fact that the negative electron actually shoots thru those hundreds of thousands of atoms without ever going near enough to any constituent of those atoms to knock any one of them out. and the fact that the positive nucleus of helium, viz; the alpha particle, shoots thru even more molecules without being deflected at all from its course, causes one to wonder whether there was anything at all that is impenetrable in the atom. Why do we say there is a nucleus there? Because direct experiment says there is. There is a certain portion of the atom which the alpha particle itself cannot penetrate. If the impact is head on, the alpha particle goes right up to the atom and then it backs straight back again, or if it comes up to the atom at an angle like this it goes off that way. (Illustrating.) It is only rarely that that happens, but Rutherford and Geiger and Marsden counted the percentage of alpha particles which goes straight on and the percentage which goes off here, and in that manner, by perfectly simple algebraic analysis that any one of you can understand, without any assumption at all except the law of inverse squares, which can hardly be called an assumption, at least so far as the attraction between the *positive* nucleus and the *negative* electron is concerned we find how big that nucleus is. By the size of the nucleus I mean the size of that portion of the atom which is impenetrable to the alpha particles. It comes out something like 10^{-13} centimeters. The diameter of the atom is 10^{-8}. Furthermore, by counting how the deflections of the alpha particles are distributed around this sphere. which we can do directly with the aid of zinc sulfid spread over the inside of the sphere we can obtain the number of alpha particles deflected thru any given angle, and then with a little analysis of unquestionable correctness, we find how many unit charges, positive electrons, there are in this exceedingly small nucleus, and it comes out approximately one-half of the atomic weight.

Now, I come to another extraordinary discovery which did not merely tell us

approximately how many electrons there are in the nucleus but it told us *exactly* how many there are, and the result checked too with the number obtained by the foregoing approximate method. This brings me to the recent discoveries in the field of X-rays, and I will call the seventh of the modern advances the discovery of the nature of X-rays, which was virtually made by Barkla in 1904. For Barkla and others had proved that there are two types of X-rays, first, X-rays which consist in simple ether pulses pushed off from an electron when it changes its speed; and second so-called characteristic X-rays which are formed thus. When the electrons bump into a target they set something in the target into vibration, and this something sends off perfectly definite characteristic X-rays, which are like monochromatic light. So, we have two types of X-rays, pulse X-rays, like white light, and monochromatic X-rays, like monochromatic light, such as mercury gives rise to. That is the seventh of our great modern discoveries and it must be credited chiefly to Barkla.

FOG WARNING BY RADIOPHONE.

(*Continued from page* 591)

described in Dr. de Forest's patent. The transmitting apparatus is so arranged that speech can be sent out from the large fog horns as also musical notes, bell signals, et cetera; on the same prearranged schedule as the radio signals. In this scheme the phonograph with records containing speech is coupled to a microphonic arrangement and the speech is intensified by means of amplifiers and the sound waves sent out thru the fog horns, thereby enabling the captain or other officer to hear the same without the aid of wireless apparatus.

The one big feature of the Point Judith Light equipment is that when a ship is within a range of eight miles of the lighthouse, it will hear the following words flashed by wireless every five seconds—*"Point Judith Light";* and after every third repetition the warning—*"You are getting closer; keep off,"* is sent out with a limit of range of about two miles. These signals will be sent out during fog, mist, rain, and falling snow.

When sent out by radio the signals can be heard with any suitable or well-known wireless telegraphic, or wireless telephonic receiving apparatus which may be employed to receive, detect, or reproduce the emitted or radiated signals. Crystal detectors may be used. The signals are sent out on a wave length continuously varied between 550 and 650 meters.

If the apparatus is equipt for musical note signals these will be received by a ship at sea; for instance, suppose the ship receives the note corresponding to middle "C"; then it will be known that the lighthouse is four miles away.

If both the middle "C" and the "E" notes are heard, then it will be known that the distance between the ship and lighthouse is only three miles. If the middle "C," "E" and "G," are detected at the receiving station, the distance is two miles, and if all four notes are heard then the distance away is one mile or less, and so on for any other pre-arrangement and adjustment of the apparatus.

This invention is bound to be a great help to all mariners and the system is a direct innovation over any that have heretofore been tried. Doubtless many disasters and wrecks will be avoided and in general to make navigation safer, altho probably it will not have as good a chance to demonstrate its great possibilities till after the war is over.

Every important lighthouse and light ship on the U. S. coasts will be fitted with this new Radiophone fog signal, as conditions permit the work to be carried on.

HOW AURORA BOREALIS AFFECTS TELEGRAPH AND CABLE LINES.

(*Continued from page* 593)

appear to be due to abnormal *earth currents* induced in our globe, and which currents cutting across such lines, induce in them powerful transient currents of short duration.

On October 31, 1903, aurora borealis disturbances affected telegraph and telephone lines extending between Chicago and the eastern cities. On telegraph wires, without regular battery being applied at terminal offices, grounded lines showed a potential of 425 volts positive, varying to 225 volts negative; the disturbance continuing between 12:15 a. m., and 9:15 a. m.

Measurements were made with ordinary direct current voltmeters. The voltage readings were not constant or steady. The positive indication, for instance, would, during a period of 3 or 4 minutes, swing backward and forward in degrees between 200 and 425 volts. Once, however, the needle of the reversely connected voltmeter indicated negative potential; the potential increased rapidly up to 225 volts; varying then, between 100 and 225 volts negative.

The ohmic resistance of the lines was about 2,000 ohms; grounded at Chicago and Pittsburgh, Pa., and at Chicago and Buffalo, N. Y. This and the following report are presented thru the courtesy of Mr. Donald McNicol, assistant electrical engineer, Postal Telegraph Cable Company, who has given this subject much study.

With reference to earth currents and cables, the writer (Mr. McNicol) may be permitted to quote extracts from his official report of 1892, in connection with the trans-Atlantic determination of longitude. At that time there were ten cables across the Atlantic, but when earth currents set in they are not all equally disturbed; in fact, it happens that some of the cables are not affected at all. The French cable from Brest, France, to St. Pierre, Miquelon Island, (near New Foundland), seems to be disturbed the most, and again the disturbances are felt to a greater extent at St. Pierre than at Brest. It often happens that St. Pierre can send messages to Brest, but cannot receive any.

Long cables seem to be more affected than short ones, and, furthermore, the abnormal earth currents appear to travel mostly from *east to west.* When the aurora is visible, it is quite certain that earth currents will show themselves. Thunderstorms and they, however, do not seem to be so closely related, if, at all.

During the past season (1892), on July 16th, there was a remarkable disturbance noticed at Canso, Nova Scotia, stopping all work completely. The greatest "kick," as it is called, was given at 12:20 p. m., eastern standard time, or 5:20, Greenwich mean time. Some weeks afterwards reports came in the technical journals, from Brest, Malta, Cairo, Madras and east to Singapore of a similar disturbance on that day. Cairo, Egypt, fortunately stated the time, and from it, it was found to have been simultaneous with that of Canso.

On August 24 (1892), strong earth currents set in at Canso, and at the time there was a marked auroral display. The southern cable (Commercial Cable Company) was far more affected than the northern one. As most of the companies have two cables, they can generally get rid of the effects of earth currents by looping the



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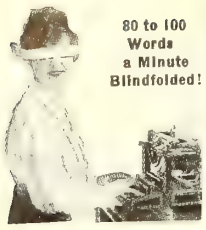
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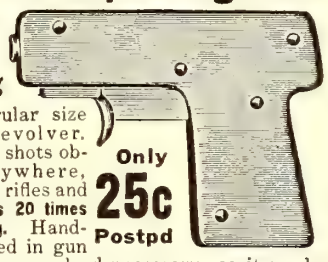


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cables together, that is, by making a metallic circuit. Sometimes the earth currents are so strong as to injure the condensers.

From the direction of the cable it is noticed that cables running east and west are more troubled with these currents than cables running north and south. There is, however, a wide difference on east and west lines. The superintendent at St. Pierre told me that he had experienced more earth currents in the past two years (1891, 1892) at that place, than in the preceding eighteen years at Torbay and Canso, N. S., and besides that they were felt more on the American than on the European side.

And furthermore: "The cable is quite unprejudiced and shows equal favor to positive or negative gallantries. They are of the most erratic nature; sometimes they take off their things and make quite a visit, one, two or three days, varying greatly in their demonstrativeness during the time, but seldom getting so bad as to totally stop traffic. Sometimes they favor us with a two or three-minute call only, as if to remind us that they are still alive. They fluctuate in degree very greatly. The strength of electromotive force of these earth currents has run up to 500 volts."

GROUND TELEGRAPHY IN WAR.

(*Continued from page* 592)

the system will operate. The writer in 1903 by a system of this type was able to telephone over a distance of three miles, using an arrangement of buried plates whereby a zinc plate was buried in the ground, while a copper plate was buried three or four times the depth of the zinc plate. The plates in this case having the same function as the spikes described above.*

In the French system mentioned, the transmission of the intelligence is accomplished by means of a low power high frequency buzzer of a certain periodicity, and the signals are received at the other end by specially attuned wireless telegraph receiving apparatus, making use of a detector, tuning inductances, etc.

There are several reasons for this. In the first place if a very powerful buzzer were used in the front trenches, it will be understood that while the signals would be received in the rear without much trouble, using highly sensitive wireless receiving apparatus, the enemy as well would have but little trouble in receiving the same messages thru "No Man's Land."

While such messages could be sent in code, nevertheless, as has been pointed out frequently by us, codes are of very little use in this war, for given time, the enemy will decipher any code no matter how ingeniously contrived within a few hours. For that reason, even today at all fronts, codes are changed almost with every other message. It is merely the time element that is required to get the message thru, and even if the enemy does decipher the message, it will take him a few hours. His purpose will be defeated, however, as the order will probably have been executed long before the enemy found time to decipher the message.

Just the same, the French have taken precautions to see that whatever messages they do send by means of their new ground telegraph, these shall not fall into the hands of the enemy. And they have actually accomplished this. We are not permitted to state just exactly how this result is achieved, except that we may state that the spikes or plates of the sending outfit are

* See "Wireless Telephone" by H. Gernsback, Page 26.

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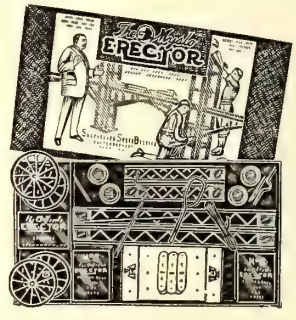
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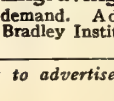
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"screened" in such a way that the resulting excitation only goes towards one direction, and does not reach the enemy at all. Then too, the high frequency buzzer is of such low power and is attuned in such a manner, that it is almost impossible to receive the signals unless they are tuned to the exact wave length, which wave length is changed every hour by both sending and receiving operators.

The advantage of this system is that it can be put in operation within a few minutes in any first-line trench and it has been so perfected now that it can be used even in advance outposts in "No Man's Land" where it would be practically impossible under normal conditions to run a line wire to the rear due to difficulties encountered in the terrain.

Nor is it necessary to separate the spikes or plates any great distance. We understand that from ten to fifteen feet is all that is required in practise, and what is most important of all, a complete outfit such as described here does not weigh more than about ten pounds, and therefore, does not take up much room. It also can be taken down very quickly in case of emergency. The other advantage is that positive communication is had at all times with the rear, and that no matter what happens to the communication trenches, the rear and the front trenches can still communicate with each other. It is of course self-understood that by means of a double-pole switch, the front line trench can send as well as receive messages. In other words, this system works exactly as an ordinary wireless outfit.

BRONZE TABLET TO MARK FIRST EDISON STATION IN NEW YORK.

(*Continued from page* 598)

marked the real entrance of the Pearl Street station into the supply of electric power to New York and its people.

This tablet marks the location of the First Edison Central Station for electric light and power establisht in America, but it wasn't the first Edison Central Station started in the world; that honor belongs to the Holborn Viaduct Central Station establisht in London, England, nearly eight months before, *i. e.*, Jan. 12, 1882, which started with two "Jumbo" dynamos and 938 lamps, which load was soon increased to 3,000-16 C.P. lamps, a third Edison "Jumbo" being added shortly thereafter. This plant was erected by Mr. Edward H. Johnson, Mr. Edison's representative in England at the time, and Mr. William J. Hammer, the chief engineer of the English Edison Company, who personally closed the switch starting up this the world's first central station for incandescent electric lighting.

The "Jumbo" dynamo is world famous, altho there are few people who know where the name originated, and we are indebted to Mr. Hammer for our enlightenment on this point. Mr. Hammer says that in 1881, Mr. P. T. Barnum, the famous showman, purchased for his circus the world's greatest elephant—"Jumbo"—from the London Zoölogical Gardens, and Jumbo was shipt to New York on the S.S. *"Assyrian Monarch,"* and upon the return of this steamer to England it carried as part of its cargo the two 30-ton Edison dynamos known as Nos. 2 and 3 (No. 1 having been sent to the Paris Electrical Exposition of 1881), and it occurred to Mr. Hammer upon installing these two huge machines to call one of them "Jumbo," the other "Alice" (after "Jumbo's" mate), and this term "Jumbo" has ever since stuck to this remarkable type of Edison dynamo, which was the true wonder of its day.

Many extremely interesting incidents occurred in the operation of this pioneer central station on Pearl Street. For instance, it was found very difficult to regulate the dynamos and engines as to speed and voltage and one of the expedients invented to improve this regulation was to have the attendants slip a small weight on or off the engine governor. Note the massive feeder switches on the wall of this early electric light station which look like giant nut-crackers. These switches were fitted with a strong spring which tended to open the blade and which was released from contact by a special trip. The switch thus opened quickly and with a minimum of sparking.

And commutator troubles. Oh! yes, they had them a-plenty in those epochal days. Due to the severe vibration set up by the high-speed 30-ton Jumbo dynamos and their attached engines, the brushes would chatter like a monkey. One of the cures proposed for this malady involved the application of a mercurial paste to the commutator, in order to improve the conductivity between the commutator and the brushes. The mercury tended to slightly short-circuit the commutator bars and last but not least, the faithful dynamo attendants were attacked by the mercury fumes liberated, their teeth being the first point of attack. Then again it finally became necessary to actually "gold plate" the commutator connections, as these joints, being formed of copper bars, tended to work loose at high speed and oxydize. As soon as the oxydization set in, the circuit thru that particular joint would begin to fail and to obviate this trouble the surfaces were "gold plated" as aforementioned.

In 1903 the Waterside Station Number 1, complete with sixteen vertical engines of 5200-5500 horsepower each, sent out electrical energy to various distributing centers. But even this was not enough for the growing city and for industry which under the spur of electric power was being re-made and thereby re-making New York. So Waterside Number 2 was built in 1906, beside Waterside Number 1 at First Avenue and Fortieth Street.

In both stations today, in contrast with 900 horsepower in generators in the historic Pearl Street station, are generators of nearly 500,000 horsepower, among them great units of 45,000 horsepower each, with still larger ones planned. And from these electric current goes to thousands of customers thru miles of mains covering all Manhattan and the Bronx.

One of the views herewith shows a modern electric dynamo which is not so much larger than the 150 horsepower "Jumbo," but which when fully excited can produce 50,000 kilowatts or more than 67,000 horsepower, or about 450 times as much electrical energy as its predecessor.

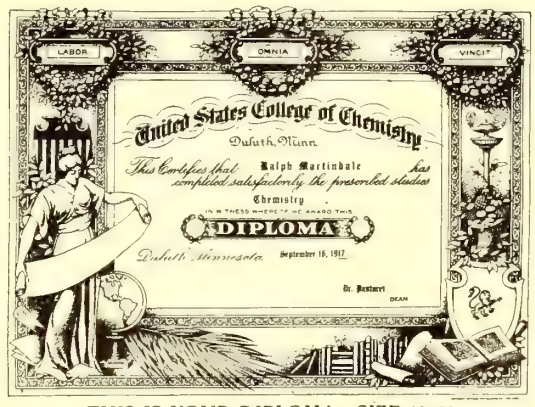
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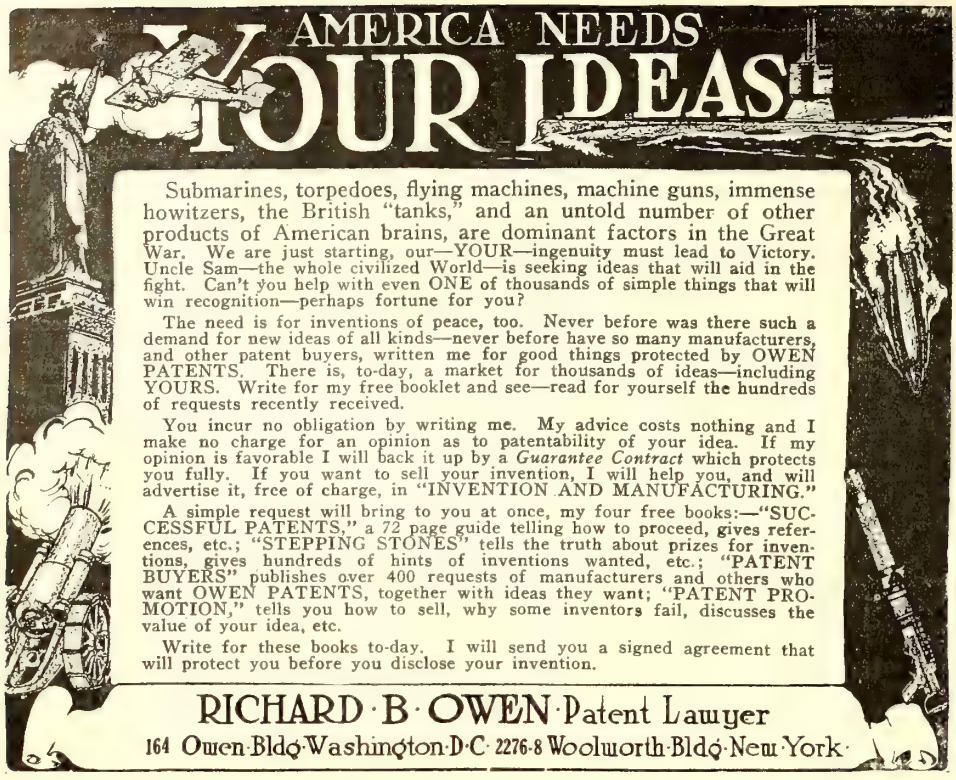
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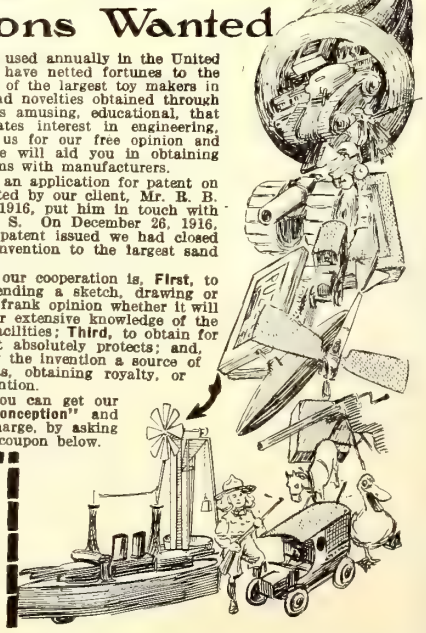
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WAR ADDRESS BY A. I. E. E., PRESIDENT-ELECT E. W. RICE, JR.

(*Continued from page* 609)

With the destruction many laps ahead, it is vitally important that ships should be loaded and unloaded with the utmost expedition. We have recently heard of an instance where a large ship, after running the gauntlet of a voyage to England, was forced to visit several different ports, and waste one month's time, before starting the return voyage. This loss of time is equal to the loss of a complete voyage. The net tonnage delivered per month is the only thing that counts, therefore ship-tons saved are worth more than ship-tons built. Quick methods of loading and unloading at specially devised terminals, here and in Europe, should be developed and put into operation. The methods are known. It simply remains for us to organize and apply them.

We must see to it that the kind of ships, in respect to size, material and speeds, are such that the greatest tonnage may be moved across the seas in the shortest time. In the time element must of course be considered the time required to build such tonnage. If an investigation should indicate that cargo ships can be built which will successfully *withstand* one or more torpedo attacks, and which can also be provided with speed and armament sufficient to give them a good chance of fighting off and getting away from a submarine, they should be built no matter whether such ships cost more, or are less adapted for use after the war, or take a little longer time to construct than those of the ordinary type.

It is entirely within the range of possibility that such ships may prove to be the only ones which will be able to navigate the seas with any decent chance of surviving. It would seem clear that, unless the submarine is swept from the seas, it is hopeless to build a large tonnage of slow moving, relatively small and inadequately defended ships, as the net tonnage which could be delivered by such a fleet of ships will be too insignificant to be of any material value. We would have bet on the wrong horse and lost; therefore, I hope that we will have the foresight to build as large a number as possible of big, comparatively torpedo-proof cargo ships as soon as possible.

We should also, at the same time, consider whether it is worth our while to continue building large dreadnoughts, battle-cruisers, and the like. which cannot possibly be finished for years to come. Our ship building facilities are limited, and if the facilities now devoted to the construction of dreadnoughts could be immediately diverted to the construction of large fairly indestructible, high-speed cargo ships, which can be built in half the time, we would be taking a great step towards solving the problem.

So much for what might be termed the "defensive method" of attacking the problem. Along with this defensive plan, we should put into execution every practical offensive plan of attacking the submarine, *such as methods of detection when submerged, methods of attack by means of destroyers, mines, aeroplanes and special artillery.* All such methods should be, and probably are being developed, and while no one of them will prove to be the panacea by itself, collectively they will be of the greatest value in reducing the menace. However, I think it is well to emphasize the fact that the only safe and sane plan

(*Continued on page* 651)

PATENT ADVICE

Edited by H. GERNSBACK

In this Department we publish such matter as is of interest to inventors and particularly those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

HUGHES RADIO BALANCE.

(189) Mr. Fred R. Bullis, Omaha, Neb., has submitted a very ingenious plan for using the regular Hughes balance for radio purposes, the idea being to upset the inductive balance by means of received wireless energy.

A. This indeed is a very good idea, and we are of the opinion that the apparatus will work as outlined by our correspondent. However, things of this nature had better be tested out under actual service, and we certainly would advise our correspondent to do so before applying for patent. We think he has the germ for an eminently practical device.

LAND SUBMARINE.

(190) Arthur J. Walsh of Montclair, N. J., submits designs and description of a submarine which can be used not only to operate under water but on land as well, the idea being to use it for offensive purposes, and the inventor seems to think that a device of this kind would be excellent for fording rivers, etc., where it would be impossible for the men to get across bridges or swim across.

A. While the idea is good, nothing new is contained therein, the trouble with a device of this kind being that a submarine for use on land, would have to be armored so heavily that it would be of doubtful value under water. The ordinary submarine has only a comparatively thin shell, and even a gun of rather small caliber will easily wreck the strongest present-day submarine if exposed from the water.

MODEL AEROPLANE.

(191) F. Paquette of Detroit, Mich., has been experimenting on a model aeroplane with two propellers, one in front and one in back. He claims to have had some success with this device, and wishes to know if an aeroplane so equipt could be patented.

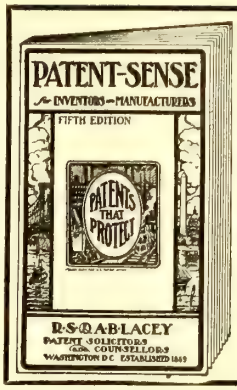
A. This idea is not new, and we doubt very much if a patent could be obtained on a device of this kind. There is nothing patentable in a device merely by transposing a certain function to the rear or to the front of the particular device.

CORKSCREWLESS CORK.

(192) Howard J. Heini of Lincoln, Neb., has been working on an improved cork, the underlying idea being that it is difficult as a rule to extract almost any cork from a bottle, and if a device could be found whereby a corkscrew could be made superfluous, the inventor thinks a valuable patent should result. Accordingly, he has submitted an idea whereby a cork, which could be made at a low cost, equipt with a certain device can be extracted without the use of the ordinary corkscrew; as a matter of fact, without any tool whatsoever, excepting the hands. Our advice is asked as to this idea.

A. Basically, we have no fault to find with this device. It is really excellent, altho a similar device, tho not quite the same, is now being used on certain perfumery bottles. The main fault we have to find with the device in question is that the metal which protrudes thru the cork comes in contact with the fluid or liquid contained in the bottle, and this is bad. If our correspondent could make his device in such a manner that no metal comes in contact with the fluid, we believe a good patent could be obtained.

Witness the fact that a fortune has been made out of the present new style, so-called "crown" bottle cap, which fifteen years ago was not known at all, and has been and is now in use all over the globe. This device was invented by a Baltimore man.



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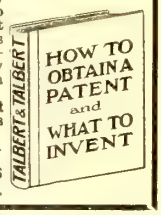
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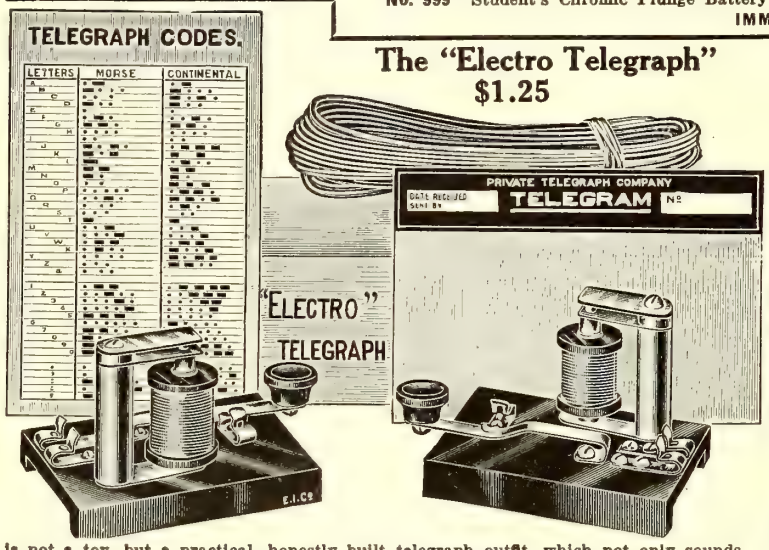
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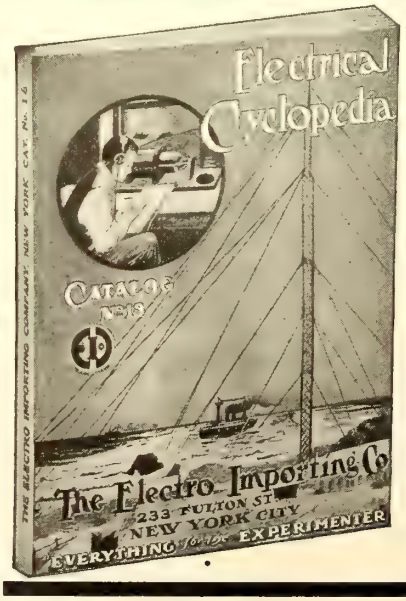
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(*Continued from page* 648)

of action is to assume that we can only win by pushing the development of all practical looking methods of attack and defense, at the same time, and to the limit of our ability.

Now I am well aware that there is nothing theatrical or startling, or novel, in the above suggested solution. For this reason it is not likely to appeal to the great non-technical public, but there is no doubt in my own mind that it represents the scientific and common-sense method, and that if followed with *patience, persistence, vigor and diligence, it will prove successful, and if successful, the war cannot be lost.* All the other problems of the war—the aeroplane, army, navy, food, manufacturing, farming, transportation, etc.—can be successfully solved by the same scientific, but simple and common-sense methods.

It is a great satisfaction to notice that this country has at last awakened to the importance of developing that great American invention—the aeroplane, and of manufacturing it on a great scale. We should do everything to help accelerate this work. If we can get aeroplanes of the right kind to Europe, soon enough and in sufficient quantities, experts tell us that it will do more to win the war than a large army.

We must also not neglect the development of the submarine, because if we fail to find a way to drive the submarine from the seas in short order, and fail to make relatively unsinkable and uncatchable ships, we may have to rely on big freight submarines, properly convoyed by fighting submarines, if necessary, in order to get food, material and soldiers to Europe.

We must not forget that, after all, all these things must be done by men collectively and that, therefore, it is essential for us to think and act collectively, and with reasonable unanimity. We must co-operate and not nullify our power by quarrels among ourselves. This means that we must be willing to give consideration to the views of others, be ready to make reasonable compromises and be constantly actuated by a spirit of conciliation. We must make every effort to get men of great experience, industry and sound common-sense in positions of trust and influence.

"HAM" AERIALS.

(*Continued from page* 616)

Speaking of using phoney stunts for aerials reminds me of one stunt I tried which worked fine. This was to put insulators in the wire clothes lines on the roof and use them for sending and receiving. All went well for some time till the maid came down stairs and said that the clothes were sparking, and every time she touched them she got a shock. I had to go up with her in order to prove that nothing was wrong and that she only *imagined it.* Some fun, but say, when wet sheets were hung up signals came in better and if you wanted to know if the clothes were dry, just listen in and you could tell by the way signals died out that the sheet was dry. Guess I will have to take out a patent on that idea.

How many have had aerials mysteriously disappear? I have, and to warn me when they think of leaving, I have the greatest little alarm you ever heard of and which lets you know just the minute anything happens. By twisting an enameled wire with the aerial wire and connecting it at the aerial switch with a constant ringing bell and special relay, cutting the wires

(*Continued on page* 652)

PATENT ADVICE.

(*Continued from page* 649)

ONE BRUSH MOTOR.

(193) C. W. Halligan, Ephrata, Pa., has submitted to us a sketch showing an induction motor using only one brush and a 12-segment commutator. The armature coils are connected in such a manner that when a coil is in a certain position its ends are short-circuited by the brush. Advice is asked if such a motor would be of any commercial value.

A. For the reason that only one armature coil could be used, the losses would be too great, and therefore no commercial advantage is perceived in this device. While there would be a slight advantage of using only one brush instead of two brushes, this advantage is offset by the occurrence of other losses. Besides, brushes are so cheap that it would not pay to change the construction of the machine merely to save the cost of a cheap brush.

PHONOGRAPH.

(194) Wm. Tredwell, Glace Bay, Nova Scotia, has an idea whereby he wishes to equip the horn of an ordinary phonograph by means of a blower or fan arrangement, the idea being that he expects to obtain the same effect as that used in an ordinary organ, better known by the name of *Vox Humana.*

A. While this looks good on paper, and while the idea ceretainly appears new, it is impossible to say if the device would work or not without actually trying it out. We would advise our correspondent to first build a model before spending money on patents.

RANGE FINDER.

(195) Herbert L. Moershfelder, Buffalo, N. Y., submits drawing and specifications of a mirror range finder to be used in conjunction with a telescope to find the range of ships, etc., accurately. Our advice is asked as to the patentability and practicability of the device.

A. While several points of the idea as submitted are rather novel, there is a very similar range finder in operation now on United States battleships, and for this reason, we doubt very much if protection could be secured on this particular idea.

AUTOMATIC WRENCH.

(196) Joseph Denninger, Germantown, Philadelphia, Pa., has sent in a sketch of a ratchet wrench on which he wishes to have our opinion. This particular wrench is made in such a manner that any jaw opening may be had and secured at a particular point merely by pressing a spring.

A. This idea strikes us as being very good, and we have not run across anything quite the same. It seems also rather cheap to produce from a manufacturing viewpoint, and we think a good patent might result. Our advice is to get in touch with a patent attorney.

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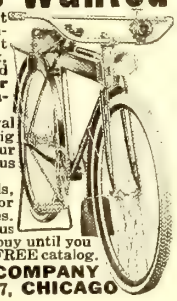
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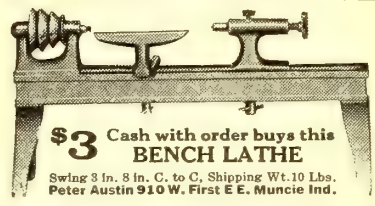
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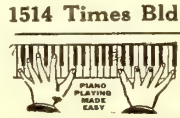
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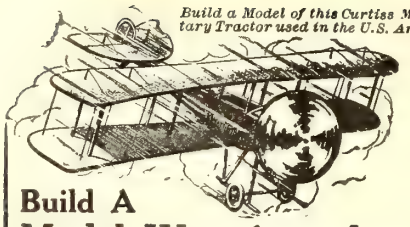


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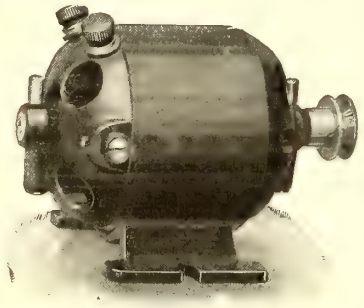


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shorts them and the bell starts to buzz. The aerial switch of course must have extra blades or contacts on it, so that when you are sending, the enamel wire is connected to the aerial wire and acts for the time as part of the aerial. I even went so far as to use two enamel wires and by using them as a closed circuit system, plus the first system, which is known as an open-circuit one, I was positive that nobody could walk away with any of my wire. Shorting the enamel wires to the lead-in was just as bad as cutting, as all the alarm apparatus down in the house was of the type where, once a circuit was made or broken, the bell kept on ringing. In case I did not happen to be at home the device was so arranged that besides the bell, which only rang for about ten minutes, the transformer would be connected to the aerial and just enough shock given to make it unpleasant for the cutter and yet not kill him. This also was arranged to be shut off after ten minutes' time. Well you say, all the cutter had to do would be to return in that time and finish the job. Correct!! but I don't think that, not knowing that the juice would be turned off and thinking that some one was using the set, would cause him to return. The act of cutting aerials is one of the lowest in the whole category of petty larceny crimes and as for the money paid for insulators and old wire I guess it is about enough to take a trolley ride and that's all.

Talk about playing clean jokes on the other fellow, I pulled one that works great. It is performed in this manner:—For some time tell the party who is to be the goat, that you have invented a "Wireless Telephone" and after pulling this line of chatter for a time, fix yourself up with a telephone transmitter, battery and receiver and not forgetting to mention that he will hear you on such and such a night at a certain time, go up on his roof and make a ground connection on a vent pipe and the other to his lead-in wire. This will complete the circuit and by talking, he will hear you thru his receiving set. It would work better if you had a talking coil with the receiver in the secondary and the transmitter in the primary; then when you connect your wire to his lead you will not have the battery current flowing thru his receiving set and make a click in his 'phones which may put him wise, if he knows anything about electricity. Call him up and ask him how he likes your new wireless telephone, but be sure to disconnect your clip from the lead and by having it lay near the aerial lead you can hear thru your receiver what he says. "Kid" him along for a few nights and your fame in the amateur world will grow. If the other fellows say that they can't get you at the same time, "gas" a little about *directional effects.*

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(*Continued from page* 614)

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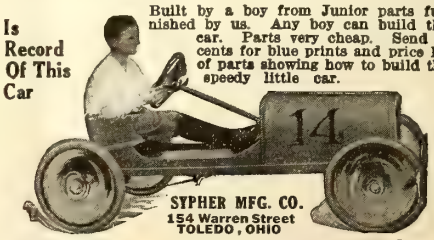
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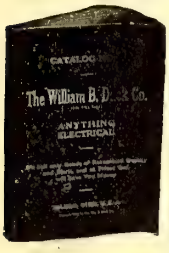
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THE ULTRA-MICROSCOPE AND THE UNDERWORLD OF INFINITESIMAL SMALL.

(*Continued from page 623*)

Zsigmondy* thus describes colloidal gold as viewed thru the ultra-microscope:—

"The tiny gold particles did not swing stationary in the water, they moved with astonishing rapidity . . . These motions show that there is a continual mixing together of the interior parts of every liquid going on unceasingly, year in, year out. . . . The smallest observable gold particles show a double motion; firstly, they possess a motion of translation so rapid that the particles travel 100 to 1000 times their own diameter in 1/6 to 1/8 of a second; secondly, they possess a swinging or oscillatory motion of much shorter period; indeed it is probable that they possess oscillatory motions of higher order and smaller amplitude, too small and too rapid for direct observation."

This his description of colloidal silver:—

" . . . Blue, violet, green, and red particles, in different shades and with a rare brilliancy of color, are seen in ceaseless movement. One particle approaches the other, circles round it in a rapid zigzag movement, and then flies off again. Sometimes several particles group together and dance like flies in the sunshine, especially when, for a fraction of a second, one particle comes near another."

He thus describes the coagulation produced by adding sodium nitrat to colloidal gold:—

"Suddenly there appeared yellow balls of mist, in a state of wave motion. The mist condenses further. One sees the tiny individual particles in a state of lively Brownian movement. The particles rush together and revolve round their common center of gravity . . . if the saltpetre solution be allowed to flow into the gold solution under the microscope, such rapid and violent whirlpool motions are set up that the eye is unable to follow the process of coagulation."

The movements described by Zsigmondy are, no doubt, similar to the swifter and more complicated molecular motions of matter. In the future, man must find some means to retard these motions before the particles can be viewed, and it is highly probable that this will be accomplisht by some process of excessive cooling.

*Zsigmondy, "Kooloidie und ultra-microskopie" (1905), Elektrochemie VIII. 684-87 (1902), Physik. Ch. LVI. 65-82 (1906).

EXPERIMENTAL MECHANICS.

(*Continued from page 621*)

drilling can be done just as well on the lathe), yet at times when drilling on the lathe is not possible, the drill press will be found indispensable. As with the other machines, the size will depend upon the character of the work, and the amount to be expended by the purchaser. There are several types on the market and the writer advises that the motor-driven type should be invariably employed. A small ⅛ H.P. motor will be sufficient for driving a small drill press.

If the amateur goes to an extreme and desires to make his shop up-to-date, then he will invest in a small *milling machine*, a *bench shaper* and a *circular saw*.

Having outlined the necessary equipment to make up a fully equipt up-to-date workshop, we shall proceed hereafter with the details, as to the how and why of handling the various tools. The author will treat in the second lesson on the "Lathe."

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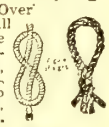
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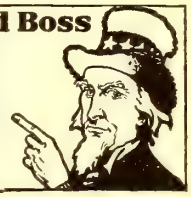
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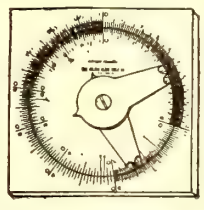
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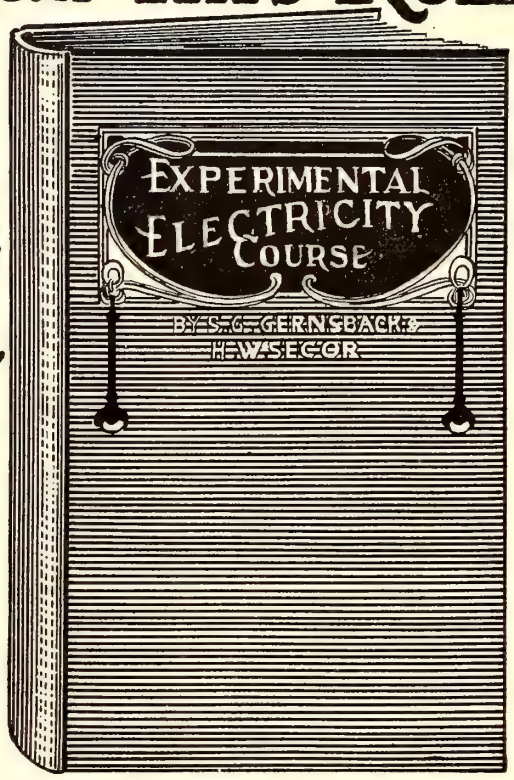
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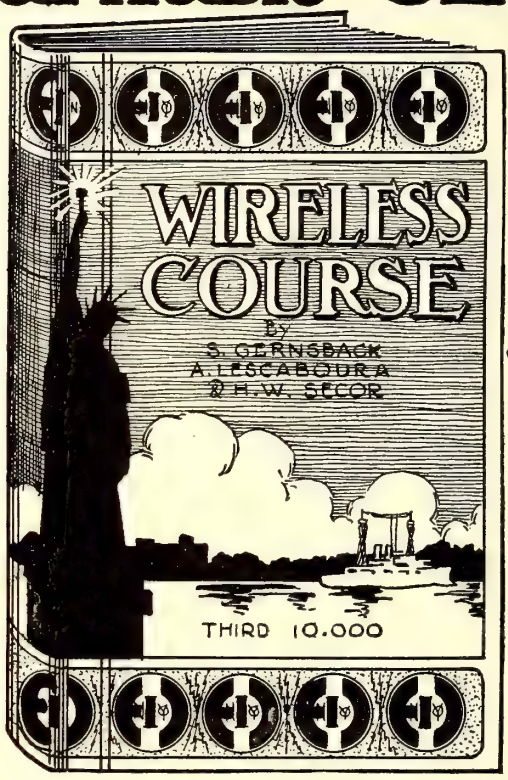
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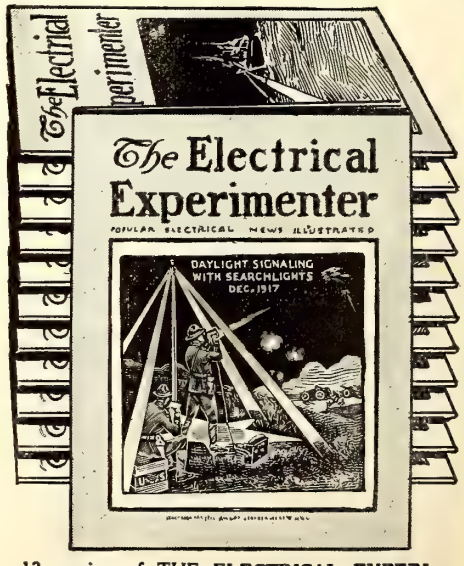
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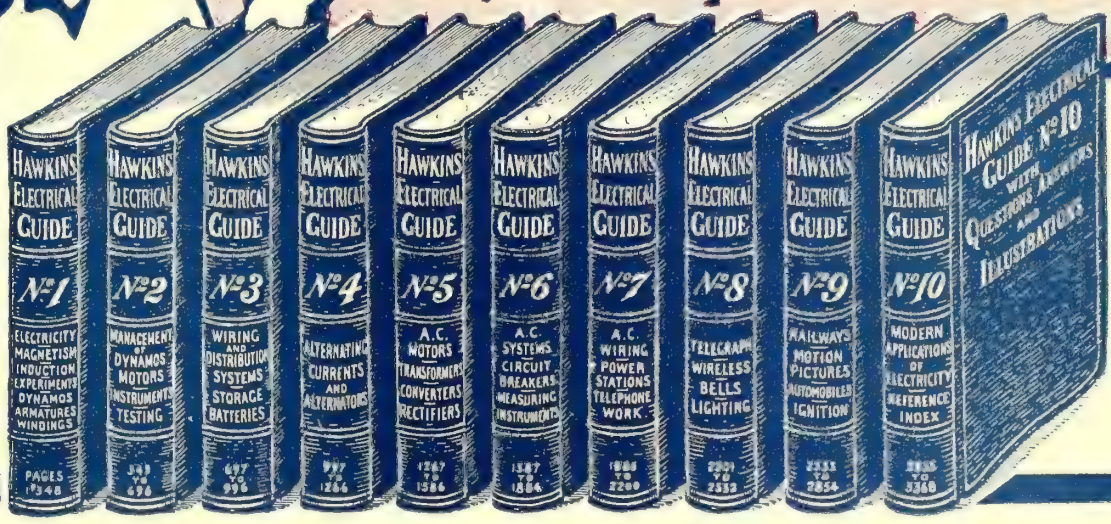
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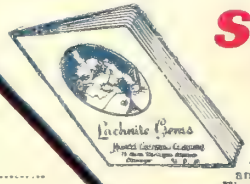
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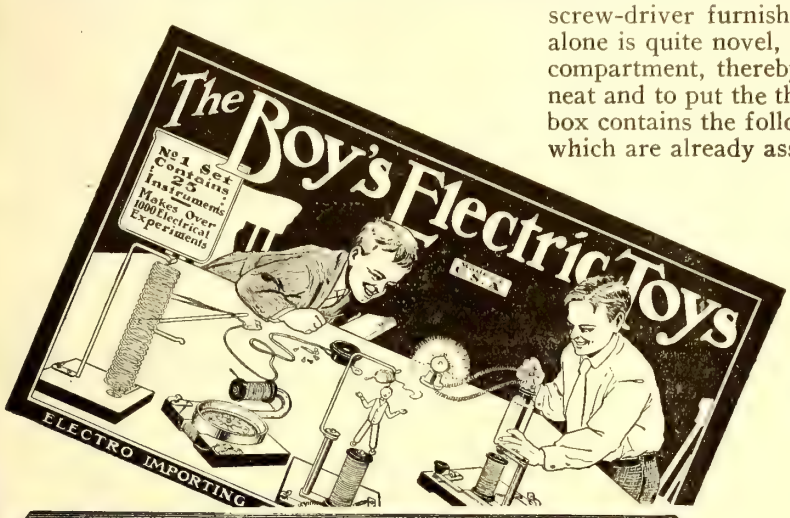
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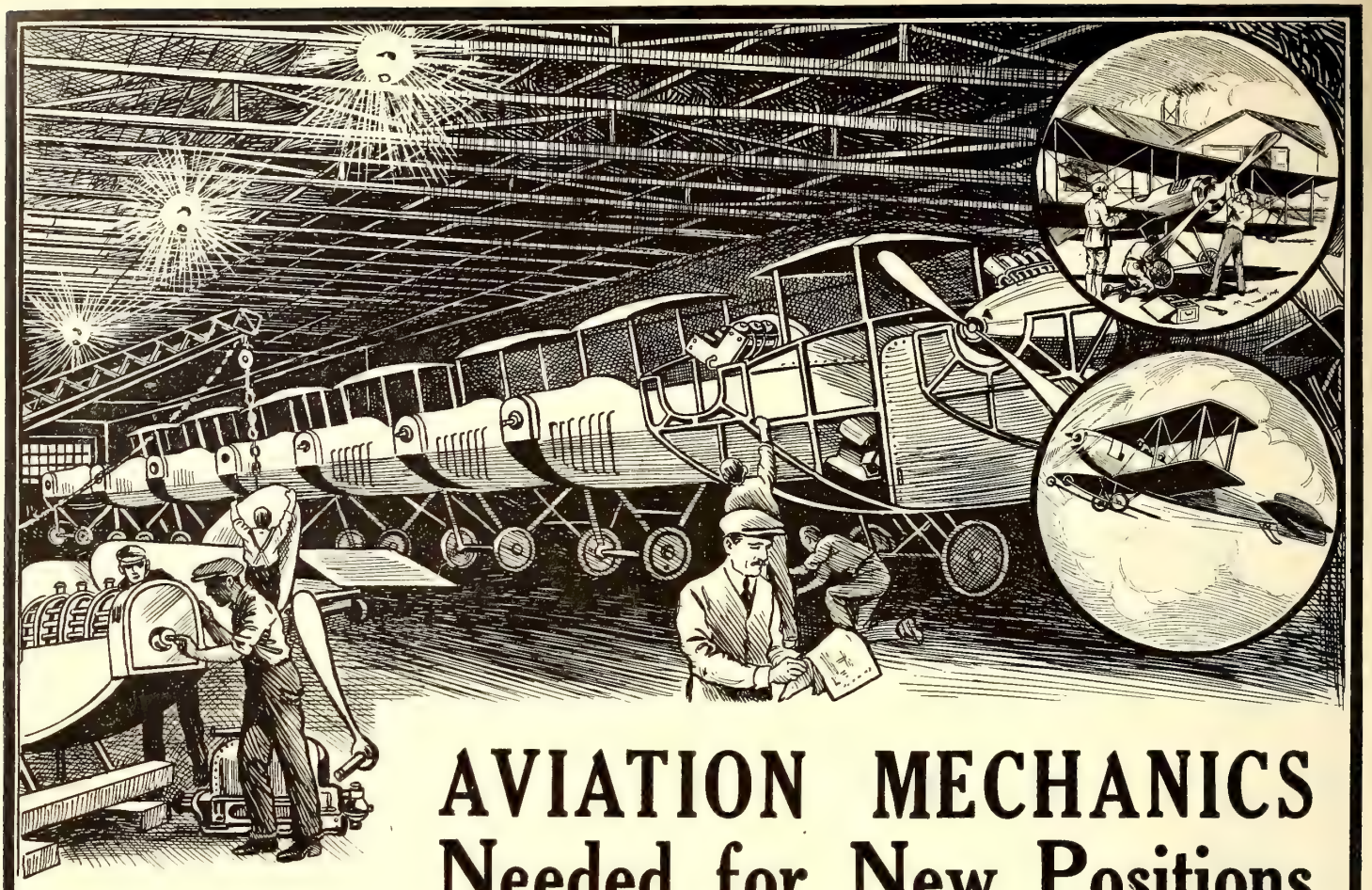
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Gravitation and Electricity

IN our issue of October, 1916, we mentioned editorially that gravitation was an electromagnetic phenomenon. We also ventured the opinion that what we know as gravitation—like light—probably was only still another manifestation of that mysterious thing we call ether. We furthermore advanced the term of "gravitational waves," to better express our thoughts, because we felt that if gravitation was an electromagnetic phenomenon, it was probably due to a distinct wave motion in the ether.

Up to the time of our writing there did not exist experimental proof that gravitation really was an electromagnetic manifestation of the ether; the ideas in our editorial merely being the rather plausible theories of our leading scientists. To the layman the idea of gravitation being an electric phenomenon came somewhat as a surprise; nor were there many adherents to the new theory. For, the reasoning was, what electrical force could possibly draw a stone earthward, when released by the hand? But at last experimental proof has been forthcoming thru the untiring labors of our brilliant Professor Francis E. Nipher, of the St. Louis Academy of Science. In a pamphlet issued November 8th, 1917, Professor Nipher supplies experimental evidence that gravitational attraction can not only be suspended or nullified by the electrical current, but it actually can be transformed into "gravitational repulsion!"

All during the summer of 1917, Professor Nipher has had his apparatus in almost continuous operation and the experiments have been repeated time and again, always with the same result. To understand better what follows, let us keep in mind the fact that all masses attract each other gravitationally. Thus, for instance, if we suspend a stone by means of a string at sea level, the only mass that will attract the stone will be the earth. In this case the stone will hang absolutely vertical, *i.e.,* at right angles to the earth. But take the same stone with its string and carry it up a mountain, let us say half way up, then the earth, too, will still attract the stone. But so will the large mass of the mountain, with the result that the string will not hang absolutely at right angles to the level of the earth, but the stone will be pulled *slightly towards the mountain,* because of the attracting mass of the mountain.

Professor Nipher's apparatus briefly consists of two large lead spheres ten inches in diameter, resting upon heavy sheets of hard rubber. Two small lead balls, each one inch in diameter were now suspended from two silk threads, stationed at the sides of the two large lead spheres, from which they were separated a little distance. Moreover, the suspended balls were insulated elaborately from the large spheres by enclosing them first airtight in a long wooden box, which was also covered with tinned iron sheets as well as cardboard sheets. There was furthermore a metal shield between the box and the large metal spheres. The large metal lead spheres now exerted a certain gravitational pull upon the suspended small lead balls, just as the mountain attracted our stone as mentioned before. The silk suspension threads therefore did not form a "plumb-line" but the small lead balls were slightly pulled over towards the large spheres.

Now, Professor Nipher applied an electrical current to the large spheres—20 amperes alternating current. The gravitational attraction was quickly reduced to zero, and not only that but in 15 to 20 minutes the small lead spheres *had moved away over one-half as much to the opposite direction* as the distance they had been attracted originally, towards the large masses. Thus gravitation had not only been completely nullified, but it was *actually reversed.*

This is equivalent to our stone rushing skyward when released, instead of falling to the earth!

Prof. Nipher's historic experiment is certainly one of the most important discoveries of the century. When it leaves the laboratory, as it surely shall—it will not only revolutionize the world, but it will make man free from his gravitational fetters that now chain him to the earth like a rock.

H. GERNSBACK.

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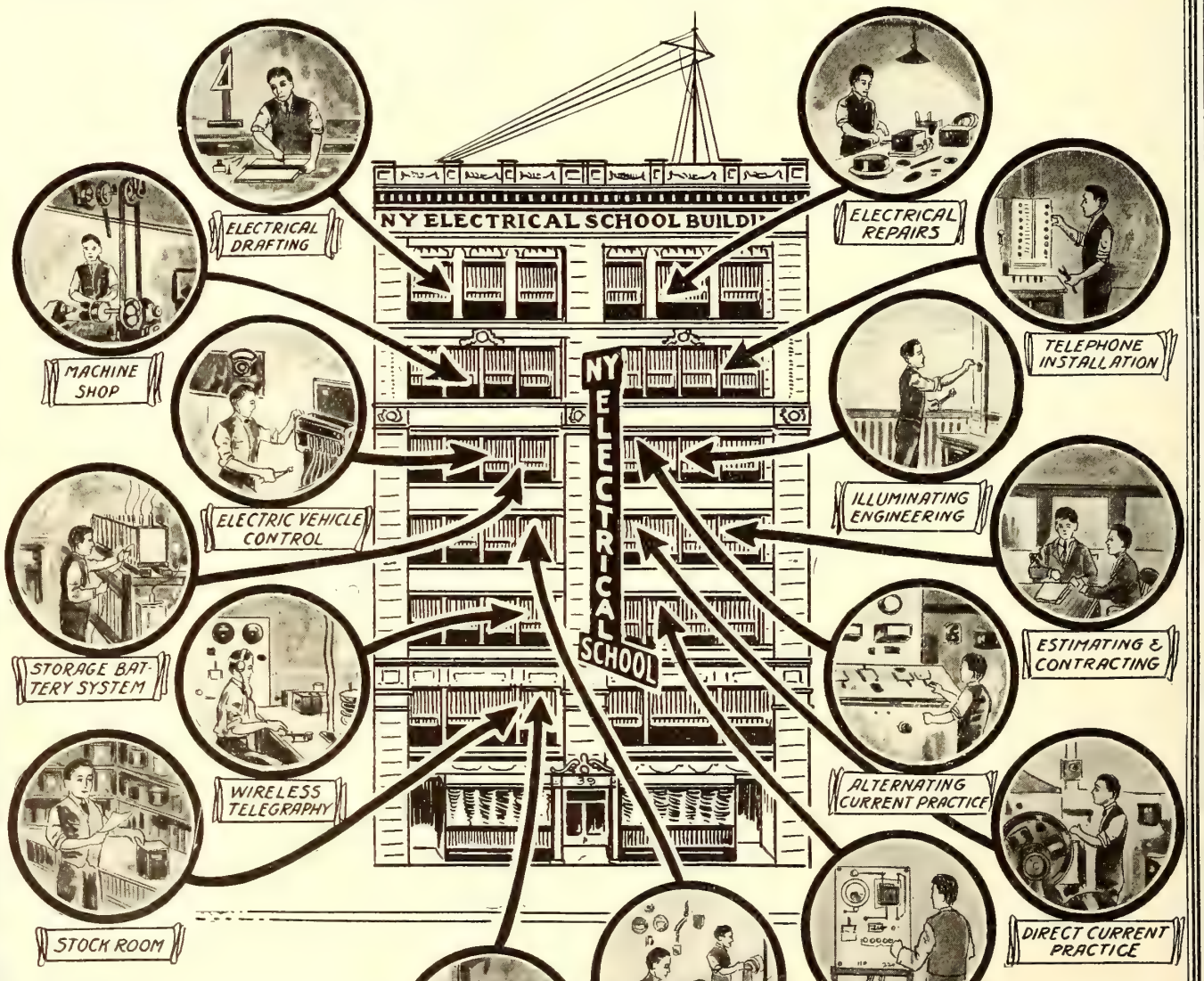
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ELECTRICAL EXPERIMENTER

H. GERNSBACK EDITOR
H. W. SECOR ASSOCIATE EDITOR

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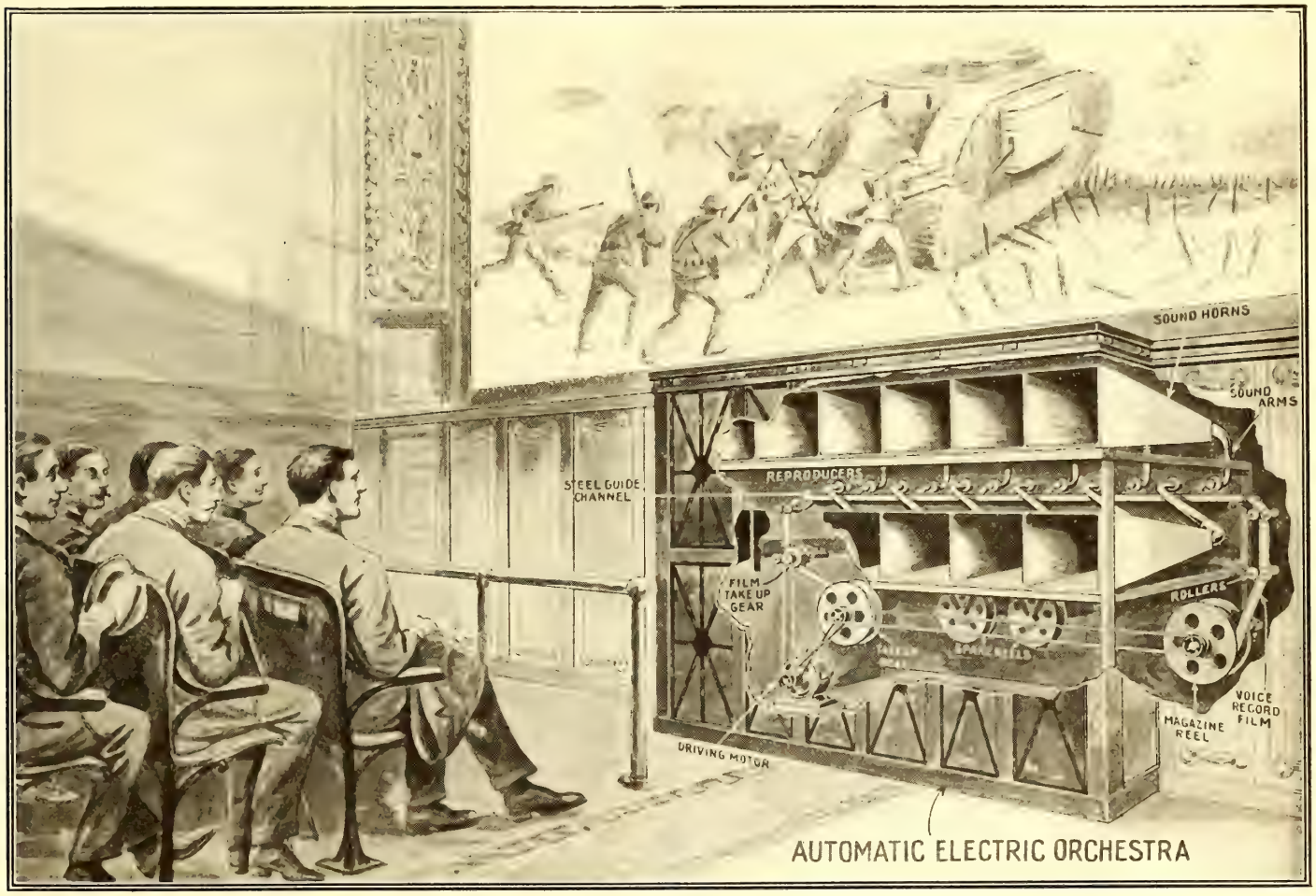
New Orchestra Phonograph Plays 48 Records at Once

WHILE the phonograph or gramophone has been perfected lately to a very high degree, there nevertheless still remained the fact that all sound waves of various lengths had to be produced at the same time with a single diafram or soundbox.

Assume that the sounds produced at exactly the same moment by a violin and a violincello or contrabasso shall be reproduced by one diafram respectively and thru the vibration of one needle transmitted to said diafram. How is it possible? The note of the violin sound may be much higher than the note of the 'cello, with a variation in the length of both sound waves so great as to require a very different vibration of the diafram to produce those two particular sounds properly and *actually at the same moment.* To do this would be just as impossible for the diafram as it would for a pendulum to swing to the right and left at precisely the same moment, or for an elevator to move up and down its shaft at the same time.

It is, therefore, obvious that these two different sounds must have been produced at different times successively, notwithstanding that we *seem* to hear them to a certain extent distinctly and apparently at the *same time.* The fractions of time between both sounds are so short that we cannot distinguish between them, just as we see in a moving picture apparently only one continuous picture and are unable to distinguish between the many thousands of single pictures which pass actually before our eyes.

This fact also explains why we find that



Theatre Managers Have Often Tried a Phonograph in Place of an Orchestra, But the Volume of Sound Proved Insufficient. The Latest Is the "Orchestra Phonograph," Which Records Each Instrument or Voice Separately and Reproduces Them All Together in Perfect Harmony. The Records Are Made on a Special Film. It Represents Science Applied to the Phonograph, for It is Manifestly Impossible for a Single Record to Record and Reproduce Faithfully More Than a Few Voices or Instruments.

Testing The "Ears of The Army"

The accompanying photo shows a British "Tommie" of the signal service testing an army telephone line near the battle front. The little poles shown in this British official photograph are used to keep the wires high enough from the ground to avoid grounding while at the same time they are low enough to prevent their being seen by the enemy.

The telephone lineman in this war is as much of a hero as the man in the trenches. He must often go out to repair broken circuits when that particular line is under shell fire. The "ears of the army" must not fail—not even for an instant. Every break in a circuit must be repaired as soon as possible, and that usually means a few minutes after a shell was hit. One thing is certain—the Signal Corps men are rendering wonderfully efficient service in this war.



Photograph Copyright by Underwood & Underwood

A British "Tommy" Repairing Telephone Lines Near the Battle-Front. Note the Short Poles in Use.

GET OUT THE INK! WRITE TO THE SOLDIERS AND SAILORS.

"Tell the boys who are still on your side of the water that if they know a single lad who is over here, doing his bit either afloat or ashore, for God's sake write to him."

This is an extract, unabridged, from a letter which came to one of us this week from faraway Egypt, says a writer in *The Oscillator*, the magazine publisht by the U. S. Naval Radio School at Harvard University. It is from an officer in command of an American vessel, and his complaint is, that aside from the human sympathy it engenders, the lack of friendly letters from the home side of the sea is a serious detriment to the morale of his crew.

"Only one of my men hears regularly from his friends," he says. "Mail does not reach us often. About once a month a batch arrives, and if you or any of the boys could see the blank dismay, the bitter expressions of homesickness that cannot be kept down when I have to say 'No mail for you this time, Jack, you'd sit right down and write a long, newsy, chatty letter to every man you know who's over on this side, three thousand miles from any American town."

It'll take up only a little bit of our time; let's every one of us shoot along the good word to every man we know over there. And there is not one of us but who has at least one friend in or alongside the Big Fight.

A new dining room table is equipt with electric plate warmers, built in the table.

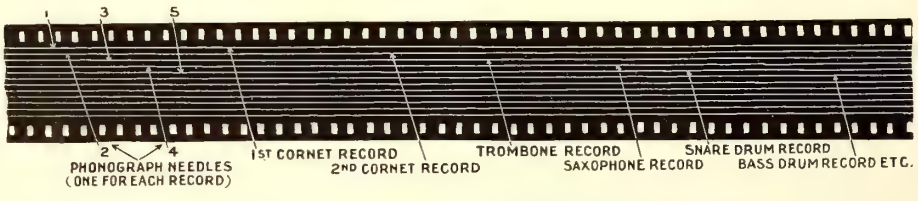
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the reproduction of a *single* voice or a single instrument, for instance a violin solo, is so much more distinct and why we obtain better effects than if we listen to a record reproducing at apparently the same time *several* voices or instruments. We also can understand the words of a single person spoken at a time from a record much better than if we hear several voices together, because the reproducing vibrations of the diafram are curtailed by the different vibrations required for the reproduction of different voices or instruments, as in most cases the diafram has to make a sort of a compromise between the different vibrations produced at a certain moment, and has to adjust itself accordingly to a certain vibration which actually does not represent the proper sound of any of the various sounds at that moment, but which seems to our ears to give the composite effect of all of them.

While we reproduce with a wonderful perfection a single voice or a single instrument with the gramophone, the effect obtained never equals the original when it comes to reproducing an orchestra of musicians or a chorus of singers.

Therefore, many persons and phonograph manufacturers have attempted during the past several years to perfect an instrument wherein several diaframs, needles and sound records are used at the same time, but the difficulty of obtaining a perfect synchronism proved unsurmountable. If the different diaframs are not actuated in absolute synchronism, the discordant effect can easily be imagined. It would amount to the same as if the various singers of a chorus or the musicians of an orchestra would not act in perfect harmony.

The difficult problem of reproducing different voices or musical instruments with a phonograph or gramophone at the same time with as many different, independent diaframs and sound records in absolute perfect synchronism and harmony has now been solved in a surprisingly simple manner by Mr. H. Hartman, an electrical engineer of New York City, who has applied for patents on his invention in practically all the larger countries. In a personal interview at his laboratory the inventor gave the author interesting details regarding his novel, wonderful invention which probably will revolutionize the phonograph and secure to the same a dominating place in many places of recreation, especially in moving picture theatres, large restaurants, music halls, etc., where this new *"electric orchestra"* will play without interruption for hours the best works of our great masters of music in a manner difficult to distinguish from the original music which has been thereby recorded. It will probably also soon be found in many homes thruout the world, especially in country places, as it can reproduce whole operas and a whole chorus of singers in perfect synchronism.



This Diagram Shows How the New "Orchestra Phonograph" Has Each Instrument Recorded On a Special Film. A Separate Needle Rests in Each of the 48 Sound Record Lines and All of Them Thus Reproduce In Syntony and Harmony.

We have already described various other inventions of Mr. Hartman in previous numbers of the ELECTRICAL EXPERIMENTER, and also his "SPEAKING CLOCK" in our February, 1917, issue, which tells the time every quarter of an hour. In this speaking clock Mr. Hartman uses a *flexible celluloid film* in place of a solid disk or cylinder as the carrier of the sound records, and out of this basic idea he has developed his present *Multiple Diafram Phonograph* or "Electrical Orchestra." While he uses a film less than two inches wide in his above mentioned speaking clock, having forty-eight different sound record lines, parallel to each other, the present invention is also based upon the use of a film as sound carrier with as many independent sound record lines on the same as there are diaframs in his instrument. The number of these is practically unlimited. The film, which moves with about half the speed of that in a motion picture projector, is wound upon a reel and inserted into a lower compartment from where the film is led over guide rollers to a long, narrow and horizontally arranged compartment which contains as many sound-boxes (diaframs) as there are record lines on the film. In designing this remarkable machine care has to be exercised, of course, to isolate each sound box as much as possible, so as to prevent confusion of the sounds in the sound-box compartment. All diaframs are in a horizontal line and resting with their own weight freely upon the film which passes thru a small channel rail and then over a second series of guide roll-

(*Continued on page 732*)

Why Not Aerial "Stepping Stones" from U. S. to Europe?

By F. S. WINGER

Each "stepping stone" a gigantic floating fortress, and the distance between each one 200 miles let us say. A constant stream of aeroplanes could thus fly from the United States to Europe—20,000 of them in one year—predicts the author of this interesting article. Radio messages could be relayed from one "stepping stone" to another with much less chance of interference and interception as at present.

It is admittedly impossible at present to attempt flying the entire aerial fleet of Uncle Sam across the ocean, however much it might expedite the delivery of the promised 20,000 aeroplanes to our Allies. Here's a unique and feasible plan—feasible at least under this war's conditions, with Germany's battle-fleet bottled up—which is proposed by a Chicago genius and author—Mr. F. S. Winger, who originally conceived this idea and described it in his book, "The Wizard of the Island," altho in that work the idea has not a military dress. The present article prepared for the ELECTRICAL EXPERIMENTER *by Mr. Winger, describes his latest ideas in this direction.*

* * * * * *

MAKE each "Stepping Stone" a huge float—each float a veritable floating fortress, defensively armed and equipt to meet any emergency which the enemy could menace them with, which under the conditions of their bottled-up-Navy would probably be limited to their submarines.

Each float to carry a supply of stores, maintain a repair department, etc., and to have just sufficient mobility to enable it to successfully oppose any drifting tendency on the part of either ocean or air currents, so that they could maintain a fixt latitude and longitude—their chief purpose.

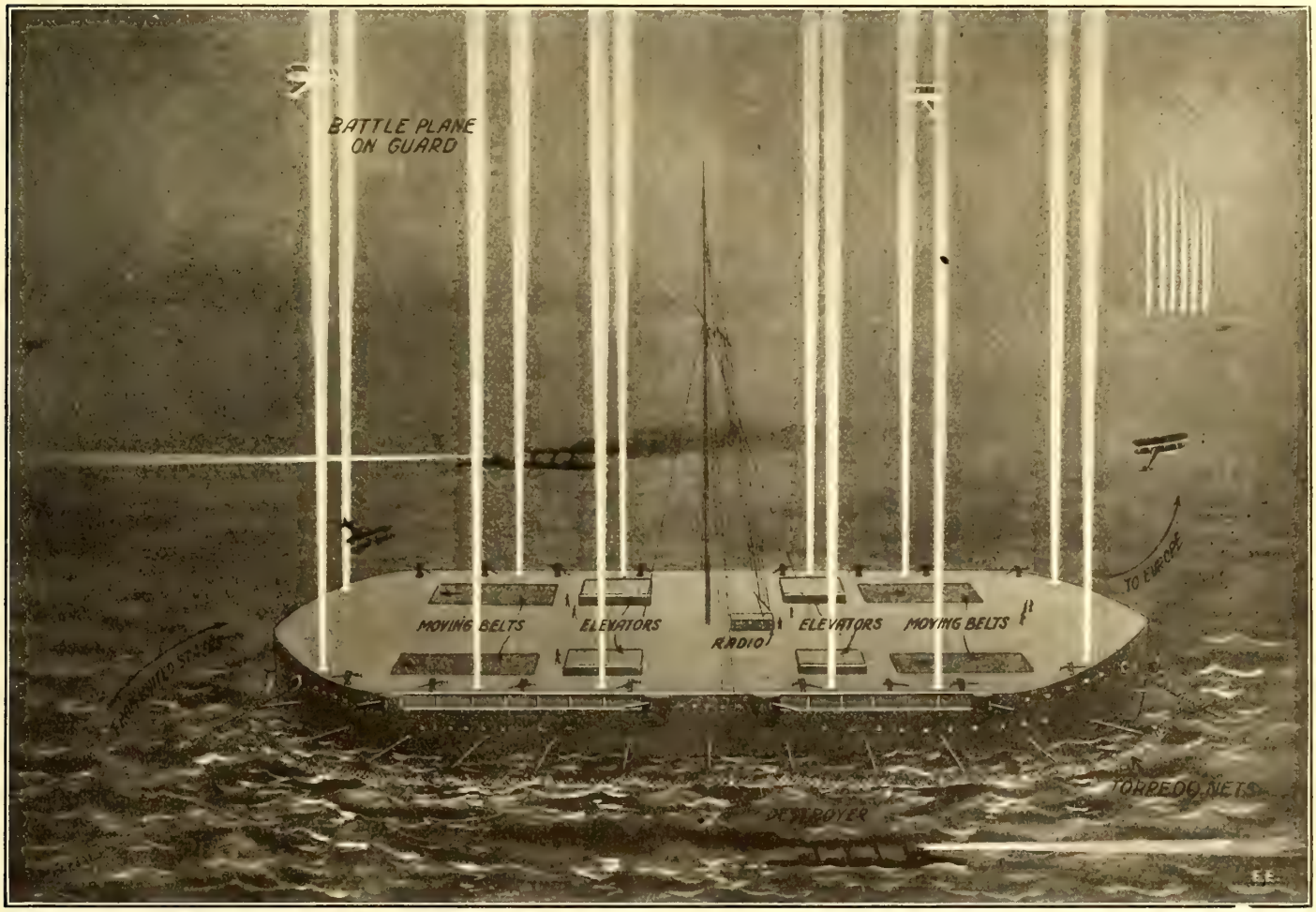
Should such craft be maintained successfully and be constructed along lines for the temporary accommodation of an endless stream of aeroplanes emanating from the shores of America en route for Europe, then, in my humble opinion, one of the most difficult of our problems will have been solved.

Under existing conditions a single pair of wings of the average type of aeroplane is a very bulky article for the hold of a ship at best, as when boxed its cubic contents would be represented by a bulk approximately three feet by five feet by thirty-five feet. Think of the tremendous storage space these alone would occupy, with the possible and even probable eventuality of their being destroyed by a submarine torpedo. Furthermore should all the parts successfully reach the shores of France or England, even then the air-craft would have to be unloaded, unboxed and reassembled, and then assigned to an aviator who had encountered the same dangers as in the instance of the knocked-down planes. Then think of the other situation by way of comparison—both aviator and airship will have reached their destination without such hazard, and both ready for immediate service when they land; the aviator accustomed to the idiosyncrasies of this particular plane—in fact having been in actual continuous service while becoming acquainted with his machine!

Suppose that it would take twenty hours of actual flight to reach the shores of France or England. The aeroplane would still have from seventy-five to eighty hours of usability left before requiring replacement of wornout parts.

The "floats" would necessarily have to be very large, with top deck free from obstructions so as to facilitate the safe landing of the airships. The process of accommodating the stream of aircraft might be

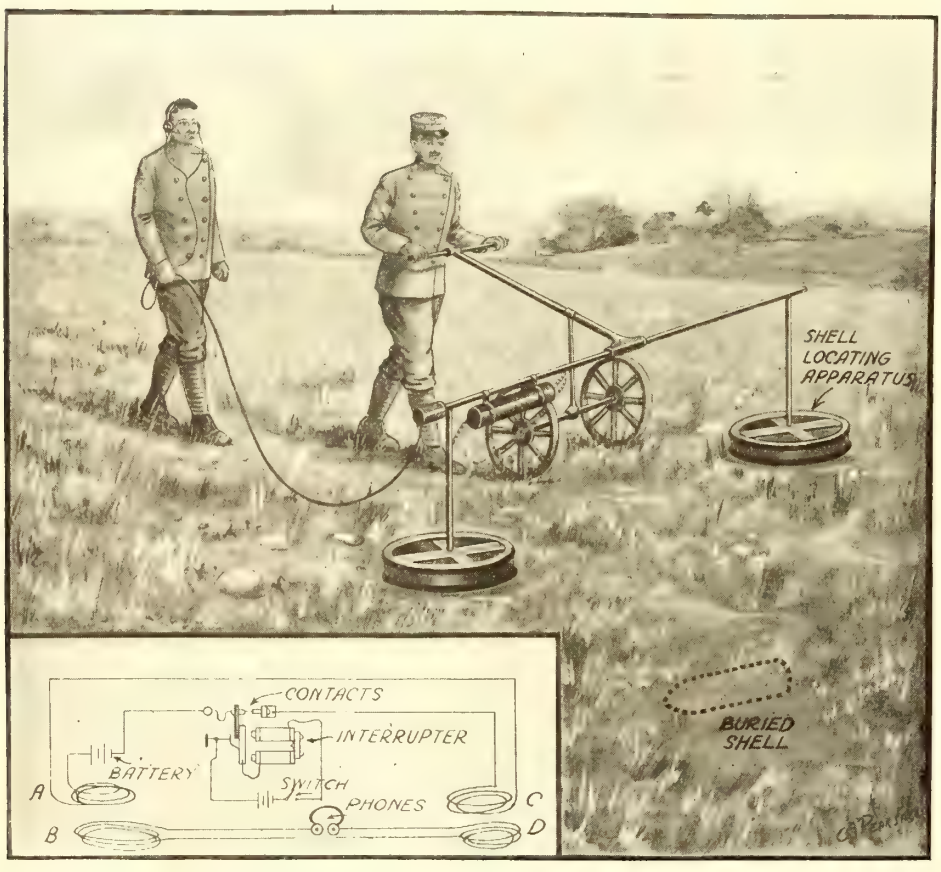
(*Continued on page 717*)



Instead of Shipping the Thousands of American Aeroplanes Across the Ocean, Mr. Winger Has Made the Unique Suggestion Here Illustrated Namely—Have a String of Gigantic Aerial "Stepping Stones" Across the Ocean and Let the Aviators Fly Their Machines Over. These Armored Ships Could House Dozens of 'Planes at Night, When Necessary, and They Would Be Marked at Night By Powerful Vertical Shafts of Light.

Hughes' Balance Locates Buried Shells

IN the early days of the war it frequently happened that the French farmers would run their plows into unexploded shells buried a few feet in the ground, with oftentimes fatal results. One of the French army engineers thought of a novel electrical scheme for accurately locating these buried shells, thousands of which had landed in the fertile fields along the one-time firing line. His idea involved the application of an extra large size *Hughes' balance,* an instrument well knwon to every electrician. The exploring coils of this shell-locating electrical balance are mounted on a light two-wheeled truck, as shown in the illustration, so that the operatives using the device can propel it over the ground at a fairly rapid rate. The exploring work has to be done reasonably slow in order to note the indications of the instrument. The necessary battery and current interrupting devices are mounted in a substantial container on the chassis, along with the locating coils. The action of the apparatus is as follows:



Back of the Battle-lines in Northern France the Land Had to Be Tilled. Many Fatal Accidents Occurred, Due to the Plows Striking Buried Unexploded Shells, Until the Hughes' Balance "Shell Locater" Here Illustrated Was Devised.

The induction balance is composed of four coils, two in the primary and two in the secondary circuit. When the relative positions of the coils are adjusted correctly, the inductances neutralize each other and no current flows in the secondary circuit. If, however, the slightest change is made in any of the coils, such as by the insertion of any metal object, the mutual induction is unbalanced and a sound is made in the telephone receiver.

A small experimental balance for use in detecting counterfeit coins, etc., was described in the August, 1917, issue of the ELECTRICAL EXPERIMENTER. Each spool is 3½" in diameter, would with exactly 300 turns of No. 32 single silk wire, spaced evenly, layer on layer. Any difference in the windings will cause trouble when the coils are adjusted.

Fig. 2 is a diagram of connections. The secondary coils are connected in series with a galvanometer or 'phones. An experimenter who has no galvanometer can purchase an inexpensive Weston ammeter. When the shunt has been removed, this will serve very well as a galvanometer. Some form of interrupted primary circuit is necessary to induce currents in the secondary. An interrupter, mounted on the armature of a buzzer, serves for this purpose. When the key is closed the interrupted primary circuit induces a current in the secondary, causing the galvanometer to deflect until the inductances are evenly balanced.

To balance the circuits so that the inductances neutralize each other and there is no deflection of the galvanometer, it is first necessary to make sure the secondaries have the windings in opposite directions to the primaries. This done, the coils are carefully adjusted until the needle of the meter is at zero. A more satisfactory indicator is a 75-ohm receiver.

For detecting counterfeit coins, a genuine coin is placed in the hole thru one secondary coil and the apparatus is balanced. Any other good coin of the same size will also balance the inductance, but if a counterfeit is inserted there will be a deflection of the indicator, or a sound in the telephone receiver. This effect is caused by a difference in conductivity of the metals. The insertion of the coin changes the mutual induction of the coils, the amount depending on the metal. In the same way metal (iron or steel) shells are located, their presence upsetting the balance between the four coils.

The sensitivity of receivers can be compared by inserting a variable high resistance in the primary circuit. The receiver which gives a sound with the greatest resistance cut-in is the most sensitive. Of two magnets, the one giving the greater unbalancing effect when held a given distance from one secondary, and directly over the center, is the stronger.

When the difference in frequency of two alternating currents is measured, one circuits is connected to coil 2 and the other circuit to coil 4. The current in the secondary coils will give beats; that is, the sound will grow strong, then weak. The number of beats per second is the difference in the frequency in cycles. Other proposed uses for this sensitive device include the locating of submarines, mines, etc., under water.

THE PRODUCTION OF COLORED FLAMES FOR DEMONSTRATION AND EXPERIMENTAL PURPOSES.

Many people will have experienced the need for a highly luminous and steady flame in arranging lecture demonstrations of spectra and interference experiments. An ingenious appliance for this purpose is described by G. A. Hemsalech in the *Philosophical Magazine.* The flame utilized is produced by coal-gas and oxygen fed into a specially designed burner, having a series of apertures not more than 2 mm. in diameter. Thru these orifices the air-coal gas mixture passes, and by suitably proportioning the mixture a very hot non-luminous flame from 12 in. to 18 in. in length and about ½ inch in diameter may be produced. The flame can then be colored by the aid of a series of specially designed sprayers. Each of these sprayers consists of a glass vessel containing a small portion of the solution which it is desired to introduce into the flame, and allowing air to pass over the same to the burner. Two capillary tubes also pass into the vessel, carrying electrode wires of iron or aluminum. The positive electrode is central and terminates slightly above the level of the liquid, while the negative passes down the side of the vessel and passes into the liquid. The positive electrodes of all the sprayers are connected to one of the coatings of a Leyden jar, and the negatives are arranged so that any of them in turn can be connected to the other coating of the jar. An induction coil, giving a 6 inch spark, is sufficient for working these sprayers. In working the apparatus all the sprayers, except the one to be used, are disconnected. A gentle current of air is then allowed to pass and coal gas admitted until a flame is obtained which is still luminous near the tip. Oxygen is then added until the flame is non-luminous. The flame is then colored by passing sparks thru the sprayer intended to be first used. Any of the other sprayers can be connected and used instead, in succession. In this way a flame colored by any desired ingredient can be obtained. The flames thus produced are stated to be very useful for showing, in a large lecture theatre, the spectra of the more volatile elements such as Ca, Sr, K, Cu, etc.

JACK "WIRELESS" BINNS NOW A CANADIAN LIEUTENANT.

Jack Binns, who leaped into fame as a wireless hero a few years ago, is now a lieutenant in a Canadian instruction camp.

Thrill of Science in New Movies

AGAIN we have with us the ever interesting "scientific movie." At present much interest is evinced by the public in all photoplays dealing with the war, secret service and the spy element. Realizing this the studios are working day and night to gratify this craving for the sensational, and how well they are succeeding is seen by the crowds storming the doors of the "film" houses.

First and foremost we might mention a gripping drama of the German spy and espionage system just released in serial form under the title of *"A Daughter of Uncle Sam,"* by the Jaxon Film Co. The inside story of the sensational manner in which countless German spy plots and intrigues have been baffled by the United States Secret Service within the last three years is shown for the first time in this tremendously patriotic photoplay. The twelve episodes reflect the campaign of the government against the destruction inaugurated in the United States by German agents. It shows how the activities of the enemy spies have been balked in their attempts to destroy ships, munition plants, warehouses containing food and other supplies.

In the photo may be seen the spy's den and the various plotters watching a *Radio-controlled torpedo.* Jane Vance and William Sorelle are featured in the swift, rapid-fire action of this film-play.

Universal's new serial *"The Mystery Ship"* abounds in numerous thrilling situations. The story centers about a *semi-visible ship* which can travel on land, water, and in the air. To make it invisible it is painted with a substance, the inventor of which is trying to recover for the heroine a large treasure, which had been the cause of her father's long search, finally ending in his death. The treasure is very difficult to locate and the "phantom" is trying his best to get it. Eventually he has in mind the placing of the secret substance in the hands of the United States Government which is anxious to secure it for war service but wishes to recover the treasure first. The Germans are equally bent on securing this wonderful substance—thereby putting plenty of thrill and punch into the photoplay. The photo shows the "Phantom" seated in a corner of his laboratory on his scientific ship.



Left Photo: "The Hidden Hand" Disguising a Confederate. Note the Poison Gauntlet. Lower Photo Shows An Exciting Moment When the Spies Use a Radio-Torpedo in "A Daughter of Uncle Sam."

Top View: The Inside of the Invisible Boat In "The Mystery Ship." Right Photo: Using the Telephone to Direct the Stupendous Film Play "The Woman God Forgot."

Artcraft pictures present a wonderful photoplay spectacle featuring the famous opera star Geraldine Farrar in *"The Woman God Forgot."* It abounds in many thrilling and tense situations, dealing with the Spaniards' early attempt at conquering the new world with all the splendor on one side—interwoven with barbaric cruelty on the other. The photo herewith shows Cortez up-to-date—Mr. Hobert Bosworth, as the Spanish adventurer Cortez, whose army conquered Montezuma and his Aztecs —at the telephone assisting Cecil B. DeMille direct the big battle scenes, showing how necessary it is to have communication with the thousands of men taking part in a "movie battle," to assure a realistic and successful "scene."

Much attention has been attracted by the new Pathé mystery serial *"The Hidden Hand."* Many startling and brilliant serials have been produced by this company and therefore the success of its latest attempt seems assured.

The story abounds in many tense situations and gives opportunity to the brilliant stars. Who is her father? That is the question a young and beautiful girl must answer. The man she had reason to believe was her father has been mysteriously murdered in his library and is also an agent of a foreign power. Before the agent dies he reveals to those present the secret of two mysterious packets and a locket which will establish the identity of the heroine, that she is a princess. "The Hidden Hand" has received news of the agent's arrival and made up one of his confederates to represent a secret service man, who is investigating the mysterious circumstances surrounding our beautiful heroine, thereby causing many complications. Others are also interested in the packet as strange provisions of the will, as yet not discovered, are suspected.

In the present photo may be seen "The Hidden Hand" in his laboratory making up one of his confederates to resemble the secret service agent and so cleverly is his work done that the fair heroine is nonplust to tell who her sweetheart is, for—"as it happens in the movies"—she is soon in love with the secret service man. On the right of the "Hidden Hand" may be seen his terrible poison gauntlet. When he so desires he can shoot a stream of poison-out gas into his antagonist's face, thereby laying him away for good.

HEARD FROM THE TRENCHES

The officer comes up an' says, "Which one of you boys would like to have a night out of the trenches?" I steps forward, an' 'e says, smilin', "Well done, my boy, you will complete the *wiring-party* to-night."—*Sketch.*

DATE OF ISSUE.—*As many of our readers have recently become unduly agitated as to when they could obtain* THE ELECTRICAL EXPERIMENTER, *we wish to state that the newsstands have the journal on sale between the twelfth and the eighteenth of the month in the eastern part of the United States and about the twentieth of the month west of the Mississippi River. Our subscribers should be in possession of their copies at these dates. Kindly bear in mind, however, that publications are not handled with the same dispatch by the Post Office as a letter. For this reason delays are frequent, therefore kindly be patient and do not send us complaints as to non-arrival of your copy before the twenty-fifth of the month.*

A Gyro-Electric Destroyer

By H. GERNSBACK

WE are primarily in this war to win it and to win it quick. This war has demonstrated the fact that men against men result unavoidably in a deadlock. There is but little doubt that any of the men of the warring nations today are not as good as those of any other. If we are to win the war, we will win it with machinery. As this war has demonstrated and keeps on demonstrating right along, it is a conflict of machines vs. machines, and the nation that has the best and the biggest machines is most likely to win out in the long run. America with its inexhaustible mechanical resources should and can do much towards shortening the war, and it is absolutely certain that if we do not bring into the field monstrous machines capable of smashing thru anything, then the Germans will do it.

America has the resources and the brains to accomplish the result. It is simply a matter of doing it, and doing it at once. Let our officials ponder over the logic and truth of this statement. It is bound to arise again.

If proof were needed what machinery has been able to accomplish in this war the recent advance of the English by means of their ponderous Tanks before Cambrai, would be a good example. Likewise, the German 42-centimeter guns have given us a good idea that, given sufficient machinery, most any obstacle can be battered down.

It has been the pet contention of the ELECTRICAL EXPERIMENTER for years that the big machine is *the* thing in modern warfare. In our February, 1915, issue, long before the present Tank made its appearance on the Western front, we already pictured a ponderous machine that could be used to batter down not only trenches, but any kind of fortress as well. In this same issue, we also depicted a huge two-wheeled affair which we termed a "Trench tractor," and this monster was supposed to make trench warfare impossible. There was much publicity accorded these various designs as well as very much ridicule, as it was not then believed that the big machines were what we claimed for them.

Just the same, our ideas were the forerunners of the present British Tanks, and in February, 1916, the first British machine was completed and taken down to a farm near London. In this locality pits, trenches and various fortifications had been destroyed so satisfactorily by the Tank, that an order was given at once for one hundred machines. The first delivery of the British Tanks was made in July, 1916. As is well known the first British tractors went into action in the Somme offensive which began on September 15, 1916. The object of the Tanks was to drive the Germans out of some high ground running east and south of Thiepval. The Tank having the element of surprise, the Germans in the first assault were driven back quite a little, but they soon rallied, and began to shell the various slow-moving Tanks.

Now it is not our intention to minimize the results or the successes of the British Tanks, but at the same time, as we have pointed out before and insist in pointing out again, the British Tanks as constructed today do not lend themselves for major operations. They are all right for a surprise attack, as at Cambrai, and it is quite doubtful in our mind if such a performance can be repeated, as the Germans by this time have learned their lesson well.

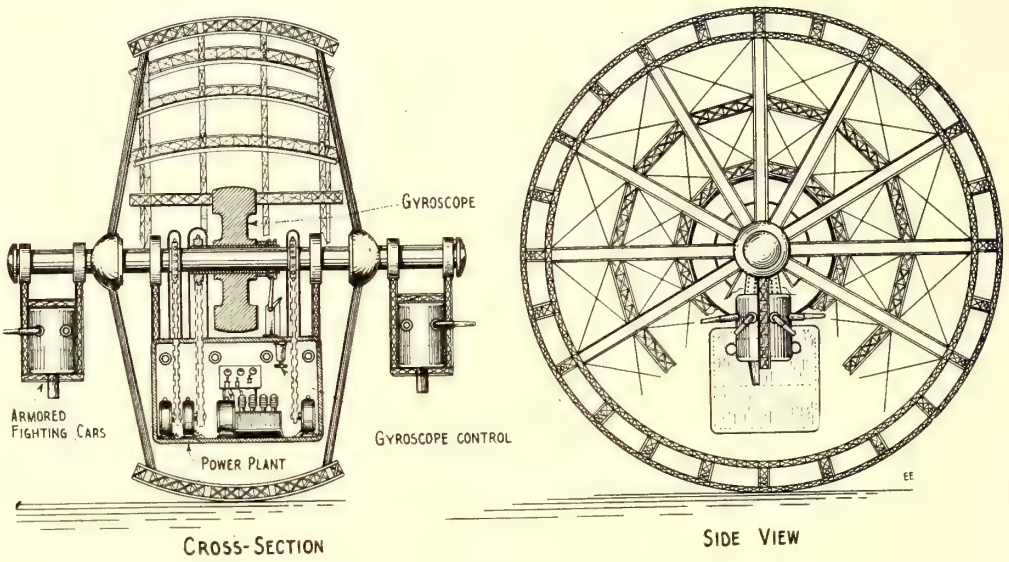
The great trouble with the Tank is its very slow speed. No tractors have been constructed so far that can move at more than eight to ten miles an hour, and as such they become easy prey to the enemy's guns which readily get the range of the slow-moving vehicles, and begin to shell them. While the British claimed no losses in the last Cambrai offensive, the Germans claim that they shot twenty Tanks to pieces. Presuming that this amount is exaggerated, there probably is quite a good deal of truth to it.

Attention is called to the fact that the movable belt tread of the Tank is quite a sensitive affair. If hit, even the bullet of a small caliber gun will almost certainly cripple the Tank. The belt is the most vulnerable part of the tractor, and as soon as it stops moving, the Tank stops moving as well, and as far as offensive work is concerned, the machine is out of action.

As we have pointed out before, what is wanted is a machine, not necessarily monstrous and weighing many thousand tons, as much as a machine that need not weigh more than the present Tank, but that can cover ground *rapidly*, so that it becomes almost impossible for the enemy to get the range.

In view of the fact that the United States Government is seriously contemplating to equip our national army with Tanks, we wish to voice our strong opposition against them, as being unfit for the important work that they are supposed to do. We have in the past issues shown designs of large machines which could batter down barbed wire entanglements and which were to be used in offensive work, but we believe that the machine here described has all the good qualities of the present Tank, but none of its many faults.

Transportation of war stores to the Western front at the present time is quite a difficult problem for the United States. It becomes a huge task just now to ship even one hundred Tanks to Europe, as they take up a tremendous amount of cargo space. In contradistinction, the machine described in this article could be shipt knocked down, the entire frame work of the wheel being made of channel iron, which takes up very little room. This is a large item, and should be carefully considered, as no doubt it will.



Sectional View Thru Front and Also Side View of Mastodonic "Gyro-Electric Destroyer." It Measures 45 Feet in Height and Can Progress Over Trenches, Barbed Wire and Gun Emplacements at 40 to 60 Miles Per Hour, Instead of Creeping Along as Do the "Tanks."

The present gyro-electric destroyer is a single steel wheel as clearly shown in our front cover and accompanying illustrations, about 45 feet high. The top of the wheel is not flat, but is in the shape of an arc which makes running a good deal easier. The wheel itself looks like a huge *ferris wheel*, and is constructed of channel steel thruout; in order to make it as light as possible, it has no continuous tread or rim but rather the steel pieces at the circumference are spaced about one foot apart, leaving a clear space for two reasons. First, the weight is cut down. Second, as our front cover illustration depicts, much better purchase is had on the ground, the machine not being apt to slip as would be the case if the top of the wheel was solid.

The wheel has one large shaft passing thru the center and extending at each side as shown in the cross-section in our illustration. This shaft is hollow and need not weigh very much. It is constructed of steel. At the hubs and at the ends of the shaft the latter is provided with armored projections, which will not be damaged in case of shell fire. In the center of the wheel is suspended the engine cab which comprises a gasoline engine of some three hundred to five hundred horsepower, the energy being fed to a generator as shown. Two of the electric motors are used for

AMONG the hundreds of new devices and appliances publisht monthly in The Electrical Experimenter, there are several, as a rule, which interest you. Full information on these subjects, as well as the name of the manufacturer, will be gladly furnisht to you, free of charge, by addressing our Technical Information Bureau.

propulsion of the wheel only; they are attached by means of a chain drive to the central shaft as shown.

It will be understood by studying the illustrations that as soon as the motors start operating, the engine cab swings forward while the wheel moves forward also. The heavy weight of the engine cab prevents it from turning a somersault as it were, but it does swing forward, and in case the vehicle is to be stopt, the cab must swing backward as shown in the illustration below. The engineer thus has it in his power to run the destroyer fast or slow, simply by changing the speed of his motors. It should also be noted that only a very moderate speed of the motors is necessary, being that the diameter of the wheel—45 feet—is so large that it will move at the rate of from forty to sixty miles with the motors running at very slow speeds. So much for the power plant.

Our attention is now called to the fact that we must steer the destroyer and steer it quickly. To accomplish this, advantage is taken of the gyroscope, which lends itself admirably to this work. The cross-section of one of our illustrations shows how this is accomplisht. A huge cast-steel gyroscope wheel is stationed on the central shaft and is driven rapidly by means of a special electric motor as shown. The gyroscope wheel while in motion, of course, prevents the destroyer from toppling over, but the writer has incorporated a new idea in the device, whereby it becomes possible with a single gyroscope to steer the vehicle. By shifting the gyroscope wheel either to the left or to the right, the vehicle will "turn" momentarily, all depending on the amount of shifting of the gyroscope, and this shifting need not be very much. If the gyroscope wheel is shifted to the right, the machine will move to the *left.* If the wheel is moved to the left, the destroyer will move to the *right.* Attention is called to the fact that this *"leaning"* is *very slight,* as the gyroscope tends to keep the machine in its upright position always. For instance, the destroyer will turn corners, not by leaning at a picturesque angle, as might be supposed, but it will actually turn corners in a vertical position, due, of course, to the gyroscope which tends to keep the wheel in its upright position always. No technical difficulty is occasioned in this gyroscopic drive or control, and any engineer familiar with gyroscope work should be able to work out the details of the machine readily.

At the two sides of the wheel we note the armored gun cabs. These can be round or square as may be desired; they hang from the shafts by means of loose slip rings. As there is nothing to hold them back, the two cabs will move backward due to their inertia while the machine is in motion; they will move forward for the same reason when the destroyer is suddenly stopt. Our illustrations show this clearly.

These armored cabs have the usual guns, the same as the British tanks, and they also have a bottom tube for the discharge of bombs as shown. All the offensive work is carried out by the two-gun cabs, the engine plant not being used for offensive purposes whatsoever. It is simply a power plant.

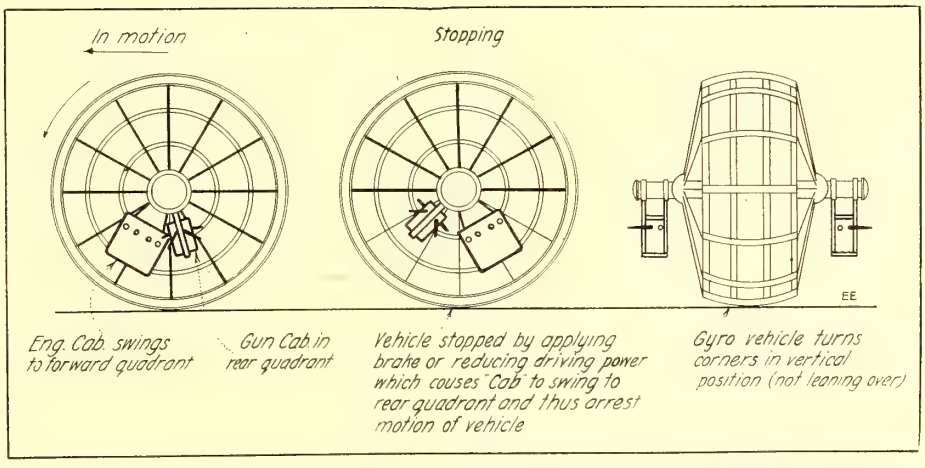
Inasmuch as the wheel of the destroyer is not solid, but made of channel steel, it will be readily understood that even a large size shell will easily pass thru the lattice work of the destroyer without doing much damage, and here is where this machine shows its superiority over the tank. It will be almost impossible to damage this destroyer by means of shell shot. Even a "dead hit" from a medium caliber gun will not cause much damage, and even a good sized shot hitting the gyroscope will not hurt it very much for the reason that the latter spins at enormous speed and will be almost certain to deflect the shot, unless, of course, it is a dead hit at right angles to the face of the wheel. The external chain drives are encased in heavy armor, and it should be as heavy as possible to prevent the machine being put out of action, and this can be readily done. It will be noted that this chain drive, the most vital part of the machine, presents but little surface to an on-coming shell. In contrast thereto you will notice the broad and very large moving tread of a British tank, which comprises almost one-quarter of the surface of the entire tank.

Reverting back to the gun cabs. There is really no good reason why these cabs are needed at all. Nor is there any good reason why the British tanks should carry guns. If the machine was at all built for offensive purposes, its weight alone would be sufficient to crush down any opposition, thereby making the guns useless. This is exactly the purpose of the present machine. Imagine this machine starting on its offensive journey. It will first smash thru all the barbed wire entanglements without any trouble whatsoever. It simply mows them down as so many match sticks, thereby cutting open a path for the infantry that follows. Suppose a nest of machine guns is encountered. Our guns become practically useless, for if the destroyer runs over the machine guns or even threatens to do so, the enemy must of necessity abandon the guns, and the destroyer "walks" over them, crushing them into the ground. The same is the case with the large size guns. You may be quite sure that if the gunners see the machine coming, they will most certainly abandon their gun, and in this case the destroyer is powerful enough to run over the gun, thereby putting it out of action.

This machine is not designed, as might be supposed, to kill off as many of the enemy as possible. That is not at all the purpose of the machine. It is simply to put out of action other machines, preferably guns, not men. Its first purpose is to cut down barbed wire entanglements—second to run over artillery, thereby putting it out of action. If we employed enough destroyers, it can be readily conceived how the enemy must invariably retreat as soon as these machines begin to advance, for the enemy denuded of all artillery must give up ground.

Some of these destroyers would, of course, be used to run parallel to the trenches, and here is where the gun carriages of the destroyers would come into their most effective work. They could drop bombs into the trenches as well as spray the occupants with machine gun bullets in order to demoralize the men in the trenches. It would become a more or less simple task to take trenches by means of this machine, but, of course, the most important part would be to destroy the larger artillery behind the supporting lines of the enemy. This the huge machines would do without any trouble whatsoever. There is practically nothing known today that could stop the progress of the destroyer. Of course this machine cannot climb steep mountains, nor ford deep rivers, but then the present tanks can not accomplish this either. But the gyroelectric destroyer can run up a hill by taking a zig-zag or oblique course. Rivers that are not too deep can be readily negotiated by running thru them obliquely, not fording them at right angles.

We are quite confident that a machine of this kind should do as good work as a thousand men in the field, and, perhaps, better.



Diagrams Which Show the Action of the Suspended "Engine Cab" and "Gun Cabs" When Gyro-Electric Destroyer is in Motion; When It Is Stopped and When Turning Corners.

NEW CODE RULE WILL REQUIRE POLARIZED WIRING.

At the recent meeting of the Electrical Committee of the National Fire Protection Association for revision for the next edition of the National Electrical Code, it was voted to change Rule 26*a* as follows:

"The neutral conductor of all three-wire circuits and one conductor on all two-wire circuits must have an identifying insulating covering readily distinguishing it from other wires. This wire must be run without transposition thruout the entire installation and properly connected at all fittings to properly identified terminals in order to preserve its continuity. When one of the circuit wires is to be grounded, the ground connection must be made to this identified wire and as prescribed in Rule 15 and 15*A*."

This rule will appear in the new edition of the Code, to be known as the 1918 edition, and does not become effective until January 1, 1919. All fittings having wire terminals, such as sockets, receptacles, cut-out bases, attachment plugs, etc., must have some identifying mark to enable them to be easily connected with the proper terminal. Therefore, the organization known as the Associated Manufacturers of Electrical Supplies has submitted the matter to members of all of its sections covering the devices affected, asking that proper committees be appointed to consider the matter and report results at as early a date as possible, in order that they may be fully prepared for the new order of rules when in effect January 1, 1919.

"The Deluge"—The Show That Electricity Made Possible

By GEORGE HOLMES

ARTHUR HOPKINS, who has presented the critical public with many successes, has outdone himself in "The Deluge"—one of the best acted and intensely interesting dramas ever presented upon the American stage. Even tho it comes at a time when all the world is in a turmoil, the play serves to illustrate the law of human nature truer and more realistic than anything seen in years. Many fine bits of side-play are shown between members of the cast and a number of tensely gripping scenes help to make the play one of the distinct successes of the present theatrical season.

The play deals with the various emotions that will grip a number of persons with widely disassociated traits and vocations when thrown together and facing death, who try to make in their last moments reparation for past transgressions, striving hand in hand to whisk death away from their doorstep. Suddenly, finding themselves face to face with the fact that the danger is past, they forget all their good intentions and fall back into paths of so-called civilization, completely ignoring each other as in the past. A play with a moral that is strikingly told.

It is not my intention to dwell on the merits of the drama more than is necessary to give the reader the basic theme upon which the play is written.

I wish to convey the danger that faces the characters in the story, which by the fascinating science of "stagecraft" is carried out in a remarkably realistic manner.

In the first act the various persons are drawn to a cafe, not of the ordinary sort, but one whose regular life only begins at midnight, behind closed doors when all the world is asleep. Reports have been circulated that a cyclone is on its way and general apprehension is felt as to whether the dams on the river above the town will hold. Suddenly, without warning, the terror strikes the town, and all rush to safety; the various persons trapt in the cafe are expressing the chances of the dam's holding; amongst their number is a lawyer who has participated in a graft contract on the construction of the dam and who realizes that it will not hold if the storm continues to last much longer, and so informs those assembled. Immediately there is a panic, but he takes the upper hand and orders that everything be securely locked. Iron shutters on the windows and doors are lowered by cranks, etc., which make the room absolutely water-tight; in other words the people are shut up in a living tomb—then the big crash comes of the dam bursting and loosing the torrents of water over the town. For a whole night the suspense continues, their fates in the balance, and gives rise to some very fine portrayals on the part of the actors in the cast.

Now as to the mechanics of this stupendous production—and believe me the effect of the deluge striking the town sure does sound like the "real stuff," when you're sitting "out front"—which far surpasses anything done heretofore in this direction.

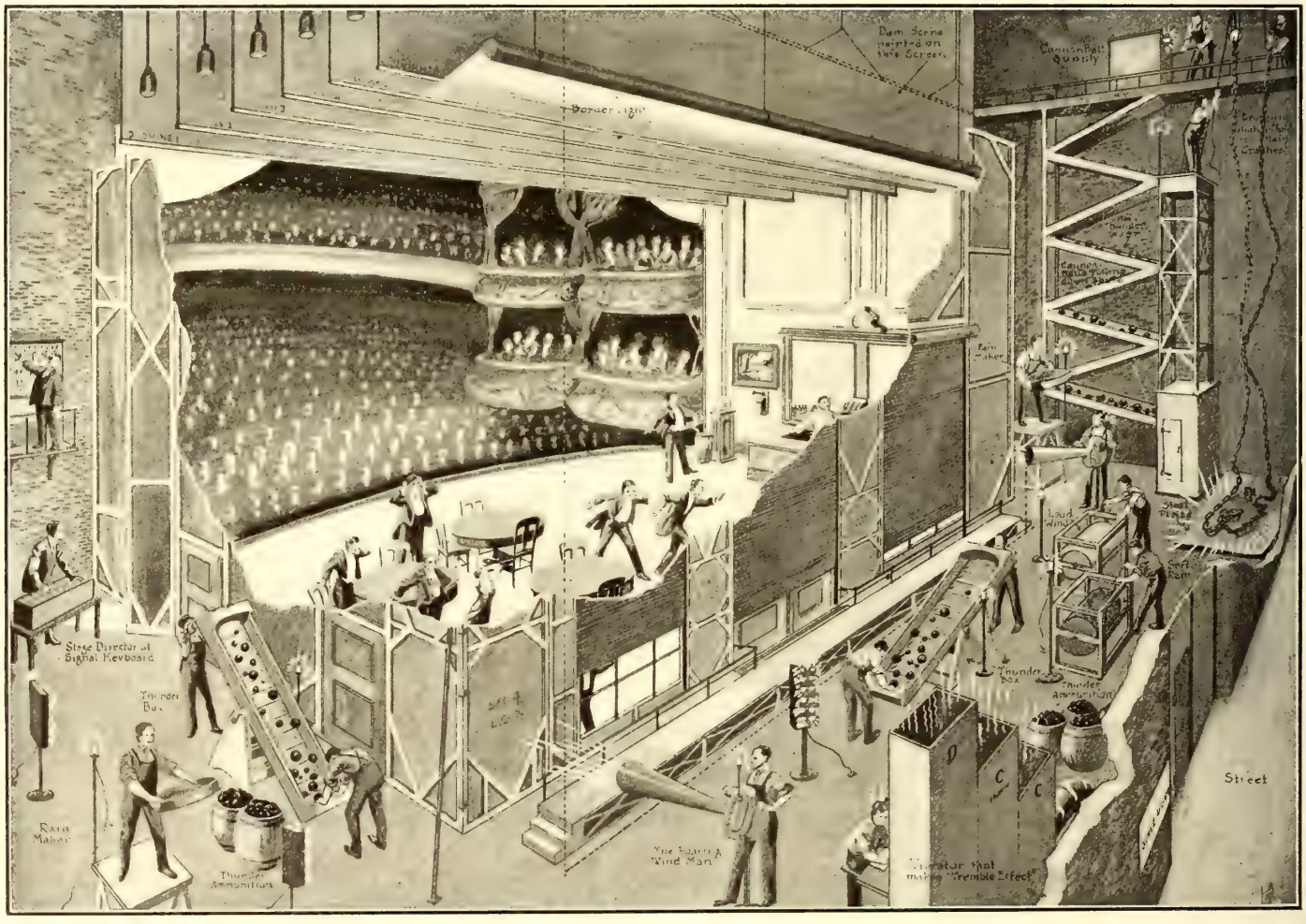
The stage has always held for most folks, be they old or young, a certain thrill of fascination and mystery. They see marvelous effects, experience novel sensations and then wonder how it is all done.

The people who produce the effects and all "show folks" in general have an unwritten law about divulging details of the how and why of things, and, therefore, much of the mystery still remains. Only in rare instances are the uninitiated so fortunate as to be allowed a peek back of the "curtain" where the make-believe and mystery-producing scenes of Theaterdom take place.

Having been intimately connected with stage life for a number of years, the author takes pleasure in giving the general public an insight as to the rôle played by modern stagecraft in this recent New York success.

"Back stage," all the space available is devoted to the miscellaneous apparatus necessary to produce the effect of the "Deluge."

The innumerable cables, braces, stands,



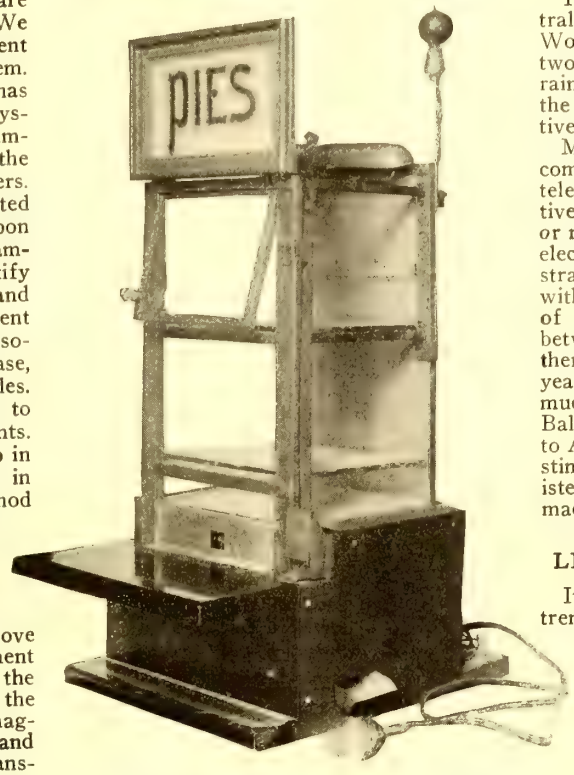
"The Deluge"—a Master-piece of the Theatrical World Recently Pro duced in New York, Involved the Application of Dozens of Electrical and Allied "Stunts" to Keep the Audience on Edge. To Give the True Effect of a "Bursting Dam" Nineteen Men Are Required, Some working the "Wind" Machines, Others Rumbling Cannon Balls Up and Down a Chute, and for the "Big Noise" a Full Size "Anchor Chain" Is Dropt Forty Feet Onto a Steel Plate!

NEW ELECTRIC FOOD VENDING MACHINES.

Automatic self-service restaurants are very popular in large European cities. We have also in some of our more prominent American cities a limited number of them. Automatic self-service in restaurants has great advantages over other restaurant systems. The most important ones are improved sanitation, quicker service and the elimination of tips and delaying waiters.

In the present device the coin inserted is accepted or rejected, depending upon whether or not there is food in the chamber. A signal-system is operated to notify the attendant of the need of refilling and the sales recorded, all of which represent entirely novel features, assuring an absolute control of each individual purchase, collectively showing the volume of sales. This recording-system makes it possible to operate an unlimited chain of restaurants. Moreover, the recording-system is put up in the form of an electric panel indicator in the manager's office, who can by this method see at a glance how his business stands at any hour of the day. Then again, when the attendant refills the empty compartment, all these operations are reversed.

All of the operations mentioned above are accomplisht thru the employment of electro magnets, which may be of the two-pole horseshoe type or may be of the ironclad solenoid type. These electro magnets are placed below the table level and the physical pull exerted by them is transmitted to the compartments above by thin steel rods operating a rocking arm or shaft. These shafts are concealed in horizontal bars supporting the glass shelves on which the food is displayed. The locking mechanism is also concealed in a hollow framework, so there is actually no mechanism to obstruct the light which illuminates the food from all sides. Heating is done electrically.



New Automatic Electric Waiter—Drop Nickel in Slot—Out Comes the Pie!

France imported $12,221,300 worth of electrical materials during the year 1916.

AUSTRALIAN RAIN STIMULATING DEVICE.

The Commonwealth Government of Australia, thru Mr. W. A. Watt, Minister for Works and Railways, has decided to install two Balsillie plants for the stimulation of rain in Victoria and in New South Wales, in the Mallee and Riverina districts respectively.

Mr. J. G. Balsillie, an Australian, has become famous for his inventions in wireless telegraphy. He has now carried his inventive genius into the domain of rain-making or rain-stimulating by means of high tension electricity liberated in the upper atmospheric strata. As a result of official trials made with his device at Bookaloo, 50 miles west of Port Augusta, an increased rainfall of between 50 and 70 per cent has been noted there. Having examined the results of a year's experiment, Mr. Watt has been very much imprest with the possibilities of Mr. Balsillie's invention. The vast importance to Australia of a successful method of rain-stimulation has been recognized by the Minister, hence the new tests which will be made.

LINEMEN IN INDIA MUST EAT.

It is said that the native in India is extremely particular about regularity in his meals; once accustomed to eating at a certain hour he must stick to it at all costs. An English engineer had an awkward experience of this when erecting a 100-foot steel pole with the aid of about 30 natives and the minimum of tackle. The pole was halfway up when the "headman" intimated that it was dinner time. Only the most desperate entreaties, coupled with threats, prevented the men letting the pole come down with a run, tho it had taken several hours to get it into this position.

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spotlights and maze of ropes would test most people's ingenuity, particularly those unacquainted with life behind the scenes.

In this particular production every available bit of space is utilized. The scene proper is what is known as a "box set," and is a permanent arrangement thru the three scenes of the play.

Details have been given strict attention, and the lowering of the iron shutters to make the place watertight is a most ingenious arrangement, the audience being able to see the shutters slowly descending as the ratchets and cranks do their work—noisily and dramatically. Now for the "big stuff":

Seated at a keyboard provided with numerous "tell-tale" lamps, the stage manager signals to the various men stationed in distant nooks and corners, to produce whatever effect they have charge of at the critical moment or moments. Near each stage hand is set a signal lamp in series with a tell-tale lamp on the stage manager's keyboard, and both work together. It requires nineteen men to produce the "atmosphere" of the deluge!!

Some "work" large trays, made of resinous wood and resembling the shape of a cheese box cover, with very small peas in the same. These trays are held in both hands and worked around in a rolling motion, thereby giving the effect of *light rain*, and may be seen being used by the men on the slightly elevated stands or platforms. Next comes our *heavy rain* machine made of a stand in which is suspended a drum made of fine mosquito screening and inside of the drum a few pounds of small peas are thrown; when the drum is revolved by means of a crank the sound effect of heavy rain is produced. The *wind making* machine is nearly the same as the rain machine excepting that the drum is made of large chicken wire over which a strip of canvas is thrown weighted on one end so that it bears against the drum. When the drum is revolved the friction exerted against the canvas gives the effect of wind. For *shrieking wind* a large hand blower such as used by riveters and blacksmiths is utilized, and the wind is sent thru a number of chambers and then out thru a large horn; when the handle is turned swiftly a loud shrieky wind effect is secured. And now for our "big slam"—large wooden troughs are used for the rumble effect and are about ten feet long by two feet wide with zig-zag slats on the bottom to bounce the cannon balls as they are rolled back and forth.

The mighty rumble of the dam bursting is made by having a similar arrangement of troughs extending from the top of the "fly gallery" (about forty feet) down to the floor of the stage, as shown in the picture which, in this case, were attached to a zig-zag stairway leading to the dressing rooms. When the "thunder-man" is signaled he lifts a small door in a big case containing all sizes of cannon balls, and permits a choice quantity of them to run down thru the zig-zag troughs, with a resulting sound climax that resembles General Byng's smash thru the "Hindenburg Line"—tanks and all—and then to top it off a life-size anchor chain is dropt from the fly-gallery on to a large iron plate, making a never-to-be-forgotten crash! Besides all this there is an immense *tremble machine* built like an organ, which when set to going gives you the creepy feeling that the building is about to collapse! The machine is worked by a giant electric blower and air compressor, which equipment is located in the cellar with pipes leading up thru the floor to the machine proper.

Add to all this the mass of paraphernalia, cables, curtains, etc., actually used and it certainly looks like one big confusion, but to those who are acquainted with all the details, little of the seeming disorder is noticed, for by a systematic routine everything happens so that all ends well and "they are happy ever afterwards!"

MEMORIAL TO DR. ALEXANDER GRAHAM BELL.

The memorial erected in honor of Dr. Alexander Graham Bell, and his invention of the telephone in Brantford, Ont., Can., was unveiled in that city October 24, in the presence of the Governor-General of Canada, the Duke of Devonshire, and other distinguished persons. Doctor Bell was present and took part in the ceremonies. Mr. Theo. N. Vail, president of the American Telephone and Telegraph Company, had been invited, but sent his regrets at not being able to be present. Bell telephone interests were represented by other gentlemen, however.

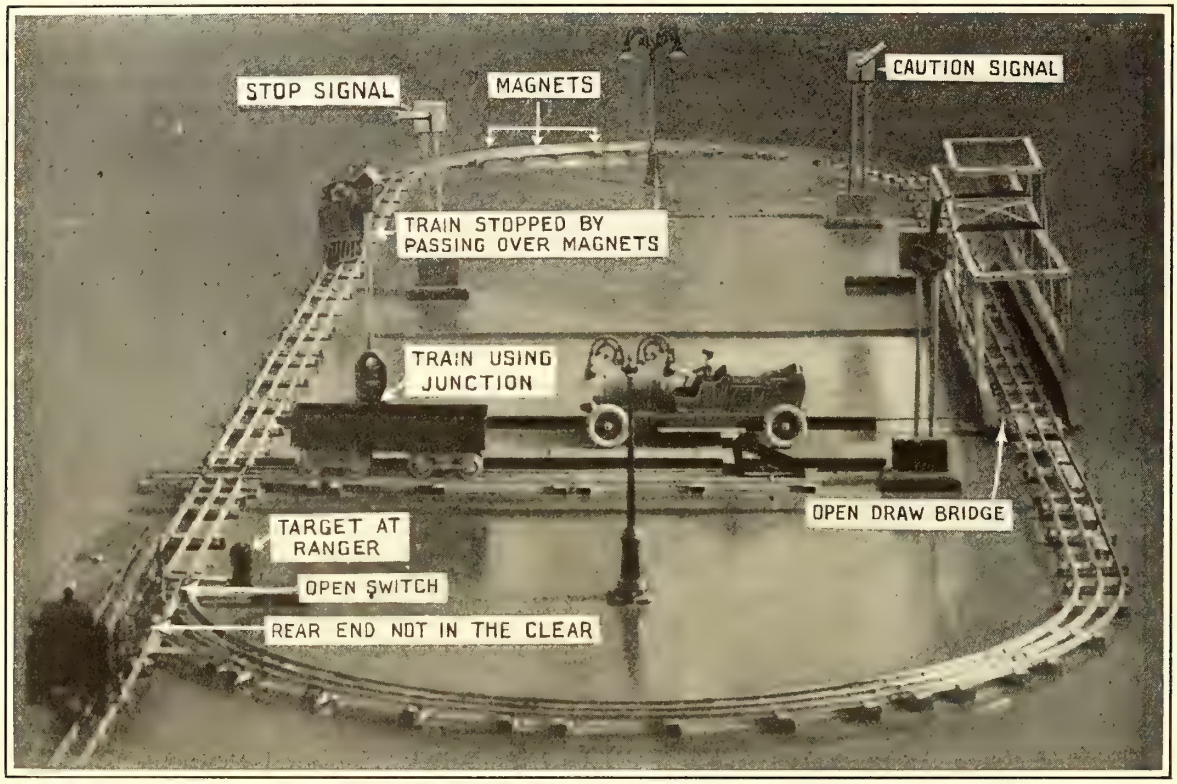
The memorial cost over $25,000, while the total outlay for the grounds and Bell homestead, dedicated as the Alexander Graham Bell Gardens, represent a cost of $65,000.

COLONEL J. J. CARTY NOW IN REGULAR ARMY.

J. J. Carty, chief engineer of the American Telephone and Telegraph Company, and lately appointed senior major of the Signal Reserve Corps, has been appointed by President Wilson a colonel in the Signal Corps in the regular army of the United States, to rank as such from August 15.

A New Electro-Magnetic Train Stop

THE numerous and varied failures made by American inventors seeking to perfect automatic *train-stops* and *controls* to eliminate railroad wrecks, have spread abroad pessimism on the subject, which has suddenly been dispelled by the advent of a new electro-magnetic method, known best among railroad men as the M-V system. It has been pronounced technically and practically invulnerable by government and railroad authorities, and promises revolutionary changes in the present method of operating trains, so its sponsors state.



The Efficacy of This New "Electro-Magnetic Train Stop" Is Demonstrated By Its Inventors With the Aid of This Complete Miniature Electric Railway System. If the Engineer Fails to Obey the Signals the Track Magnets Act To Cut Off the Steam and Apply the Air Brakes.

Never have the railroads hauled so much government property as during this war, and the tens of millions lost in wrecks in the past few months has incited war conservators to support the new system as a war measure. Inasmuch as it is a simple tho peculiar adjunct of the present block signal systems it can be installed quickly and inexpensively.

A danger condition in any given block energizes a *field of electro-magnets* of a new type placed in the track at braking distance from the semaphore in the approach block, and also a *field of magnets* at a given distance from the "caution" semaphore. The *last* field reduces the speed of the train to a predetermined rate, while the *first* field operates a stop under service application of the air-brakes, regardless of the presence of either engineer or fireman in the engine cab. It works equally well on either steam or electric railways. See Fig. 1.

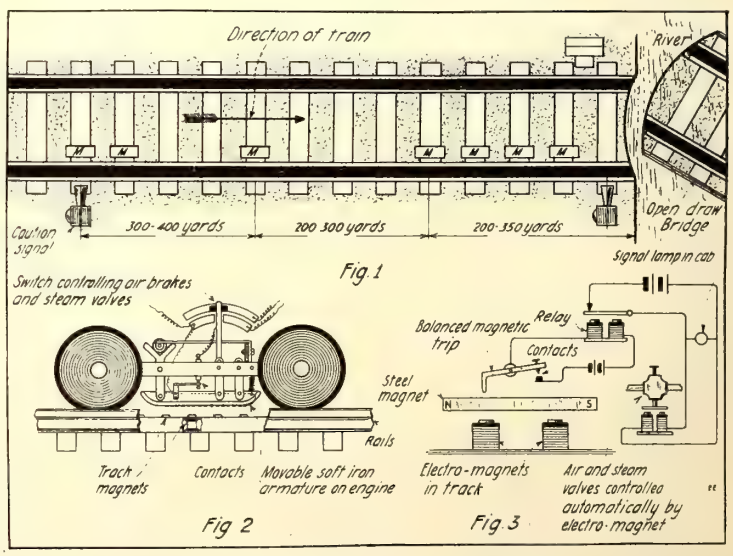
At present danger of a head-on, rear end, side-swipe or crossing collision, or a broken rail, open bridge, open switch, rock, snow or land slide, wash-out, burned bridge, etc., in "A" block causes the operation of a "stop" signal in "B" block and a "caution" signal in "C" block, all of which are worthless should the engineer be unable to see them thru smoke, fog or snow; or should he be sick, injured or dead in the cab, or should he misunderstand or purposefully disobey them. The present signals are operated by circuits in the rails—low voltage currents too weak to leak across from right rail to left rail by creepage or any contact lighter than the wheels of a loaded hand-car.

The M-V system operates with these same low voltage currents without additional installation save that the current from semaphore battery or feed wire is relayed from battery well or supply station to the field of track magnets. The magnets have the form of a square "U," with short poles of precise ratios to the bulk thereof. As a new result the low voltage current in its transit thru one of these magnets secures a remarkable distance traction that enables the magnet to pull positively thru any known substance of several inches thickness.

Present M. C. B. standards require three inches clearance on trains, the cow-catcher being carried at that and everything else being higher. At four inch clearance the M-V system suspends a long bar of soft iron, preferably suspended in one of its designs, see Fig 2, by swivels, from the axles of the forward trucks of the tender. As the magnets are housed and fixt in the track and do not move to operate, they are not interfered with by snow, sleet, ice, debris, etc. When the engine and tender pass over an energized "caution" track magnet, the soft iron armature is pulled downward (or else released upward, if deënergized magnets are used for danger signaling and control), closing for an instant the control contacts (Fig. 2), thus applying the brakes partially for a moment. The "stop" track magnets will cut off the steam and apply the brakes.

In another, newer arrangement, the armature bar under the engine does not change position in its function and the same natural conditions such as snow, debris, etc., do not affect it. It is a member of a closed circuit on the engine from the moment the engine leaves the round-house. On the top of it, so housed that it is independent of oil, gas, speed, shock, oscillation, vibration, or foreign current—rides a balanced trip or trigger with one end held to the bar by the magnetism of the steel bar. When the bar passes at either low or high speed over an energized M-V track magnet, the bar partly demagnetizes in the usual way and the trigger falls by the infallible law of gravity, breaking the closed electric circuit on the engine. This sets the cab air and steam valve actuating device in operation.

(*Continued on opposite page*)



This Diagram Illustrates How the Electro-Magnets Are Placed Along the Track at Danger Points so as to Act Gradually on the Train's Air Brakes. Also Two Methods of Applying the Magnetic Action.

JAPANESE WARSHIPS USE RADIOPHONE.

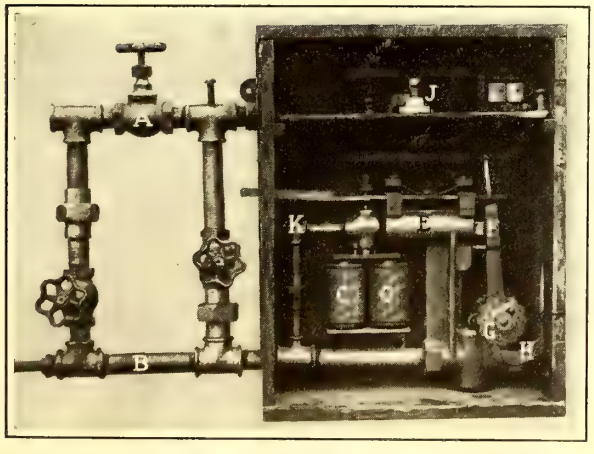
Many of the largest Japanese warships have been equipt with wireless telephones, which operate successfully for distances up to 100 miles.

(Continued from opposite page)

The main function of this cab device is to turn off the steam (or electric power) instantly and to begin a service application of the air-brakes. On an electric locomotive the breaking of the circuit automatically breaks the power circuit. On a steam locomotive the breaking of the closed circuit turns a valve in front of the throttle. The service application of the air brakes is more involved.

In the cab device, which occupies but a square foot of cab space, are two small solenoids operation on the closed circuit. The breaking of the closed circuit releases a small superimposed armature which by spring action makes a new contact that energizes two larger solenoids; these draw downward a transverse bar serving as the foot of a plunger carrying a pin valve, that by the descent of the bar is drawn into line with the duct of a small divergent line from the train pressure pipe. The air from the train pipe passes thru the pin valve into a cylinder and operates against a piston which actuates a lever that gives one reduction of the air pressure by a valve to the open air, and then exhausting, returns by spring pressure and gives another reduction and so on till the train comes to a complete standstill *smoothly*, without sliding of the wheels or destructive jar. The amount of each reduction is predetermined according to the length and weight of the train, by a special ratchet movement on the lever to which various wheels are adjusted, notched for from six to one hundred cars or more.

The system is immediately valuable in that it enables the big steam railroads of the country to put into speedy operation the same operative protection which has given absolute satisfaction in covered trackage in the New York subways, Boston and London subways and the Hudson & Manhattan tubes since their construction, without one collision, loss of life or money. It is prospectively revolutionary in that railroads are now enabled to "get" from the track into the train infallibly at any point of line under all weather conditions. It is possible to run a train from New York to Philadelphia today without either engineer or fireman, say the inventors of this new method of "stopping a train with a magnet," and it may soon be practicable.



A Full Size Model of the "Cab Device" as Demonstrated by the Inventor. It Automatically Shuts Off the Steam and Applies the Air Brakes.

EGGING ON BUSINESS BY ELECTRICITY.

Off with the old, on with the new. Grandma's method of guessing the egg is 99 per cent pure fails to pass the censor today. Modern methods have egged off the old ideas, and today efficient electricity has the call, saving time, temper and trouble.

Here are nimble fingered, keen eyed egg testers, separating the false from the true by means of electric egg candlers, operated on ordinary house lighting circuits. The electrical egg tester never lies. Its hidden eye and supersensitive nose rout out hen products that are inclined to "cheat."

This form of commercial electrical inspection dispells the doubt and guesswork, speeds up shipments, cuts labor costs and is helping Hooverize cost-to-customer.—*Photo Society for Electrical Development.*



Here We See Nimble Fingered, Keen Eyed Egg Testers Separating the False from the True by Means of Electric Egg Candlers, Operated from the Ordinary Lighting Circuit.

MANY NOVEL PATENTS ISSUED IN YEAR.

Invention in this country reached high-tide during the calendar year 1916. Forty-two thousand separate patents were issued to inventors by Uncle Sam. It is not the number of patents issued, however, that is worthy of note, but the character of the inventions. The patent office deals with all the efforts of the world in every field of industry to advance the useful arts. Great interests are involved, not merely of private, but of public concern, in the discoveries that are listed with the patent office.

As an illustration of what the discoveries of the 12 months mean, reference may be made to the fact that one concern in Chicago reports that it has effected a reduction in coal consumption from nearly seven pounds a kilowatt hour to 2.7 pounds a kilowatt hour, as a result of a new invention.

A New York rapid transit company introduced improvements in the year which, according to the patent office, have caused a drop in coal consumption from 2½ pounds a kilowatt hour to 1½ pounds a kilowatt hour.

An electric plant, thru some new invention, it has shown, is now able to generate electricity from coal more cheaply than can be done from the waters of Niagara Falls, says *Patent News*. These great economies are due in large measure to new inventions relating to automatic stokers and regulators attached to furnace construction, to forced draft and to coal-handling machinery.

The year brought new and valuable inventions that had to do with wireless telegraphy, telephony, the control of torpedoes, searchlights and gun pointing, vacuum cleaning, X-ray apparatus, liquefaction of air to produce oxygen and nitrogen for commercial use, flying machines, the moving picture and mercury vapor lamps.

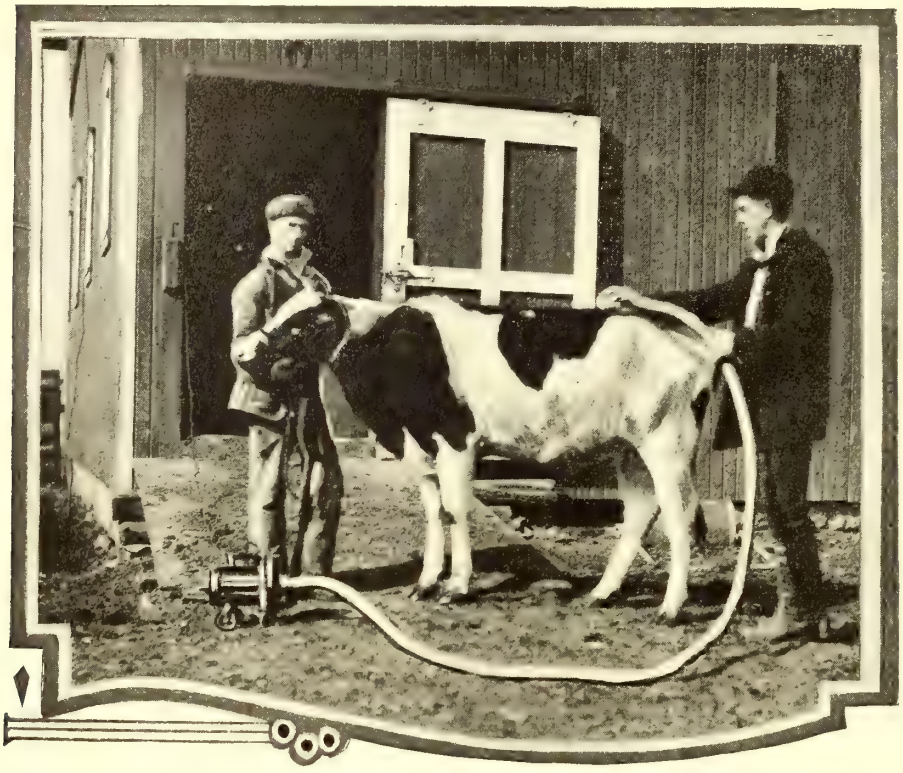
For a period of some five years an industrial fellowship maintained by trained scientists have devoted their time to the study of methods of bread-making, with the object of producing better bread. In the last calendar year, certain of the processes developed thru this study were patented and put into operation.

Better nourishment of the yeast has reduced the amount required in raising the bread and maturing the dough, with the consequent lessening of the amount of flour and sugar used up by the yeast and converted into carbon dioxid and alcohol. The savings of these and other economies to those employing the novel processes patented during the year are estimated to amount to more than $1,000,000 a year. This estimate is based on the present high scale of prices, but on any scale of prices would, it is asserted, be enormous.

The patents in the electrical field during the year were numerous. In the field of farming implements there came the improved tractor engines, better apparatus for digging, irrigation and drainage canals, improved beet harvesters, and thousands of other useful as well as interesting ideas.

Bossie Gets An Outdoor Bath

One of the most menial tasks about the farm and dairy is that of keeping the cows clean. Progressive dairies are rapidly awakening to the fact that a small electric vacuum cleaner of the portable type will soon pay for itself in performing this duty. A few deft whisks of the vacuum cleaner tool over Bossie's hairy coat and she's as clean as a whistle. It is doubtful if there is any other method which can approach this one for cleaning the coats of such animals as the cow.



Photos courtesy of Society for Electrical Development

If There Is One Job That the Boy on the Farm Detests—It is Cleaning the Cows. And Modern Dairy Regulations Demand Extreme Cleanliness from the Cow, Down to the Final Product. Wherefore We Learn That Dairymen Are Now Using Electric Vacuum Cleaners for Keeping the Cows Thoroly Clean.

A small electric motor, costing but a few cents per hour to run, drives the highly efficient vacuum suction brush. This treatment has been found to promote sanitation and health among cows as well as horses. The new device does away with the laborious as well as unsanitary task of curry-combing the cattle to produce the rich, full coat which the experienced farmer accepts as a sign of good health.

The electric vacuum milker is another of the modern devices which have proven a god-send to the dairymen. The second illustration herewith shows the 20th century way of milking cows. All the attendant has to do is to attach the four suction nipples to the cow's teats, the machine does the rest. It milks the cow more quickly than the old-fashioned method and is more sanitary in every way.

ELECTROTHERAPY HELPS CATARACT OF THE EYE.

If there is one ailment that has baffled treatment by either surgical, mechanical or electrical treatment it is cataract of the eye. Many people, especially older men and women, go permanently blind with this trouble. It is, therefore, that we read with gratifying interest of a successful electrotherapeutical treatment of such a case and which is discust by Dr. Moses G. Campbell in the *American Journal of Electrotherapeutics and Radiology.*

The patient, Mrs. W., was free of these troubles and had a vision of R. E. 20/100, L. E. 20/70. We had then a favorable case. *Treatment* was commenced February 11, 1916. Radiant light and heat, autocondensation and galvanism were used. During the first month I had difficulty in securing a proper electrode. I then used radiant light and heat. The patient failed to improve during this time, and complained of pain in the eyes. The light was then omitted. Autocondensation was given thruout the treatment with the idea of improving the general nutrition of the patient who was in a rundown state on account of a spell of grippe, and to relieve or improve her rheumatoid condition of hands and feet.

Galvanism was the main local agent used. The mode was negative pole to the eyes and positive to the back of the neck.

The electrode that gave best service was made as follows:

The pad to the back of the neck was 3" x 6". Material used was four layers of absorbent cotton covered with two layers of silent or underlay table cloth, and finished with two layers of gauze or cheese cloth. This was soaked in a solution of sodium bicarbonat (ordinary baking soda) ʒii to a quart of water. To make the connection with the rheophore and the positive pole a carbon terminal was used instead of metal in order to avoid any possibility of *metallic ionization.* This carbon terminal was a portion of the carbon element of an old sal-ammoniac cell. The spring from an old dry cell was fastened by a screw to the carbon and used to make the connection with the conducting cord. I have found this spring very satisfactory means of making connections for electrodes. The electrodes for the eyes were of copper gauze wire twisted to form a stiff centre piece with flat ends the size to cover the eyes. The center was covered with adhesive plaster, the eye pieces with 2 layers of absorbent cotton, then two layers of silent cloth followed last with cheese cloth.

These electrodes for the eyes were well soaked in a 2% sodium chlorid (common table salt) solution and kept wet thruout treatment by applying the solution frequently with a dropper. Mode of application was three (3) to ten (10) milliamperes twenty minutes daily, six times a week.

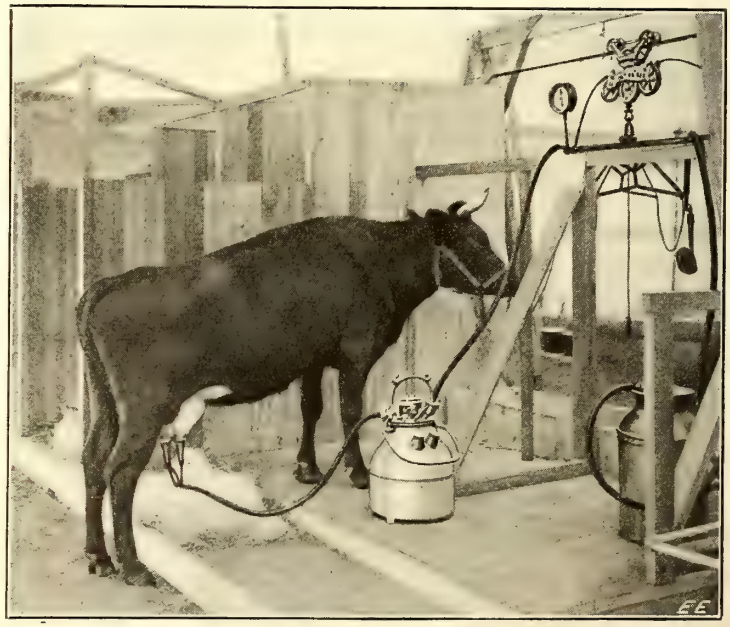
Fifteen treatments were given in February, 27 in March, 23 in April, 16 in May, 7 in June, making 88 treatments given during five months.

Results. The oculist's report was as follows:

"On first examination patient reports a haze or cloud before both eyes, being unable to see clearly with glasses. She noticed about the last of March a marked improvement in clearness of vision, that 'the cloud' before eyes was not so great. My impression was that in June when she left Atlanta that the cloud had about disappeared. With the ophthalmoscope the cataracts appeared not so dense."

He admitted that the improvement was beyond his expectation and was such as to enable him to make her vision practically normal with glasses—1.50 sph.

At the time treatment was discontinued, she could see objects clearly. Her home oculist examined the eyes and told her she would never go blind.



To Milk Fifty Cows Used to Be a Job for Ten Men—Now One Man Can Do the Work—Thanks to the Electric Vacuum Milker Here Illustrated.

Telephone Switchboards of Yesterday

HELLO, Central, give me Rector four-six—four-two! Thus speaks the twentieth century business man—and in ten seconds he is in telephonic communication with the desired party. That is, if Central is feeling right and the line is not busy. But imagine the exasperation of the business man of 38 or 40 years ago, who could count himself lucky indeed if he got his party after half an hour of arguing with the "Central boys"—who, we are told, often became so flustered that they sast the subscribers back in several languages.

The telephone probably furnishes the most impressive object-lesson in development in the comparatively few years of its life, but the switchboard has undergone the most remarkable metamorphosis of all.

The illustrations herewith are exceptionally interesting in that they bring the old and new types of central telephone exchange switchboard into strong contrast, and many people will be inclined to remark, "Is it possible that such changes could have taken place in telephone switchboard development within forty years?" But the world has been moving forward with rapid strides since Dr. Alexander Graham Bell first brought his telephone to the attention of the skeptical world, in 1876.

In Fig. 1, is shown the appearance of the first commercial telephone switchboard,

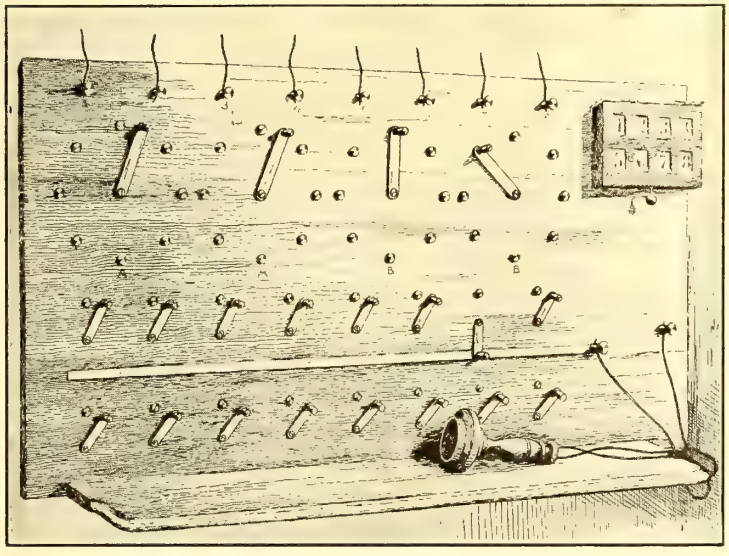


Fig. 1. The First Commercial Telephone Switchboard. It Was First Used in New Haven, Conn., Jan., 1878, and Had Connections for "Eight" Subscribers.

used in New Haven, Conn., in January, 1878. It had connections for eight subscribers, as shown by the call box on the upper right hand corner. The names of these eight subscribers ought to be engraved on the rolls of fame for their faith in the telephone promise.

As becomes evident to any electrician this telephone switchboard resembles the "attic" laboratory switch panel of one of our later-day electrical "bugs." The telephone receiver shown was made of wood, and it is indeed interesting to note that while the modern telephone switchboard bears a resemblance to the old-time board, in name only, the telephone receiver remains almost identical to the one you see in this historic illustration. It shows that Dr. Bell had the right idea from the very start.

The early switchboard shown at Fig. 2, bears the date of 1878 and was used in establishing the first telephone system in Chicago, Ill. It was put in operation in August of that year. Fig. 3 is a photograph of an early American telephone switchboard of unknown date. It apparently possest several advantages over the first types used, judging by the elaborate arrangement of the connecting jacks.

A good idea of the early telephone switchboard is given in an article in *Electric Industries* by Mr. James G. Lorrain, one of the pioneers in English telephone developments. Mr. Lorrain says in part:

"The Manchester (England) Exchange was the first (July, 1879) telephone exchange in Great Britain, and indeed in Europe. The switching apparatus consisted of a Williams' (American make, as devised by T. A. Watson) 'standard' switchboard, as it was called, and a separate operating table. Two operators were required to work 75 lines. One sat at the table to receive calls and *shouted them out to the other operator,* who plugged the lines together at the switchboard. The noise in a switchroom fitted with a number of such operating tables may be imagined when it is considered that one "Central boy" had to shout the number to another boy at the plug board, situated about 10 to 12 feet away! In 1879 and 1880 New York City had some of these telephone exchanges installed and working. These switchboards were of the plug and strip type and patterned after the old style telegraph switchboard. It soon led to the abandonment of such apparatus in large stations.

"Almost immediately afterwards the London Exchange was started, Mr. Ormiston and Mr. Fletcher acting as engineers. About three weeks later I went to Liverpool and started the exchange there; and this was quickly followed by an exchange started in Sheffield by the late Mr. Tasker and by one in Wolverhampton. About this time Mr. Edison's representatives started the formation of exchanges in this country with, I think, the 'Fitch' form of Edison carbon transmitter and the Edison 'motograph' receiver.

"In August, 1879, a company —the Lancashire Telephonic Exchange, Limited — was formed to take over the Manchester and Liverpool exchanges; and that company subsequently, in 1881, proceeded to transfer its business to the Lancashire and Cheshire Telephone Company, Limited.

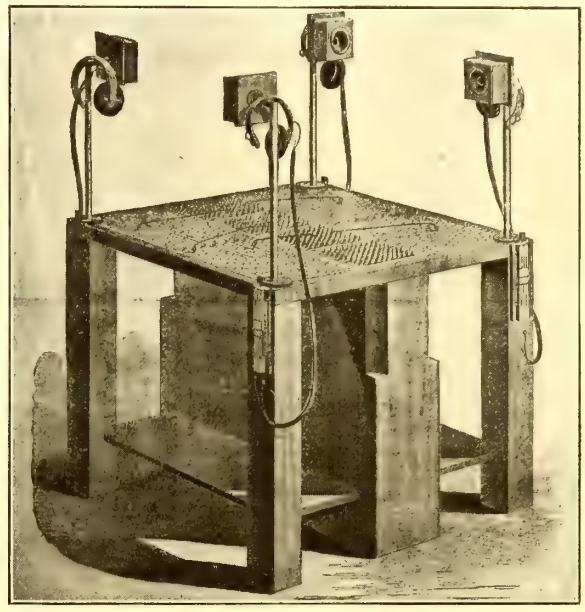


Fig. 3.—A Really Pretentious Telephone Switchboard of Early Vintage. Its Exact Age Is Not Known But It Was Among the First Attempts Made To Establish Telephone Service.

"In planning the Edinburgh Exchange I made a good many departures from previous practise. Instead of taking the lines of all our subscribers to one central station, I put up four central stations, three in different districts of Edinburgh and one in Leith, and these I fitted with the 'Jones' operating tables. This central switching apparatus differed considerably from that of the 'Williams' type used in the English exchanges. With the Jones system each operator was seated at a separate table fitted with 50 lines and arranged in such a manner that flexible connecting leads could connect any two of the tables. A very much more rapid service could be given by this means; and there was no shouting in the exchange room. I also adopted magneto call-bells for the subscribers, instead of battery call-bells as had hitherto been the practise. Some of these were constructed on the old 'thunder-pump' principle."

There is probably no other business which has advanced as speedily as the telephone system.

The appearance of a modern telephone switchboard—that of the Chelsea Central office in New York City—is shown in Fig.

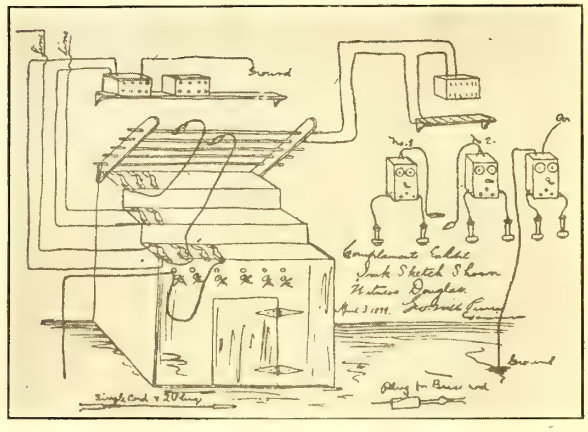


Fig. 2. Original Sketch of First Telephone Switchboard Used in Chicago, Ill., August, 1878.

4. Such an exchange handles thousands of "calls" in a single hour. Instead of requiring anywhere from 10 minutes to half an hour to complete a call—it now takes about 10 seconds.



Fig. 4. Contrast This Picture of a Modern Telephone Exchange With Those of the First Telephone Switchboards Shown on the Preceding Page. Instead of Waiting Half-An-Hour For a Call, It Is Now Put Thru In 10 Seconds.

TEACHING TELEGRAPH AND TELEPHONE AT COLLEGE OF CITY OF NEW YORK.

The College of the City of New York has establisht an evening telegraph and telephone course as an introduction to practical operating methods and commercial systems in telegraphy and telephony. There will be lectures and illustrative laboratory experiments on the following topics: General telegraph equipment, general telephone equipment, telegraph city concentration units, Atkinson repeater, magneto switchboard, coin collector telephone stations, line faults and tests, duplex telegraphy, quadruplex telegraphy, common battery telephone switchboard, artificial telephone lines and transmission tests, Wheatstone high speed telegraphy, simplex submarine cable telegraphy, terminal and outdoor construction.

The material in this course is specially chosen so as to make it of value to employes of telephone and telegraph companies who desire advancement, and who may expect to secure this by mastering something of the methods used in everyday transmission of traffic. The Western Union Telegraph Company gave all the equipment for the course and fitted up the laboratory. A large attendance is assured for these excellent courses.

PROF. BELL ON TALKING BY RADIO.

In his speech recently to the Canadian Club at St. Catharine's, Ont., Can., Dr. Alexander Graham Bell, inventor of the telephone, said:

"If the telephone has not reached its extreme limits, what next?

"I can not say what next, but I can tell you of something that happened in Washington about three weeks ago.

"The telephone has been applied to wireless, and a man in Arlington, just across the river from Washington, talked with a man on the Eiffel tower in Paris by telephone without wires.

"But that is not all. A man in Honolulu heard the conversation. From Honolulu to the Eiffel tower is 8,000 miles, one-third of the circumference of the globe. Does it mean that we can talk from any part of the world to another and without wires?"

ELECTRIFICATION IN THE CASCADES.

War burdens have failed to halt the Chicago, Milwaukee & St. Paul road in its electrification of its Cascade mountain division. Contracts, it is announced, have been awarded for locomotive and sub-station equipment at an approximate cost of $3,000,000.

The contracts call for 17 locomotives, costing about $100,000 each, and for substation equipment on the 211 miles from Othello, Wash., to Tacoma and Seattle.

The road is rushing the work to save in fuel. The electric zone now extends 440 miles from Harlowton, Mont., to Avery, Idaho.

GEORGE H. PARKMAN
of WASHINGTON, D. C.
is requested to communicate with the Editor of this publication at once in a matter that will be of great interest to him.

CARTOONING FAMOUS ELECTRICAL MEN.

IF YOU take it from the man who invented it, the telephone is a nuisance. The man who invented it, of course, is Alexander Graham Bell. And he is still a young, spry and industrious youth of seventy, full of schemes and dreams. And still, as it has been for forty years, his hour for retiring is anywhere between 2 and 4 o'clock—a. m., says the New York *Evening Mail*, accompanied by the grotesque yet novel sketches here reproduced. But about the telephone:



What the Cartoonist of a Prominent New York Newspaper Thinks of Alexander Graham Bell, Father of the Telephone.

"My interest in it ceased," he says, "when it grew to commercial utility. It no longer needed me nor I it. In fact, I won't have one of the things near me if I can help it. They're a nuisance."

Perhaps it's a good thing we're not all inventors.

And then they tackled Thomas A. Edison, the electrical wizard of Menlo Park, who is now hard at work helping Uncle Sam to win the World War. And the signs are that he is succeeding. To resume:

When Edison was a night telegraph operator and very young, he rigged up a device that would automatically send over the wire every half hour a signal indicating he was awake and on the job when he was in fact blissfully sleeping. And he has been busy ever since.

This little device he developed into the call box, millions of which are now used the world over to keep messenger boys eternally at work. It really wasn't a very chummy invention, but then it's only one of twelve hundred or more for which he has taken out patents in the last half century, and the rest average up better.

Mr. Edison is only seventy; his grandfather lived to be 103 and his great-grandfather was 102, so he figures he has a long and busy life ahead of him.

THE NOBEL PRIZES.

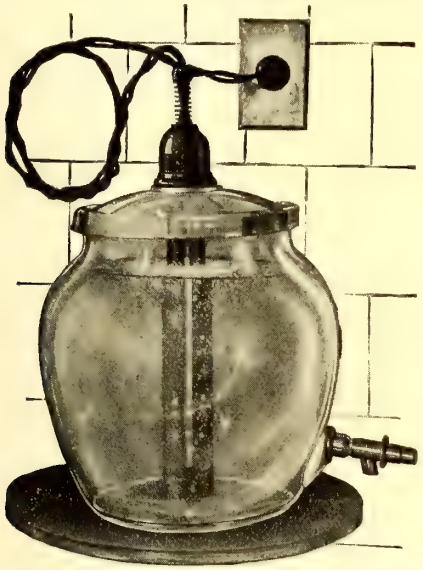
The Stockholm Academy of Science has decided not to award the Nobel Prize for physics and chemistry for the years 1916 and 1917. The prize for 1917 will be reserved until next year.



And Here's His Opinion Exprest In Pen and Ink of the Inventor of the Incandescent Lamp —Thomas A. Edison.

AN ELECTRIC WATER PURIFIER FOR THE HOME

Potable drinking water is rarely found. All water is either polluted, is hard, has an offensive taste, color or odor; contains organic matter or other unhealthy vegetable or mineral solids. The methods of treatment at supply stations are unreliable,



Where Water Has to Be Purified for Drinking and Cooking, the "Electrolytic" Water Purifier Does the Work; Quickly and Efficiently. It Connects with Any Lamp or Base Receptacle.

whereas the electrolytic process of sterilization possesses high efficiency and insures absolute protection.

Boiling water has become a common practise, but boiled water is not potable. Bottled waters are also extensively used, and besides being expensive they are not always safe when delivered to you.

Appreciating the need of some method of rendering drinking water safe, numerous filters and sterilizers have been manufactured and sold, ranging in price from fifty cents to five hundred dollars. Filters remove some of the impurities but do not sterilize, while the Electric Water Purifier does the combined work of the high-priced sterilizer and filter and with greater efficiency, according to the publisht bacteriological tests.

A NEW SELENIUM CELL.

By R. G. Morgan.

Herewith is illustrated the latest multiple-unit selenium cell, which is of simple design, also a casing, with one soldered connection, for holding a number of these cell units.

The influence of light upon the electric current when flowing thru selenium, prop-



A New Form of Light-Sensitive or Selenium Cell. It Is Formed of Many Small Cells, All Held In a Brass Ring, Which Forms One Pole of the Circuit.

erly prepared, is well known to electricians.

The cells on the market at present are expensive and quite delicate, having a dark to light resistance ratio usually of about 10 to 1, carrying a maximum current of 20 milli-amperes.

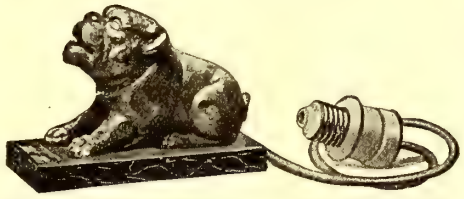
These new cells operate on a pressure of 110 volts. The maximum current that can pass without fusing the selenium is about 75 milli-amperes, at the above pressure. The dark to light resistance ratio is about 4 to 1.

A six- or eight-inch length of insulated copper wire is inserted in a piece of copper tubing, ½" by ⅛" inside diameter. The insulated wire just fits the tube, and when it is inserted the copper wire is central to the tube and lies in the tube's axis. The copper tube does not touch the bare wire at any point; 1/16" from the end of insulated wire the insulation is cut away. This end of the wire is inserted in the tube until flush with end of tube, so that there is a circular air-gap between the inner surface of the tube and the wire. This air-gap is bridged with a filling of fused selenium. Electric current cannot pass from tube to wire without flowing thru the selenium, and, as stated above, the selenium changes its electrical resistance according to the amount of light falling upon it. These unique cells are now available on the market.

Electricity is measured out by the usual house service electric meter with greater accuracy than water measured with a water meter or gas measured by a gas meter. It is immeasurably finer in accuracy than any grocer's or butcher's scales, and the average percentage of accuracy is over 95 per cent.

LET THE "ELECTRIC BULL-DOG" LIGHT YOUR CIGAR.

Those who have electric current in their homes will find this "Bull-Dog" cigar lighter an ornament and convenience at the



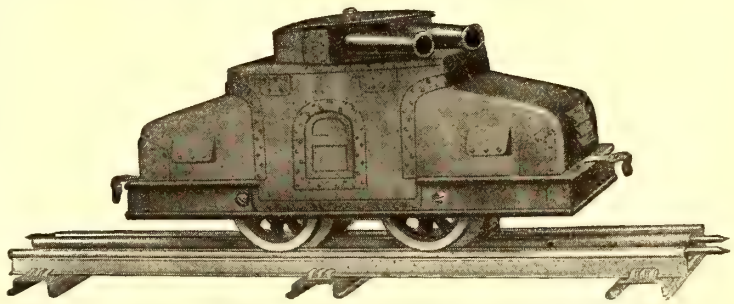
Novelty Electric Cigar Lighter for Home Use.

same time. It is fitted with a flexible cord and plug so that attachment to any electrolier or floor pocket is but the work of a moment. Zip, goes the button. Presto! your cigar is lighted. No mussy, smelly alcohol smudge pots to soil your clothes. or burn your hands. And the beauty of it is that it always works—no pushing an igniter trigger ten times to obtain a single light—not to mention the cussing.

A TOY ARMORED CAR.

The miniature electric armored engine here shown is a faithful copy on a small scale of those new and terrifying siege guns now being operated on specially built temporory tracks on the battlefields of Europe. The bodies of these monsters are formed out of heavy sheet steel. The die work brings out every detail of the heavy riveted plates, ventilators, doors, etc. Another realistic detail is the battleship gray enamel in which they are finished.

The revolving turret upon which two long miniature guns are mounted is a reproduction of the original. The motor is similar to those used in other miniature electric railway engines, and is powerful enough to haul any number of trail cars, which are enameled in the same battleship gray as the motor car. One of these armored trains makes a timely addition to any boy's outfit.



War Has Invaded Toyland—Here We See the Latest Miniature Electric Armored Car for the Kiddies.

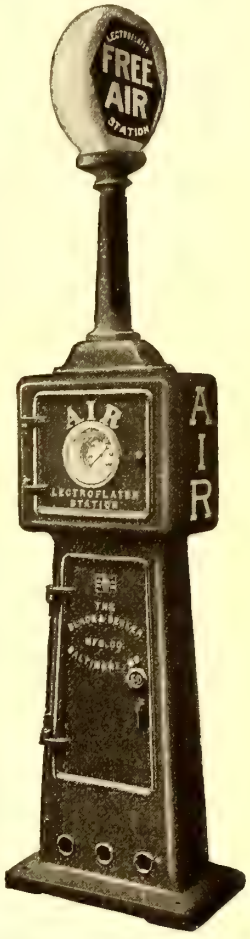
ELECTRIC CURB MACHINE SUPPLIES FREE AIR TO AUTOISTS.

A new and decidedly appealing device for automobilists has recently been placed on the market by a Baltimore concern, consisting of a curb machine for distribution of free air.

The free air machine is automatically operated day and night. The pressure dial in the upper front door is flooded with light by an electric lamp concealed inside the cabinet, and the tire valve connector on the end of the hose is so arranged that the pressure in the tire before starting to inflate is registered on the dial.

Directly over the hose rack, as shown in the illustration, is the electric switch conveniently located for starting and stopping the machine when the large dial registers the desired pressure.

It is impossible for anyone to tamper with the working parts of this free air station, for the reason that they are all contained in the upper locked compartment, even the switch controlling the large opalescent globe being locked in this compartment. This leaves nothing but the hose and starting switch in the lower compartment and, if so desired, the lower compartment can be locked and keys furnished customers.

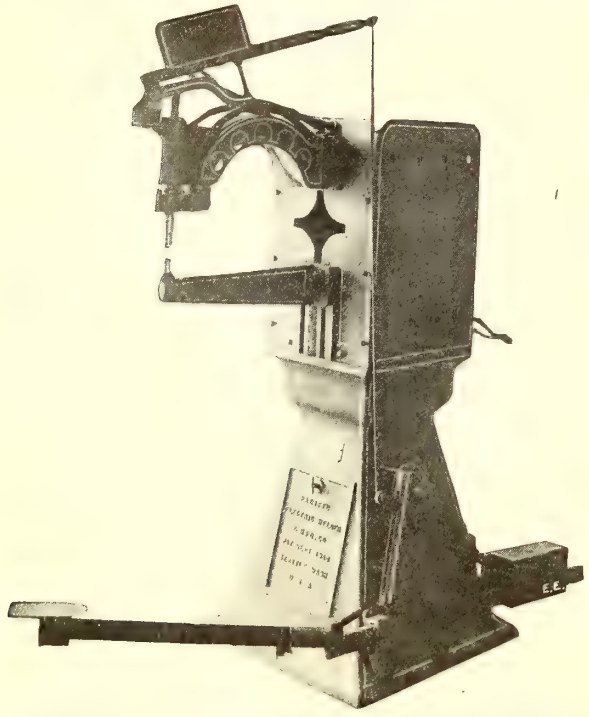


New Automatic Electric Air Machine for Free Use of Autoists.

The machine operates on either direct or alternating current. The cooling system is automatic and uses no liquid, eliminating freezing and evaporation. It has no exposed mechanism, electrical or mechanical, and is perfectly safe for even a child to operate.

ELECTRIC SPOT-WELDER SAVES TIME AND MONEY.

Electric spot welding is the process of joining or fusing together electrically two or more metal sheets or parts without any preparation of the stock used. Mechanically, it is equivalent to riveting, but it is claimed to be stronger and much quicker and more economical.



The Electric Spot Welder Here Shown Can Be Operated by Unskilled Labor and Does the Same Work As the Old-Fashioned Riveter, Faster and At a Much Lower Cost.

The process of spot welding is simple: The material is placed between the electrodes or welding points where it is desired to make the weld. Then, by applying pressure either with the hand or foot lever, the metals are prest together, electrical contact instantly made and the weld accomplisht.

Single-phase, alternating current is used in electric welding. As the voltage is reduced in the welders by a special transformer, there is no possibility of the operator receiving any shock.

Wrought iron and steel are the best materials for electric welding. Rust, scale and dry paint act as insulators and should be removed from steel before welding so that the current may flow freely. Galvanized iron can be welded, but the galvanized coating will be burnt off where the welding points touch the iron. Copper, brass and bronze welding is a trifle slower, as they are such good conductors of electricity they offer practically no resistance to the flow of current. The welding of cast iron is not recommended.

As a general rule, current cost 50% less than rivets, but the principal item which makes spot welding invaluable to sheet metal and ornamental iron manufacturers, etc., is the very large saving in labor. For instance, a large stove manufacturer installed an electric spot welder and it is now doing the work of six riveters, the current costing less than one-half that of rivets.

A general idea of the cost of operating these welders may be obtained from a statement made by a manufacturer using one of these devices: The operator welded a thousand articles per day at a cost of ten cents for power and two dollars for wages; cost to weld one article 2-10 of a cent. Before installing a welder this same firm was paying ten dollars for wages and sixty cents for rivets for riveting one thousand articles; cost of riveting one article, one and six-tenths cents.

Which goes to show by installing an electric welder this firm made a saving of one and four-tenths cents per article, or $14.00 per day on 1,000 articles.

Spot welding is acknowledged to be 75% to 100% stronger than riveting, is much faster, leaves a better finish and is far more economical, besides being perfectly noiseless.

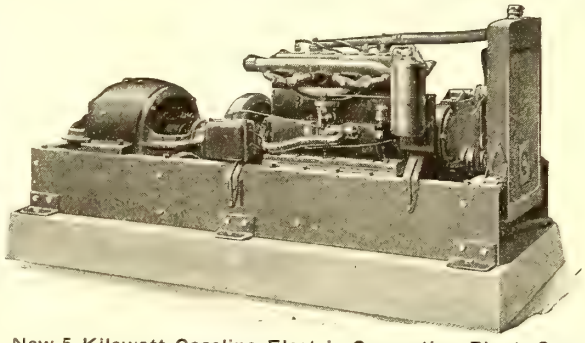
NEW 5 K. W. AUTOMATIC ELECTRIC PLANT.

To meet a constantly increasing demand for a larger size automatic electric lighting plant, an Ohio concern announces the addition of a 5 K. W. lighting plant. As shown in our illustration, this model presents an exceptionally sturdy and business-like appearance.

It furnishes current for light and power, requiring no attention beyond replenishing the supply of fuel and oil. The action is automatic thruout.

The engine is 4-cylinder, 4-cycle, and develops 20 horsepower, giving it a reserve capacity for nearly 100% overload. This, together with the fact that the set runs at the slow speed of 900 R.P.M. insures smooth, easy running, and long life.

The generator is especially designed for the work, and is directly connected to the engine thru a flexible coupling, the armature being permitted to "float" in its bearings.



New 5 Kilowatt Gasoline-Electric Generating Plant, Complete With Automatic Battery Charging Devices. The Plant Is Self-Starting.

The engine is water-cooled, the pump forcing water from a tank of large capacity thru the cylinder jackets. This heated water is then returned to the water tank after being cooled by passing thru an automobile type radiator, thru which a fan forces a stream of air.

The electrical apparatus is mounted on a neatly arranged switchboard and may be installed wherever convenient near the plant. It provides for the full automatic operation of the plant, keeping the batteries charged at all times. Any flow of battery current, either charge or discharge, is accurately measured so that the batteries are given better attention than if used on a hand operated plant. For starting, current is taken from the battery and the generator is temporarily a motor until the engine starts firing. The plant is so arranged that the engine starts and recharges the batteries when they are 25% discharged. Thus the battery is never allowed to drop below 75% of full charge capacity, "sulfating" of the plants is prevented, and long life of the batteries is assured.

THE "GALVANOSET" — A NEW ELECTRO-MEDICAL APPARATUS.

One of the great problems always confronting the electro-medical practitioner has been how best to safely apply currents derived from the ordinary lighting mains.

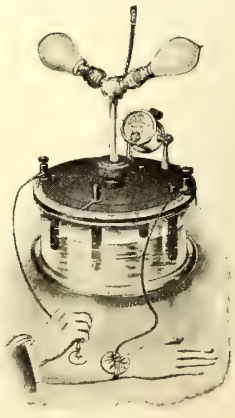
With this new English make of apparatus one utilizes the main supply of electricity by attaching it to any electric light socket by a standard attachment which can be quickly connected when required.

The current is then conducted thru two suitable resistances into a vessel of water by means of two electrically indestructible electrodes, which are placed on opposite sides of the vessel. At right angles to these two electrodes a second pair of electrodes is placed in the water; *these are connected to the patient.* As long as the two electrodes, which we will call "Patient" electrodes, remain at right angles to the two electrodes, which we will call "Supply" electrodes, no current will be obtained, as the electrical potential in this position will be zero. The supply terminals are mounted on a disc of vulcanite, arranged so that it is free to rotate over a graduated celluloid scale. If this disc is now rotated from its right angle or zero position, any desired current can be obtained from minimum to maximum by the most gradual increase. If it is desired to reverse the polarity of the current leading to the patient, the disc is brought back to its zero right angle position and then rotated in the opposite direction.

A current giving every degree of variation from 0 to 500 milliamperes and at a voltage from zero to the maximum required, and absolutely safe under all circumstances, is readily obtainable. This apparatus has great advantages over wire rheostats. The disadvantage of wire rheostats is that they are apt to break and give the patient a severe shock. Again, with the wire rheostat the patient is always connected to one pole of the supply, and if by accident the patient gets into connection with the opposite pole, he is then in direct connection with the main supply.

With this apparatus it is impossible for the patient to get into direct contact with either the positive or negative side of the supply.

The weight of the complete apparatus is seven pounds, so it can very conveniently be taken to a patient's house. A dead-beat D'Arsonval milliamperemeter, with shunt winding, records the current passing to the patient. This is mounted on the apparatus in a convenient position, and is permanently connected in the circuit.

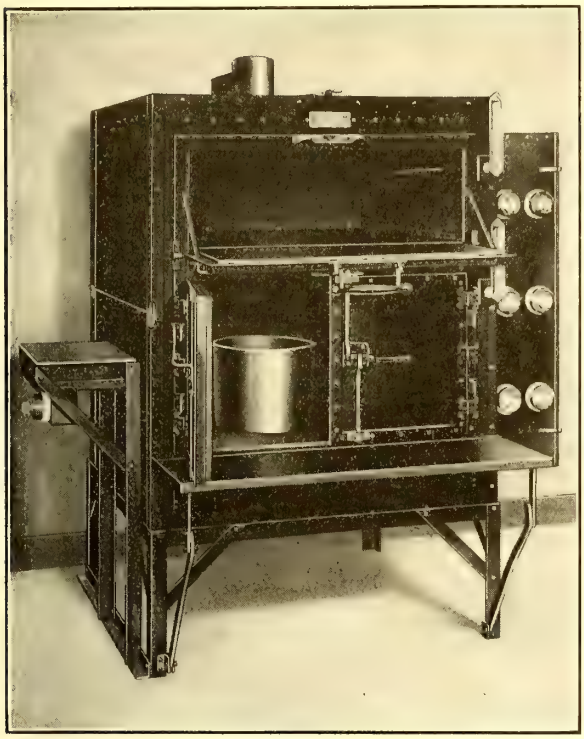


Unique Electro-Medical Current Regulator.

The construction of this device is extremely simple, yet sturdy and efficient.

A NEW ELECTRIC ARMY OVEN.

A new method of cooking is rapidly becoming popular. It is in the combination electric oven which is designed for all kinds of cooking; Boiling, Roasting, Baking, etc.



A New Electric Oven Designed for Use by Uncle Sam's Soldier Boys. It Is Rated at 15 Kilowatts and Has Several Separate Compartments Provided With Three-Heat Switches. The Hot-Plate at the Left Is Used to Heat a Coffee-Urn.

One of these large electric ovens designed for use by the U. S. army is illustrated here.

There are many advantages in this system of cookery. First, the use of such a combination oven eliminates the necessity of a range—as it handles all the heavy cooking. Short orders and any small emergency cooking can be done on a hot plate—which is much more economical than maintaining a fire in a big stove. Secondly, it conserves heat, kitchen space and time—and saves the heating of one, two and oft-times three cooking devices.

Foods boiled this way are more evenly and thoroly cooked because the constant, uniform heat penetrates *all* sides of the vessel at the same time. Thru the heavily-insulated walls and the closely-fitting doors of the oven, there is no air circulation to carry off the flavors and juices of baking and roasting meats.

Moreover, the great saving in meat shrinkage is an important factor and there are a number of restaurant owners who have estimated that it more than pays their entire electric bill which includes ovens, lights, coffee urn heaters, etc. Another feature is the efficient utilization of the heat. Thru the heat-conserving properties of the oven, oat meal and other cooked cereal, baked apples, pork and beans, etc., can be placed in it after the current is off and the day's work finished—and be thoroly cooked next morning by the slowly receding heat.

The fireless cooker construction eliminates the air currents and this feature in turn eliminates the interchange of odor and the impregnation of the flavor of one food with that of another.

An electric hot plate is mounted externally on one side of the oven on which the coffee urn rests. The oven has the following compartments: Lower compartment has swing-type doors which can be opened independently of each other. The upper compartment has the drop-type door. Swing-type door has outside shelf. Compartments are separate—making it possible to heat only one when a limited amount of cooking is to be done. Has three heating elements—one under each deck and one at the top of the upper compartment. Each element is operated by a three-heat switch. Two mercury thermometers are fitted on the oven. The oven has a maximum consumption of 15 kilowatts. It weighs approximately 1,500 pounds.

NEW ALTERNATING CURRENT SOUNDER.

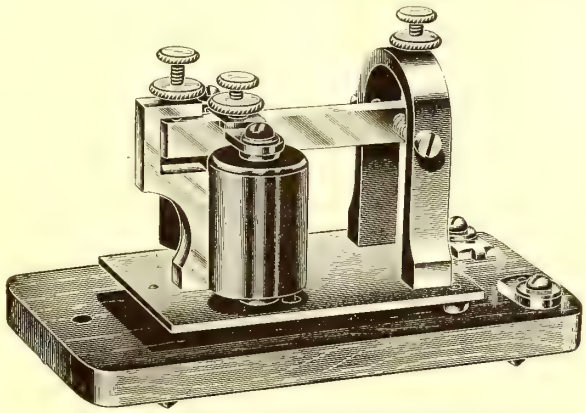
The illustration shows a practical alternating current sounder, the principle of which is so simple that it is a wonder it was not discovered long ago. It was invented by Mr. J. J. Ghegan.

The instrument is the same size as the regular local sounder which it resembles in general appearance, the only change being in the position of the magnet spools and the construction of the armature. It can be used on any 110-volt, 60-cycle alternating current circuit either in series with a lamp or thru the secondary of a small step-down transformer. The transformer method is preferable, as with it the local wiring may be of the ordinary kind used in local battery work, and one transformer can furnish current for several sounders.

The instrument can also be operated on the 110-volt circuit without either lamp or transformer, when specially wound for such use.

Altho the current required to operate the sounder in the ordinary way, thru the front contact of a relay, is very small, it can be arranged to work thru the back stop so that current would be used only when the sounder might be working.

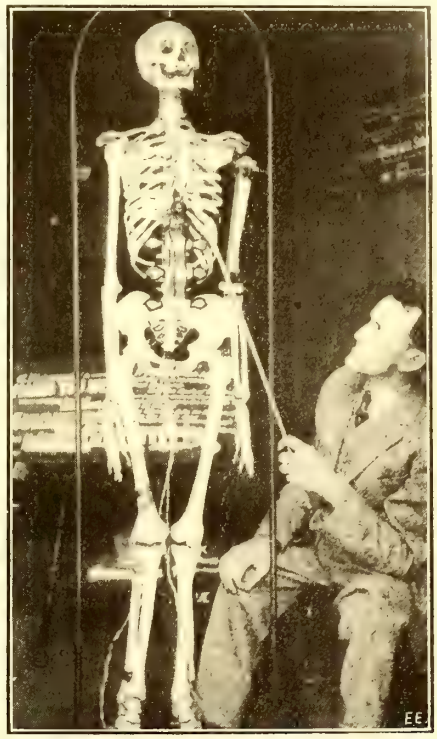
This sounder will work on direct current without any change of adjustment, so that in places where there is a liability of interruption to the alternating current lighting circuit, two dry cells could be switched in to bridge over any such interruptions.



New Alternating Current Telegraph Sounder.

A LIVELY ELECTRIC SKELETON.

Dr. Ratledge, of Los Angeles, has a novel idea of explaining a method of healing or manipulating the spine. He has fastened a skeleton so that it hangs in a frame made from pipe. Electric lights are placed where the different vital organs were once located. Small lights are placed in the eye-sockets, and long tubular lights are placed on the arms and legs.



A California Doctor Has Devised an Electric Skeleton with Which He Clearly Demonstrates, by Flashing Different Lights About the Limbs, the Action of the Spine and It's Nerves.

Along the spine at the point where the nerves lead off to the various vital organs there are placed electric switches which connect with the various lights. To illustrate what happens to the vital organs when the nerves leading from the spine become pinched or otherwise injured, the instructor turns the switch leading to any particular organ, which instantly dims the light supposed to represent the particular vital organ, such as the heart, lungs, etc. This is supposed to illustrate the manner in which the force flowing to the vital organs is shut off when the nerve is obstructed. To show what happens when the nerve is cut or otherwise becomes unable to transmit the nervous energy, he turns the switch off, causing that particular light to go out, illustrating how a vital organ becomes incapable of performing its work when shut off entirely.

Contributed by G. W. GEIGER.

PRINTING TELEGRAPH ON LACKAWANNA RAILROAD.

The Lackawanna Railroad Company has installed and put into operation two printing telegraph instruments between the offices of the traffic manager, located in New York, and the car service superintendent in Scranton, Pa., a distance of 150 miles. These instruments are used in connection with the freight clearing house system recently adopted by the Lackawanna Railroad. This printing system is proving very successful.

How Jimmy Saved the Troop Train

By JOHN T. DWYER

Showing How Quick-Witted "Jimmy" Hanlon Thought of the Right Idea at the Critical Moment and Thereby Earned the Gratitude of the War Department

"I WONDER how Jack made out with his examination," mused Jimmy Hanlon, as he sat at his key in the dispatcher's office of Winslow station. "Seems to me he ought to pass easily enough. Well, I should know pretty soon, for here comes the rascal now or I'm greatly mistaken. But Lord! he sure is making enough noise."

Bang! went the lower outside door of the station and the resulting vibration sent a tremor thru the whole building. Then a clattering of hasty footsteps and finally the office door swung on its hinges, revealing the puffing and panting Jack Godfrey, who generally acted as night shift for Jimmy.

For a few seconds he stood there trying to get his breath, and then blurted out:

"Congratulate me, old boy! I've come out with colors flying! And what do you think? They actually gave me a rating. From now on I'm Corporal Godfrey of the Signal Corps, if you please."

"Whew! you don't say so!" ejaculated Jimmy. "Why pretty soon you will be a General or something, and then I'll bet you won't want to look at your friends any more."

"Nix, Jimmy, you know I'm not that kind, altho to tell the truth, it does make me feel a little tighter around the vest to realize that I'm to wear *chevrons*. But say, I wish you would reconsider your decision and join with me," continued Jack more seriously. "We've been chums so long now that it will go kind of hard to separate. Come, can't you manage it somehow?"

"No, Jack," replied Jimmy soberly. "You know there are others depending on me and it wouldn't be fair to them. But," and his eyes lighted up with enthusiasm, "you may be sure that if I had 'no entangling alliances,' as Washington might say, I'd be there in a jiffy. Never mind," he continued, "I'm a good deal like Micawber and will hope for something to turn up, which will enable me to take my place beside my old friend."

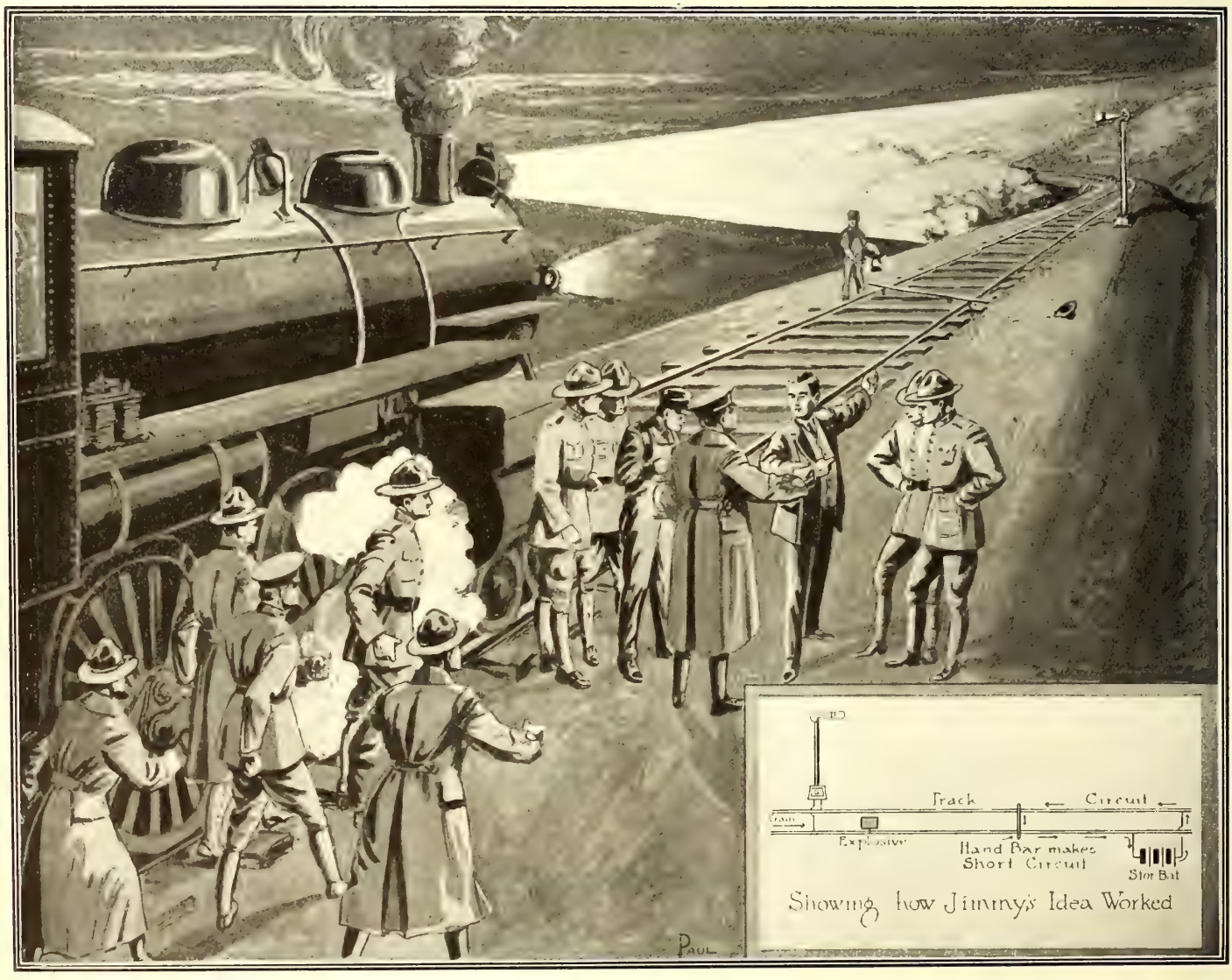
Further conversation for the time being was interrupted by the sudden sounding of the instrument and Jimmy turned to give it his attention.

"That's interesting," he said, after getting the news. "Harris at Edgeville states that a special train loaded with a regiment or so of infantry has just gone thru there on the way to the coast from where the boys will embark for France. No doubt, she'll pass by here in another half hour or so. Seems to me, it would be a good idea for the people of Winslow to give them a rousing greeting and send-off."

"Not much chance," Jack replied rather scornfully. "In the first place, there are too many rabid pro-Germans in this burg. Why, really I wouldn't be at all surprised if some of these hot-headed Dutchmen tried to wreck it."

"Nonsense! Jack—the kind we have here are of the harmless variety. Besides, there are still a number of true Americans in this town that would make short work of them if they tried any such low-down stunt."

"Well," he added rather abruptly, "here I am talking like a 1905 model Edison phonograph, when I should be on the road for home. So, you had better take charge



". . . Young Man," Spoke Up One of the Officers, Whose Eagle Insignia Showed Him To Be the Colonel in Command, "What You Have Done I Consider To Be the Cleverest Bit of Ingenuity That I Have Come Across in a Long While. . . . Such Work as You Have Performed To-night Will Not Go Unrewarded. . . . You Have Saved the Lives of at Least One Thousand of the Nation's Fighters."

of the fort, General, or rather Corporal, until morning. Good night! and don't let any German plots worry you in the meantime."

"Good night!" responded his chum cheerily.

The fact that it was growing dark and that Jimmy lived about three miles outside the town prompted him to take as short a cut as possible, and so it was he decided to go by way of the railroad. This would shorten the distance considerably and, at the same time, enable him to reach home before supper.

He had gone but a little ways, when as usual with one of his mental temperament, he soon fell into a deep study over the events of the day, especially as regarded his friend's enlistment and his own misfortune in not being able to join.

"I don't know what I'll do when Jack is called," he mused rather sadly. "He's always been such a good scout that it will go hard to lose him even for awhile, and then again, perhaps, it may be forever." This latter pessimistic thought he put away from his mind, as he did not like to entertain any such fate for one who had been his constant companion since boyhood. "Yes," he continued, "I sure will miss him. In my mind, Sherman didn't say half enough about the virtues of war."

Jimmy had been so intent on his own mental retrospections that he failed to notice the silhouettes of three figures standing along the track about twenty-five yards ahead of him. They, on the other hand, were equally oblivious of the proximity of another, which was due mainly to the fact that they were busily engaged in conversation.

At first, the three spoke in low tones but gradually, as their confidence increased in the belief that there could be no one to hear them at such a time and place, they became less cautious in controlling their voices, with the result that Jimmy was soon rudely awakened from his reverie by the sounds.

His interest and curiosity aroused, he resolved to be a silent party to their animated conversation. While, at first somewhat scrupulous on the point of acting as an evesdropper, he put aside his conscience by arguing that perhaps something might be wrong, after all. "It certainly does look queer," he admitted to himself. As he was about to move closer so as to catch the topic of their conversation, one of them struck a match, evidently in order to light a cigarette, and the resulting illumination enabled Jimmy to secure a look at their faces. To his surprise, he recognized at once the features of one of them as Fritz Schuster, the town butcher, who was notorious for his rabid pro-German leanings, which had taken expression several times in an abusive denunciation of America for waging war against the Fatherland.

Jimmy's curiosity at once gave way to suspicion, for to him it seemed very significant indeed that one so firmly antagonistic to the country should be found at such a place; the more so, when taking into consideration the fact that the troop train would be due in a few minutes. Whatever doubts he might have had as to the grounds for his suspicions were immediately dispelled by hearing the conversation that followed:

"I tell you, Fritz," spoke up the rather tall one, who appeared to be a German secret service agent, "that was a clever idea of yours to place the 'nitro' on the tracks running alongside the bluff. When she explodes, the train will not only be blown off the rails, but ditched as well, and down a hundred foot embankment at that. In my opinion," he added grimly, "there will be no survivors."

"Jah!" answered Fritz, in a little broken English, "so mouch the better! I chust lof them Americans! Vell, dis will be two thousand less for the dear *Vaterland* to fight. Maybe," he continued with a show of pride and vanity, "maybe the Kaiser giff me un iron cross, chess? Ain't dot so?"

"Most certainly he will," spoke up the third and shorter man who seemed to be the one in authority, "for if this job turns out right, I intend to bring the matter to the attention of the Imperial Government. Germany always takes care of those who serve her interests."

Jimmy waited to hear no more. He had listened long enough to convince himself that the troop train was in peril. There remained but one thought in his mind and that was to save it either by removing the dangerous explosive or else warning it in time of the menace. With Jimmy, "to think was to act" and so, swiftly and silently, he beat a detour around the conspirators to avoid being detected by them. Now, it was about three-quarters of a mile to the spot where the explosive had been placed, so he figured that by pushing himself to the utmost, he could cover the distance in time. Bracing himself for a moment, he exerted all his strength and then leaped forward.

The race with Death had begun!

Now it was that his old training practise came into good use. Swiftly he sped by the trestles until they fairly seemed to fly past him. One hundred! two hundred! three hundred yards!—still more than a half mile to go. Manfully, he tried to keep up the same pace but the strain was too great and he gradually slackened. And no wonder! His legs now seemed to weigh tons so that it took excessive effort to force them ahead and his breath came in quick short gasps. The "man" in him, however, would not quit, but urged him to renewed exertion.

"Oh, Lord give me strength. Two thousand lives!" he murmured again and again. If he could only hold out for a little longer, the race would be won and Death cheated of its prey.

Then it happened. A thud against something hard and the next moment Jimmy was sent hurling to the ground. Stunned by the suddenness of it all, he did not arise at once but lay prone for a few seconds. Almost immediately, however, he sought to get to his feet, but the effort caused such an agony of pain that he sank back again to the ground. His right foot and ankle had received a serious sprain in falling over an iron hand bar which had tript him. The pain was excruciating but not enough to drive from his mind the troop train, the whistle of which, even at that moment, sounded in his ears.

"My God! it's coming and I am helpless to save it! Oh, if only there were some way to signal the danger."

That word "signal" brought the big idea to Jimmy, for like a flash, there past thru his mind a plan as simple as it was practical and he at once lost no time in putting it to the test.

It was this: Only recently, the railroad for which Jimmy worked as operator, had installed a new electric Block System for a distance of about two miles on either side of the town, with the blocks about a mile apart. This system was of the "normal safety" type and the semaphores at the entrance of each so called "block" were kept normally in an upright position of "clear" by means of a local motor and relay, operated in turn by the normally closed track circuit. As long as the block remained open, that is, not obstructed by a train ahead, the semaphore would remain in the "clear" position, but as soon as a train entered the same, then the rail current would be short-circuited via the axel and wheels of its locomotive, thus depriving the local relay of current. This being so, the semaphore naturally would obey the laws of gravity and fall to a horizontal position of "danger." Should another train then come, it would be in a position to know just what the condition of the track ahead was, and stop accordingly.

Fortunately, from the description unwittingly disclosed during the conversation of the conspirators, Jimmy surmised that the explosive must have been placed about fifty yards within the entrance of the block, so if there could be found something to provide a "shunt" across the track circuit, the semaphore could be dropt and thus the oncoming train warned of the danger ahead.

Feverishly, he searched his pockets for some pieces of loose wire but without success. Something must be done and done quickly, for already he could perceive the train as it took the curve two hundred yards or so before the block entrance.

"Why, the very thing!" he cried aloud. Notwithstanding the intense suffering caused by the movement he crawled over to the track and picked up the iron bar which had caused him to fall. A few short seconds and it was placed directly across the rails of the track in such a way as to bring about a complete "shortcircuit" of the electric current.

(*Continued on page 733*)

The "March" Electrical Experimenter

We have in preparation a great variety of subjects for the "March" issue of the ELECTRICAL EXPERIMENTER. *We are sure that you will enjoy every one of them and moreover find them both entertaining as well as highly instructive. A great many people complain now and then because we publish articles which seem mere "theories." Perhaps so—but you can rest assured that these special articles, often illustrated at great expense by elaborate wash drawings, possess a new basic feature: something which will invariably visit us in daily life before a great while. Past experience has proven this many times over. Such an article appears on page* 661 *of this issue describing a radically new principle in talking machines—the* 48 *record "Orchestra Phonograph." It's new—it's interesting—it's instructive! Read it and learn something.*

For the March issue:

"At War With the Invisible"—A gripping story, well told and with a thoroly scientific atmosphere, by R. and J. Winthrop.

"Arlington via the Talo Club"—An amusing account of a visit to the King of all Radio Stations, by W. J. Howell.

"Wireless on the Submarine"—A topic of universal interest. Explains how the U-boat flashes messages a thousand miles or more.

"The First Trolley"—With interesting photos, by George Holmes.

"Experimental Physics"—Lesson 11, *by John J. Furia, A.B., M.A.*

How to Make a Water Jet Vacuum Pump—by Prof. H. E. Metcalf.

Telegraphing thru the Earth—of interest to all "Radio-bugs."—By Roy T. Griffith.

Siphons—How they work, by F. W. Russell and J. L. Clifford.

Wavemeters—Their uses and Construction—by M. W. Sterns.

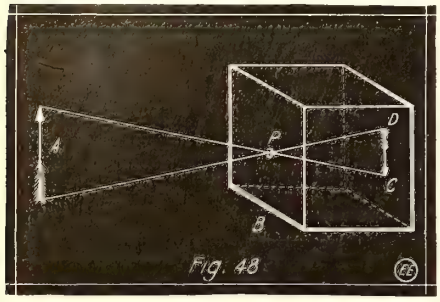
Experimental Physics

By

JOHN J. FURIA, A. B., M. A. (Columbia University)

LESSON 10.*
Photography.

IN lessons 8 and 9 we discust the formation of images by mirrors and lenses and noticed that it was quite easy to "catch" the image of an object thru a lense. If the screen on which the image is caught is sensitized so that it will retain the image after the object has

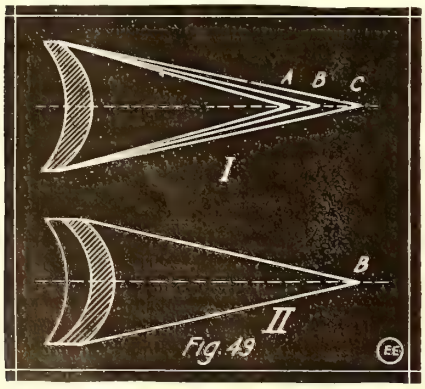


Illustrating the Principle of the "Pin-hole" Camera. The Object Is Reversed on the Screen as Indicated at D-C. One of the First Cameras.

been removed, we have a *photograph.* In this lesson we shall take up in detail the formation of the image on the screen (photographic plate or film) and the next lesson will be devoted to the retaining of the image.

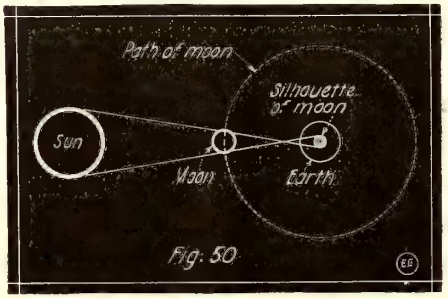
EXPERIMENT 55—

The simplest form of the camera (the *pin-hole* camera) can be easily constructed and used successfully (see figure 48). Secure or make a light-tight box about 6 inches on a side, and punch a pin-hole thru the center of one side. We shall call this side the *front* and the side behind it the *back.* The back should be hinged so that a photographic plate can be inserted. Let "A" represent a tree or some other object. Then light from the top of "A" will pass thru pin-hold "P" to point "C" on the back, while light from the bottom of "A" will pass to the point "D" (above "C"), illustrating the principle that light travels in straight lines. If a room be darkened and light from a bright object be permitted to come in thru a pin-hole an inverted image will be formed on the wall of the room just as in our pin-hole camera, and a picture can be taken. It is important to note that a clear image is formed despite the fact that no lens has been used.



The Difference Between the Focal Point of a Simple Lens (I) and the Achromatic Lens (II).

The writer has made good pictures of outdoor scenes with a pin-hole camera giving an exposure of about three minutes. Naturally it would be quite inconvenient to have to wait so long for each exposure, and one would have to limit oneself to taking pictures of still life, so that for practical purposes we use a lense in place of a pin-hole which gives us a sharp image and at the same time lets in a great deal of light hence permitting a short exposure. From the discussion in the last lesson it is apparent that the convex lens is the type to be used, and also since the image is sharp only when "focused" the back or front of the camera must be movable so that the distance between the lens and screen (ground glass or plate) can be changed as required. If F represents the focal length of the lens (found by the method explained in lesson 9) and I and 0 represent the distances of the image and the object, respectively, then $1/F = 1/I +$



The Principle of the "Silhouette"—A Partial Eclipse Is Caused by the Moon Getting Between the Sun and Earth, Casting a Shadow or Silhouette on the Earth.

$1/0$ is the formula from which any one of the quantities can be computed if the other two quantities are known. Hence by use of this formula the maker of the camera is able to furnish a scale showing just where

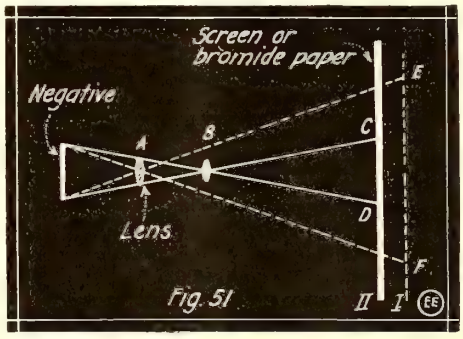


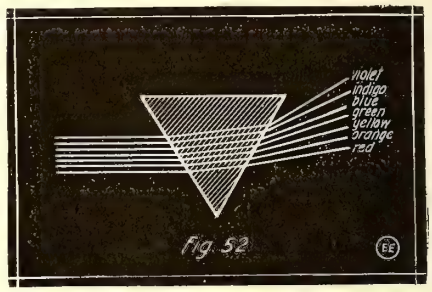
Diagram Showing How, When Light Is Past Thru a Photo Negative, the Image Can be Enlarged by a Lens "A," and Thrown on a Screen at E-F.

to set the camera so that an object a certain distance away will be in focus.

EXPERIMENT 56—

If a strong light is focused thru a lens on a white screen it will be found that the actual focal point will be difficult to find. A point "A" will be found which seems in focus, but which gives a violet tinge to the image. (See Fig. 49.)

Another point "C" will be found giving an image with a reddish tinge and other points in between of various tinges. This dispersing of the different colored rays (to be treated on in detail later) so that the different colors do not focus at the same point, is corrected by the use of the achromatic lens. The rays which act on the sensitive surface of the plate or film are those from the violet end and are called *actinic* or *chemical rays.* The visual rays are from the red end. Hence if these rays are separated by the lens the image formed on the screen is not the one which will make the picture. However, flint and



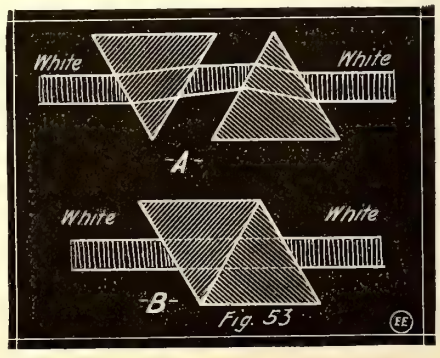
How a Prism Breaks Up a Beam of White Light into Its Component Colors, as Shown at the Right.

crown glass have different dispersive powers, and, therefore, one can be made to correct the action of the other. Flint glass bends the chemical rays more than does crown glass, and so by combining a negative lens of flint with a positive of crown glass the chemical and visual rays are brought to focus at the same point. In the case of small cameras dispersion (chromatic abberation) is so slight that it is not necessary to use the achromatic lens.

DIAFRAM OR STOPS.—The best part of a lense is its center since the light passing thru the center is correctly refracted as in the case of the pin hole. Hence the smaller the lens opening (diafram stop) the sharper the picture but the greater the time required for the exposure. The fast lenses are lenses which will focus sharply even when the diafram is open at a large stop, thus letting in a large amount of light and permitting a short exposure.

EXPERIMENT 57—

To make a silhouette of a person or object take the picture with the camera facing the illuminating source (the sun for snapshots) and the object or person in between the camera and the illuminating source. The result on the ground glass will be a shadow of the person or object, and the picture of this shadow will be a *silhouette.* It should be noted here that a partial eclipse is really nothing but the



If White Light Is Past Thru Two Prisms, the Result Is White Light, Since the Rays Bent Up by the First Prism Are Bent Down by the Second Prism.

passing of a silhouette over the earth (see Fig. 50).

Continued from Nov., 1917, issue

(*Continued on page* 715)

The Home-Treatment of Tuberculosis by High-Frequency Currents

By DR. FREDERICK FINCH STRONG

Lecturer in Electrotherapeutics, Tufts College, Boston

STATISTICS show that one death in every seven is caused by tuberculosis, usually in the form called "Pulmonary tuberculosis," "Tuberculosis of the Lungs" or "Consumption." Sanitary regulations, isolation of cases and hygienic education are rapidly lowering this high death rate, but tuberculosis is still humanity's most terrible scourge.

Thruout the ages "The Great White Plague" has done more to retard human progress than all the wars of the centuries —not excepting the present Armageddon.

Fortunes have been spent in the study of the prevention and cure of this disease; countless fortunes have been made by quacks and mistaken enthusiasts who either claimed or believed themselves to have discovered "A Sure Cure for Consumption." The discovery of tuberculin by Koch was widely heralded as the longed-for panacea, but it proved a failure, and up to the present time no "specific" has been found for the cure of tuberculosis.

The importance of the subject is further emphasized when we reflect that even when it does not manifest as consumption, tuberculosis still does its insidious work in undermining the stamina of the entire race. Dr. A. C. Geyser states that "ninety per cent of all children are infected before their twelfth year, and nearly all bodies that come to autopsy show unmistakable signs of previously existing tubercular lesions." That more people do not develop the disease in its active form is due to the natural curative forces that are always at work in the human body.

Disease germs grow only in a suitable soil or medium; healthy human tissues do not furnish this medium. Only when these tissues are weak, inactive or charged with dead matter do they allow disease germs to multiply in their midst and produce their poisonous secretions.

In a previous article in the March, 1917, EXPERIMENTER—"Electricity and Life"—the writer called attention to the existence of the "Vital-force," or "Prana," thru the activity of which all life is maintained. This is absorbed from the food, air and water, and is probably distributed by a circulating system all its own—a subtle "Etheric Body" which interpenetrates the coarser molecules of the organism and is doubtless formed of imponderable chemical atoms finer than the gas atom and coarser than the electron. Just as modern physicists find it necessary to employ the hypothesis of "The Ether of Space" in order to account for the phenomena of radiant energy, so the most advanced of our physiologists and biologists are assuming the existence of the "Etheric Body" in order to explain the phenomena of life in animal and vegetable bodies.



Portable Yet Effective Electrical Apparatus for Diathering and Tesla Treatment of Tuberculosis.

Probably the great sympathetic nervous system distributes the life-carrying matter of the etheric body in much the same way as the heart and blood vessels transmit food and oxygen to the cells and tissues. The latter circulation depends upon the maintenance of the former, for if pressure is made over certain nerve centers the blood stream is retarded or ceases altogether; pressure on another center stops the breathing mechanism and death from syncope follows. Great discoveries will be made in the immediate future thru the study of the nerve currents and their relation to the Etheric Body and to "Vital Force."

It is because this vital circulation is fairly active in the majority of persons that so many recover spontaneously from pulmonary tuberculosis. But in cases of weak "vital resistance," where the Prana is not actively distributed to the lung cells, the tubercular germs grow, multiply, secrete poisons and ultimately make the physical body unfit for its human tenant who is forced to move elsewhere!

This lowered cell vitality results from hereditary weakness, improper food, and above all, from insufficient fresh air and out-of-door exercise. We can prevent this hereditary weakness in future generations by following Eugenic principles and exercising the same care that we now use in breeding blooded cattle and horses.

But meanwhile we have in our midst countless thousands of poor sufferers in whom tuberculosis exists in an active form, and the majority of whom face a lingering death scarcely less horrible than that resulting from the "poison gas" of the war zone. What can we do for these unfortunates? Those of them who can go to the special tuberculosis sanitariums and have daily treatment under proper surroundings stand a fair chance of recovery, especially when the disease is in the early stages. There are hundreds, however, who cannot go to such institutions.

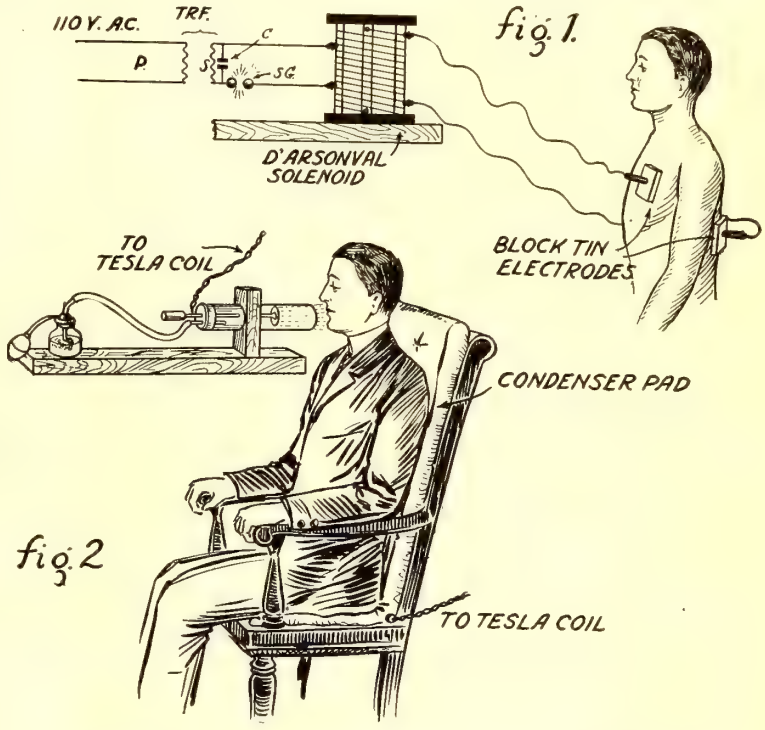
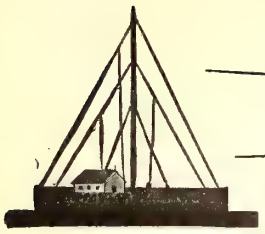


Fig. 1 Shows Treatment of Tuberculosis by "Diathering," Fig. 2, Treating Tuberculosis by "Ozone Nebula" and Tesla Currents.

When we do not use a machine it rusts and falls to pieces; when we do not use an organ or tissue of the human body the life-force and blood supply are diminished and we have a condition where disease germs can find a ready foothold. If certain parts of the lung are not periodically expanded by the inspired air they become "Anaemic" and susceptible to tubercular infection, which afterwards spreads to other parts of the lung. Now if we can find a way of revitalizing these anaemic areas, nature will use the blood and oxygen to start a regenerative process and the bacilli and dead cells will be thrown off in the expectoration. This latter material—the "tubercular sputum"—carries the infection to others; it should always be burned or received in vessels containing antiseptics such as creolin or sulphonaphthol. If this were always done the disease would soon be stamped out.

It is a well known fact that high-frequency currents when past thru the body cause every molecule to vibrate to their particular periodicity, and this vibration produces secondary effects, notably the release of heat in the tissues and the increase of local blood supply. When an acute infection occurs in any part of the

(*Continued on page* 718)



RADIO DEPARTMENT



Notice to All Radio Readers

As most of our radio readers are undoubtedly aware, the U. S. Government has decided that all Amateur Wireless Stations, whether licensed or unlicensed, or equipt for receiving or transmitting, shall be closed.

This is a very important consideration, especially to those who are readers of THE ELECTRICAL EXPERIMENTER, *for the reason that we desire to continue to publish valuable articles on the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have publisht in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools thruout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment. Remember that you must not connect up radio apparatus to any form of antenna.—The Editors.*

How New York Police Use Radio

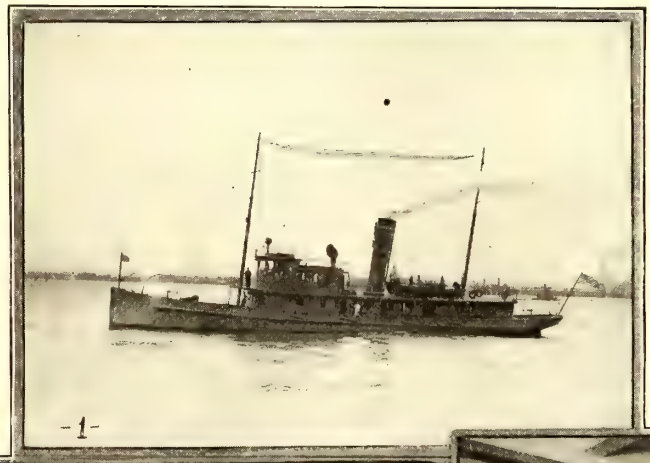
IN the programme of general preparedness instituted by the Police Department of New York City, wireless telegraphy was adopted early in 1916 by Commissioner Woods, as an added means of communication between the different divisions of the Force. As such it is the first instance on record where wireless telegraphy has been brought into use in a municipal department in the world.

Altho the Police Department already had a large private telephone system, the necessity of a dependable means of communication in addition, was realized. Considerable work was done with signal flag and Morse "blinker" light system, and also with portable field telephones, but wireless telegraphy has received the most attention to these various auxiliaries.

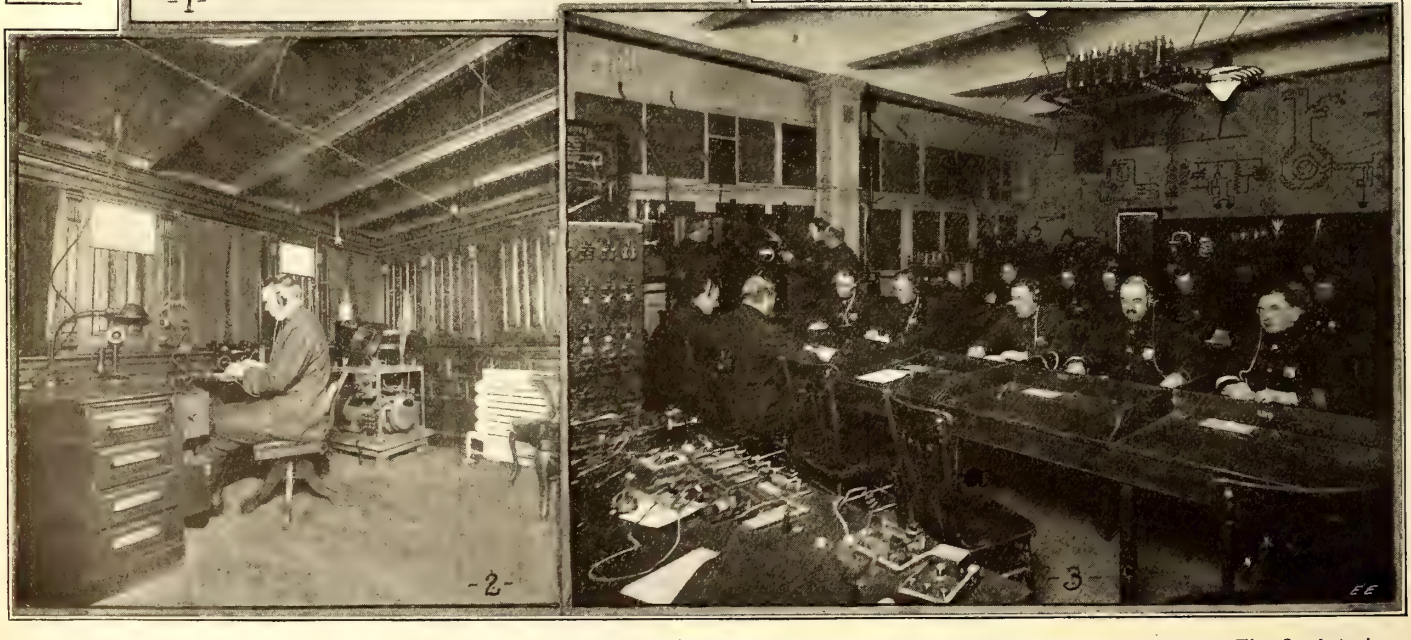
In introducing this part of his plan for police preparedness, Commissioner Woods first establisht a school of instruction in radio work at headquarters, one of the class rooms of the Training School being fitted up with a buzzer system for code practise and with blackboards for demonstration work and circuit diagrams. Sergeant Charles E. Pearce, a member of the uniformed force and a former telegrapher, who has been studying and experimenting with wireless in his spare time for several years, was given charge of the school, and thirty of the members of the department who had had experience in telegraph, telephone or signal work were assigned for the course of study. On completion of the course all past the Federal examination and received licenses as first class radio operators.

High grade commercial wireless equipments were then installed in the headquarters buildings in Manhattan and Brooklyn, and also on the Department steamer "Patrol." This ship is the flag-ship of the

(*Continued on page* 716)



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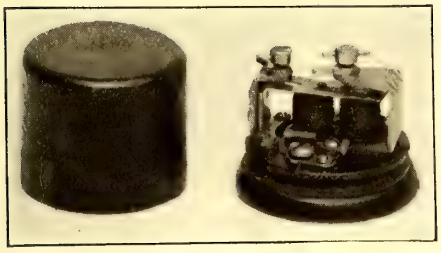
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Fig. 1. The New York Police Boat "Patrol," Fitted with Radio and of Inestimable Service To the Harbor Department. Fig. 2. Interior of Radio Cabin On the "Patrol." Fig. 3. Some of New York's "Finest" Being Taught the Radio Code and Method of Handling the Apparatus.

NEW RADIO BUZZER AND BLINKER KEY.

The new hy-tone radio buzzer here illustrated was designed by a New York radio engineer, Mr. Louis G. Pacent. It is fitted with locking attachments that lock the adjustments after the proper pitch or note is obtained. Once locked the adjustments will not loosen and the note or tone will remain steady until the user wishes to obtain another note.



New Hy-tone Radio Buzzer for Learning the Code and Other Purposes. Has a True 500 Cycle Note, and Tone Is Adjustable.

The common adjusting screw, or the one which is mostly used, is made into a miniature vise; this permits the user to make the necessary adjustments without the use of tools of any description. The special adjusting screw is provided with a slot and needs to be adjusted only in special cases where a larger difference of tone is desired. These buzzers are supplied with this screw adjusted so that the user can easily do his own adjusting with the common screw, for the clear tone mostly used—namely 500 cycles or 1,000 sparks per second.

The base is of Bakelite-Dilecto, an insulating material which affords small losses, will stand any climate and is past by the United States Navy Department. Special hard silver contacts are used which wear evenly and a clear, persistent tone is obtained. The cap is of brass, black enameled and is fastened to the base by a bayonet socket.

The hy-tone radio buzzer has been approved by the United States Navy Department Bureau of Steam Engineering.

It will prove extremely useful for exciting wave meters, inductance bridges, etc., and is ideal for learning the code in conjunction with a telephone receiver.

The "blinker key" is made in conformity with the specifications of the United States Navy Department, and is equipt with Navy standard contacts, which are of sterling silver, ¼ inch in diameter. The key was designed by Mr. Pacent also, and several other models similar to it have been designed for handling heavy radio transformer currents.

These contacts are interchangeable and can be readily replaced when necessary. The lower contact can be removed without disturbing the insulation or fitting holding



Improved Blinker and Radio Key for Handling 110 Volt Currents. Fitted With Shockproof Knob and Heavy Silver Contacts.

it in place so that it is not necessary to remove the key from the base.

A special phosphor bronze current carrying spring is fastened on the base and lever so that the current is carried by this spring and not by the trunnion screws.

The trunnion standards are tapt and threaded to take a bushing which is also tapt but threaded at one end only. The unthreaded ends take the lever trunnions. The bushing is for making the coarse adjustments which are made permanent by means of lock nuts. The threaded end of each bushing is fitted with screw and lock nut making and securing fine adjustments. The advantage of this double adjustment, secured by employing adjustable bushings, prevents the ejectment of the key trunnions from the trunnion sockets and also permits of severe usage without impairment.

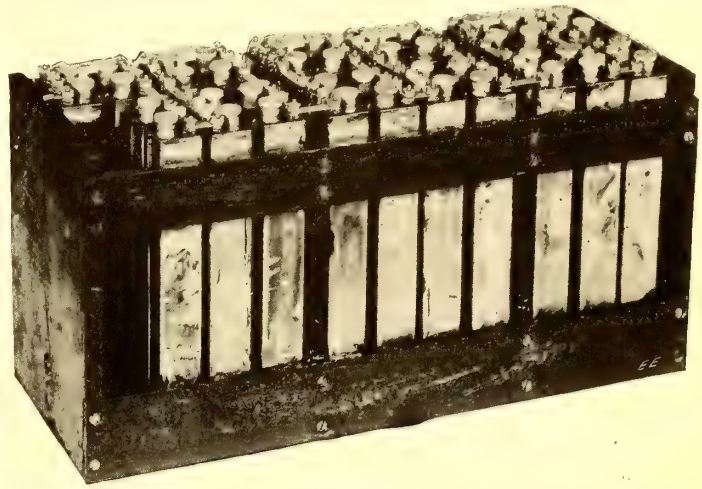
Storage Batteries for Electron Relays

By MILLER REESE HUTCHISON, E.E., Ph.D.

It is a well-known fact that the "wing" circuit of an electron relay or Audion must be energized by a source of electrical energy entirely free from pulsation of electromotive force.

Notwithstanding the splendid work which has been done in "ironing out" the commutator ripples of dynamo electric machines, there are frequent periods when, owing to any one of a number of causes, non-periodic pulsations result, which seriously affect the operation of the relay.

It is for this reason that *batteries,* both primary and secondary, have been satisfactory sources of electrical energy for the wing circuit.



Complete Set of Special Nickel-Iron Storage Cells in Carrier for Use in "Electron Relay" Circuits. The Battery Is Placed in a Steel Case, Fitted with a Folding Lid.

Until recently, batteries of miniature dry cells have been employed and have proven fairly satisfactory when absolutely new ones could be readily obtained from the factories; but such cells have a comparatively short period of usefulness, produce a "frying" sound in the receiver when polarization of the elements occurs, and are relatively expensive because of the necessity of frequent substitution by new ones, etc. These disadvantages are pronounced on shipboard, where the dampness makes the life of such a battery particularly short and uncertain, where the unreliability of any piece of apparatus is emphasized, and where a reserve stock of dry cells cannot be depended upon because of their rapid deterioration at sea, says the author in a recent paper presented before the *Institute of Radio Engineers.* On long cruises this uncertainty is of considerable moment.

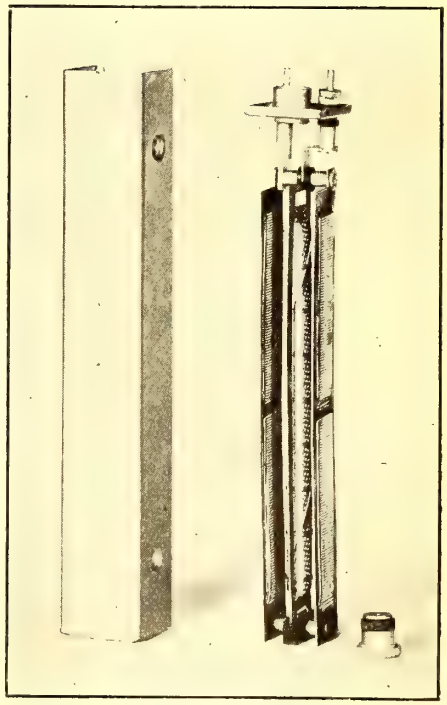
About a year ago, radio engineers and those upon whom devolves the responsibility of maintaining radio apparatus at remote land stations and aboard ship, cast about for a more dependable and more economical battery for this service.

My attention was first called to this demand by Professor Alfred Goldsmith, who, having used storage batteries in the Radio Telegraphic and Telephonic Laboratory of the College of the City of New York, was familiar with their ruggedness and dependability.

A special storage cell was thereupon developed and several batteries of these cells were sent to Professor Goldsmith for an extensive series of tests. After due time and a few minor changes, the commercially available battery appeared, incorporated with a standard size storage battery for heating the filament. Both have proven highly satisfactory in practical service and have been adopted as the standard for electron relay service by at least one Government.

A battery of any kind, for use in radio work, must, above all things, be dependable, even when subjected to the greatest of all abuse—neglect. Of course, when under the eye of a trained battery expert, almost any kind of a storage battery will give good service, if the demand upon it is such as does not necessitate ruggedness; but small units, widely scattered and in the hands of many who may be entirely unskilled in storage battery practise, seldom receive more attention than an occasional charge (which may be a prolonged overcharge at excessively high rates), and the

(*Continued on page* 722)

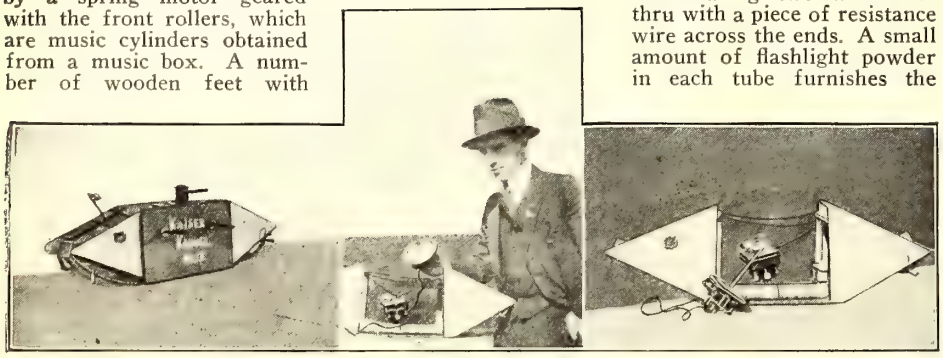


Parts of New Nickel-Iron Light Weight Storage Cell for Use in "Electron Relay" Wing Circuits.

A Radio-Controlled "Tank"

By FRANK COPERMAN

Much can be accomplisht in the art of radio-telemechanics by the aid of simple apparatus found in the experimenter's laboratory. The photos show a model radio-controlled "Tank." The frame and cover are constructed of wood, reinforced by cross wires. It is propelled by a spring motor geared with the front rollers, which are music cylinders obtained from a music box. A number of wooden feet with twisted braid on each side make up the caterpillar belts. The points on the rollers grasp the braid and carry the belt around without slippage. The belts are set on a slant so that the Tank travels in a large circle.



An Interesting Radio-Controlled "Tank" Which Fires Several Cannons and Ambles Along Just Like the Real Ones, Which the "Tommies" Are Using.

An electro-magnet to each side of the brake on the spring motor serve to throw it on and off. The coherer and de-coherer are mounted on the base of a 150 ohm relay; this in turn is suspended upside down in the center of the tank; coiled springs on each side keep it from swaying. The selective control is novel, as only one press on the key is needed to start and stop the tank or fire any one of the five guns at will. A circular piece of cardboard (see diagram) with several curved contacts, cut from copper strip, mounted as shown, is fastened over the dial of a clock-work from which the balance wheel has been removed. The minute hand is replaced by a copper strip; this moves over the contacts with moderate friction. A rod with a tin "flag" to serve as a pointer is mounted along with the copper strip as shown in the diagram. This clockwork switch is mounted in the rear end of the tank with the tin flag projecting up between the belts. The cross wires and a two foot chain pulled along behind serve as antennae to pick up the waves sent from a two-inch spark coil, untuned transmitting set.

When the clock-work switch is wound, the flag slowly revolves. If the key is closed just as the flag points over contact No. 1 the tank will start off. When the flag reaches contact No. 7 a press on the key will bring the tank to a standstill. Over any other contact a press will fire one of the guns which are brass tubes plugged at one end with a cork having two wires run thru with a piece of resistance wire across the ends. A small amount of flashlight powder in each tube furnishes the "bang." This "Tank" answers to the name of "Kaiser Kanner No. 13."

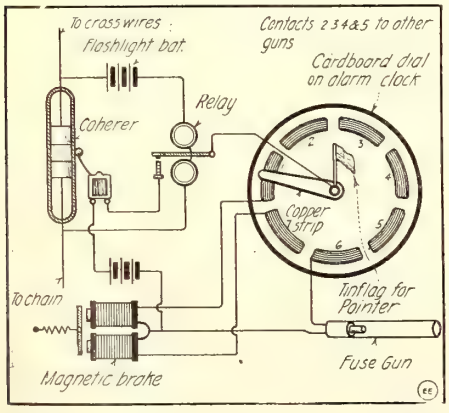


Diagram of Connections Used in Miniature Radio-Controlled "Tank"—An Interesting Model Which Every Radio-Bug Will Want To Build.

NON-RADIO COMMUNICATION SCHEME DON'T WORK?

One of the readers of the ELECTRICAL EXPERIMENTER recently complained that he had tried the ground circuit non-radio communication scheme suggested by Mr. E. T. Jones in the Sept., 1917, issue, and that it would not work.

We referred the matter to Mr. Jones, who replied to the querist as follows:

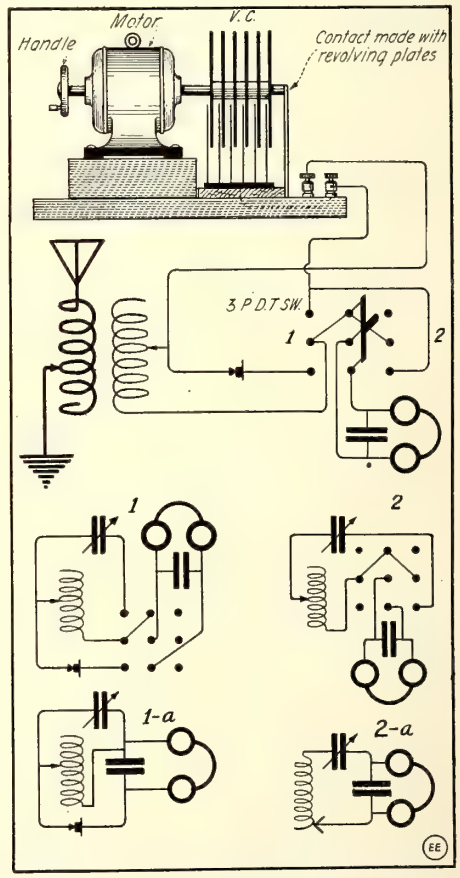
"Your letter of 12th regarding my non-radio communication system, has been handed to me by the ELECTRICAL EXPERIMENTER and I am indeed sorry to learn of your unsuccessful attempts to communicate with your friend. I will endeavor to throw some light on the subject in order that you may try this system again.

"The condensers must be of large capacity, in fact not smaller than 1 MF, furthermore you state that you are using 75 ohm phones, in this respect I may say that these phones are not sensitive enough to pick up the disturbance caused by the buzzer at the other end. I am using 2000 ohm phones with my set. Also notice that you have the three wire system, while this should not make any difference, so long as the middle wire is accepted as the grounded side, but it may be to some advantage to try both of the outside wires; that is at different intervals; try it on the other ungrounded wire instead of the one now employed. If after trying this you do not hear signals cut two lamps in series parallel, thus allowing more current to flow thru the buzzer circuit. Should this prove of no avail, then your friend must either be on a different circuit (where no metallic connection whatever is made between your house and his) or his or your apparatus is not properly connected, as no one here has had any trouble whatsoever with this system; I have worked as far as thirteen city blocks. I hope that you will obtain the desired results now."

USING THE ROTARY CONDENSER TO RECEIVE UNDAMPED WAVES.

Having noticed your special request in the last few editions for articles treating on "Wireless Subjects," I herewith submit a practical way to receive *Undamped Waves*, based on the recent Patent No. 1,233,841, printed in the "Patent Department" of THE ELECTRICAL EXPERIMENTER. Mr. Elmer E. Bucher is the owner of the above mentioned patent. As yet I have not seen in print anything referring to the reception of undamped waves using this system.

The principle of the arrangement is to have a condenser (variable) either geared or belted to a motor, which rotates the movable plates at a uniform rate of speed. Thus the capacity rises from *Zero to Maximum*, and then starts over again after having returned to the zero mark. Mr. Bucher states that this system is applicable to both spark and arc systems, but as far as I have succeeded, strong spark signals were the only ones of this character received. It works admirably well in connection with the reception of undamped waves. Owing to the above conditions, I have arranged connections which allow this condenser to be used in receiving undamped waves in its proper place (in series with the receiving circuit, same as the *tikker*), but for damped waves, as indicated in diagram, the three-pole double-throw switch is thrown in position—1. This allows the condenser to be used as the SHUNT CONDENSER across the secondary of the loose coupler, and in this position the ordinary connections used for the reception of spark signals is had. Now, when the switch is thrown over on the other side (position 2) this SHUNT CONDENSER is thrown in series with the secondary, fixt condenser, and 'phones in which position the set is ready to receive undamped waves. Of course the motor is started and the condenser plates made to revolve.



Various Hook-Ups Used With Bucher Rotary Condenser Scheme For Receiving Undamped Waves.

There is a lot more of experimenting to be done along these lines as this is an entirely new field pertaining to the reception of undamped waves.

Contributed by E. T. JONES.
(Chief Electrician-Radio, U. S. N. R. F.)

The How and Why of Radio Apparatus

By H. WINFIELD SECOR, Assoc. I. R. E.

No. 6—Radio Receiving Tuners.

From time to time we will describe one particular instrument used in either the radio transmitting or receiving set, explaining just how it works, and why. We have received so many requests from new readers asking for such explanations, that we have decided to publish this matter in serial form. In the course of several issues all of the principal transmitting and receiving apparatus will have been covered. The subject for the sixth paper is RADIO RECEIVING TUNERS.

THE tuning of incoming radio messages is accomplisht thru some form of inductance coil or coils. The simplest tuned circuit involves the use of a *tuning coil;* as shown in Fig. 1, this comprises a single layer of wire wound on a hard rubber, fiber or other stable, insulating tube and which has an air core. The number of turns in use at any time is adjustable by virtue of movable sliders or else by multi-point switches connected up to equally spaced sections of the coil.

The hook-up, Fig. 1, shows what is known as an *auto-transformer* connection; *i.e.,* the single coil acts as both primary and secondary simultaneously. The aerial tuning circuit is formed thru lead-in, inductance, slider B, and so to ground. The closed oscillating or detector circuit is composed of the detector, slider C, inductance between C and D, slider D, and fixt condenser F.C. The telephone receivers are shunted across the fixt condenser. The 'phones are sometimes connected across the detector as indicated by the dotted lines. The former hook-up is usually preferable, especially where the capacity FC is variable, either gradually or in steps. The magnetic field set up within the inductance coil is shown by the dotted lines. It is possible to obtain higher or lower potential in the detector circuit C D, as compared to that existing in the primary by simply arranging the sliders C and D to embrace more or less turns than are in use in the primary circuit at any instant. High wave lengths are tuned in by connecting a variable condenser across the secondary sliders C and D, and also in some cases across the aerial and ground inductance terminals, depending upon the amount of inductance and capacity in the antenna. To tune in short waves, shorter than the fundamental period of the antenna circuit, it becomes necessary to insert a variable condenser in series with the ground lead as indicated at X. This reduces the capacity of the aerial circuit in accordance with the formula for the joint capacity of two or more condensers connected in series:

$$Cj = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2}};$$

where Cj is the total or joint capacity and C_1 and C_2 are the respective capacities connected in series.

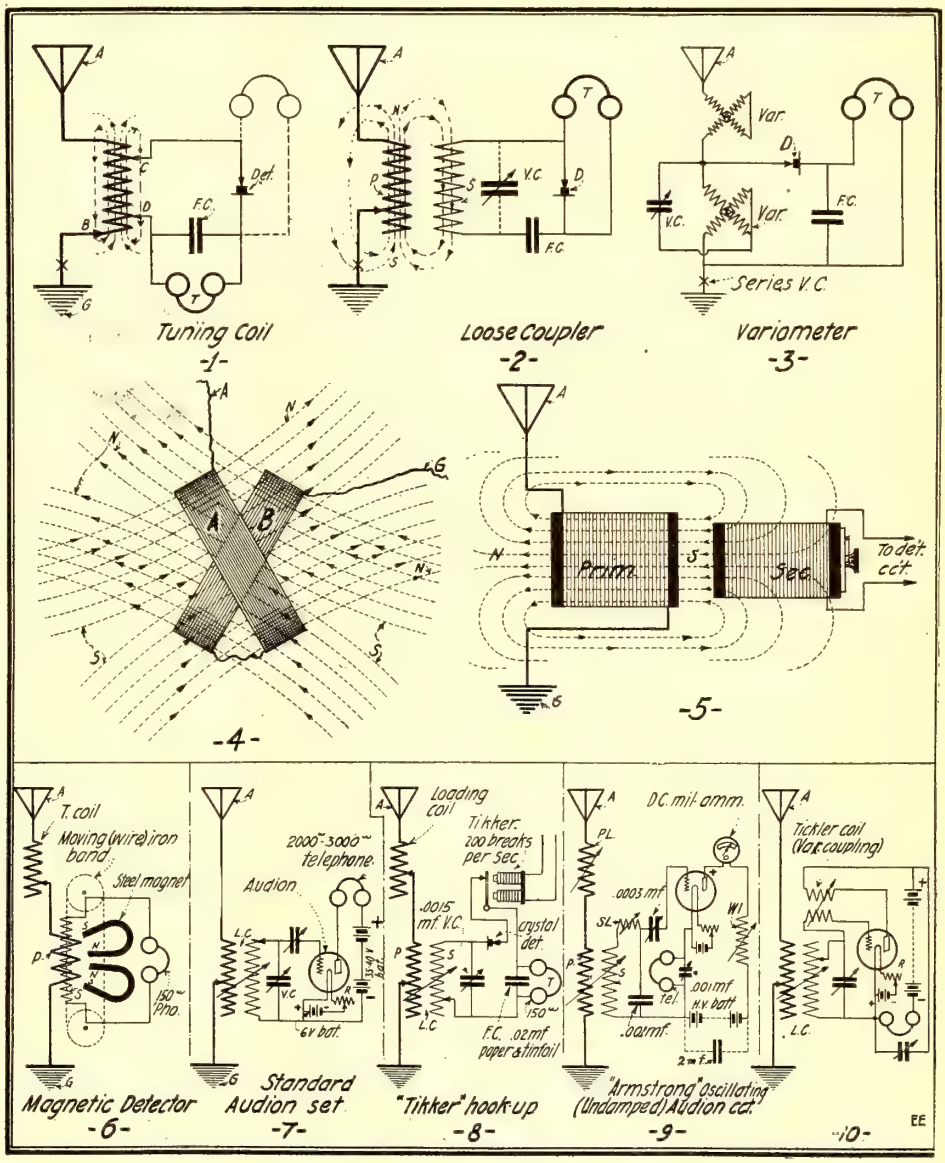
The received signal current taken off in the detector circuit at C D passes thru the crystal or other detector and fixt or *blocking* condenser as shown. The crystal detector acts as a rectifier of the high frequency incoming oscillations, and the signals are heard in the 'phones.

Fig. 2 illustrates a two-coil coupling transformer or *loose coupler* as it is called in radio parlance. The primary winding is connected to aerial and ground, and is thus energized by the aerial oscillations. The oscillating magnetic field thus set up induces a similar current in the secondary which acts upon the detector and 'phones. Usually, a variable condenser is connected across the secondary coil to enable the operator to tune this circuit in syntony with the primary oscillatory circuit, with regard to frequency and wave length.

Fig. 3 shows a typical receiving circuit employing two *variometers;* one in series with the aerial lead-in to act as a *loading coil,* the other acting as a means of transferring the aerial circuit energy to the detector circuit in the manner apparent.

The variometer is a very efficient tuning instrument and acts upon a unique principle. This action is outlined at Fig. 4. Simply exprest, the variometer changes the inductance in the circuit by the reaction between the magnetic field of the primary and secondary. The complete variometer comprises two short cylindrical coils (sometimes spherically wound) with the inner and smaller diameter coil pivotally mounted within the larger stationary coil. The inner coil is connected in series with the outer one and can be revolved about its axle thru 180 degrees. Now, when in one concentric position, the two coils are connected so that their magnetic fields *oppose,* the inductance of the variometer is practically zero. If the inner coil is then turned on its axle, the inductance will gradually increase and maximum inductance obtained when the inner coil has revolved 180 degrees; *i.e.,* when this coil has completely changed sides with respect to the outer coil. This effect is readily understood from the diagram Fig. 4. The dotted lines show the magnetic field due to the outer coil "A," as well as the resultant electro-magnetic field produced by the inner coil "B." As becomes evident in the relative position of the two coils here shown, a considerable portion of the North and South magnetic field due to coil "A" is neutralized or counteracted by the South and North poles of coil "B." When coils "A" and "B" are turned until their faces align with their N. and S. poles coinciding, then it is seen how the one magnetic field will completely

(*Continued on page* 729)

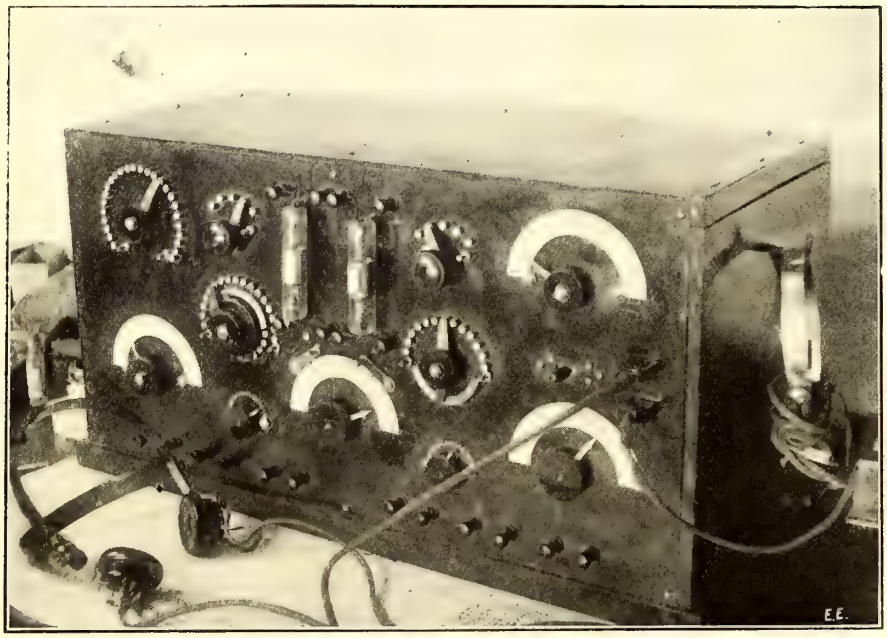


The Diagrams Above Show All the Principal Radio Receiving Circuits, Including the Arrangements for Employing Tuning Coils, Loose Couplers and Variometers. Circuits for Both Damped and Undamped Wave Reception Are Given.

Detail Construction of a Damped and Undamped Wave Receptor

By F. MacMURPHY

DURING the past year I have been studying different forms of receivers for different uses and have finally arrived at the conclusion that I have as efficient a receiver for practically all uses as can be obtained at a fair price. The set about to be described is suitable for the reception of both spark, arc and high frequency alternator stations. Credit is due Mr. A. S. Blatterman's article in this Journal for suggestions made relative to this station. No greater mistake could be made by the amateur experimenter than to try to build a receiver of this type suitable for damped, as well as undamped waves, without first having a definite and sure knowledge of the principles involved, as failure will surely follow. If the receiver is to be used to receive the high-powered stations in Germany and Honolulu for example (after the war, to be sure), then it must be very carefully proportioned and thoroly understood.



Appearance of Finished Damped and Undamped Valve Receptor. It is of the Cabinet Type and is Both Efficient and Attractive.

In the accompanying diagram (Fig. 1) is shown the general design of the panel compartment. The Cabinet is made of mahogany and has a Bakelite panel 24 inches by 12 inches, ¼ inch thick, fitted into it, as shown in the figure. Tubular Audion bulbs were used in practise and sockets were substituted by four binding posts as shown in Fig. 2. This figure gives the detail dimensions of all the panel mountings; while Fig. 2A gives the side view of the cabinet showing how the panel is fitted.

Interior of Cabinet (Condensers).

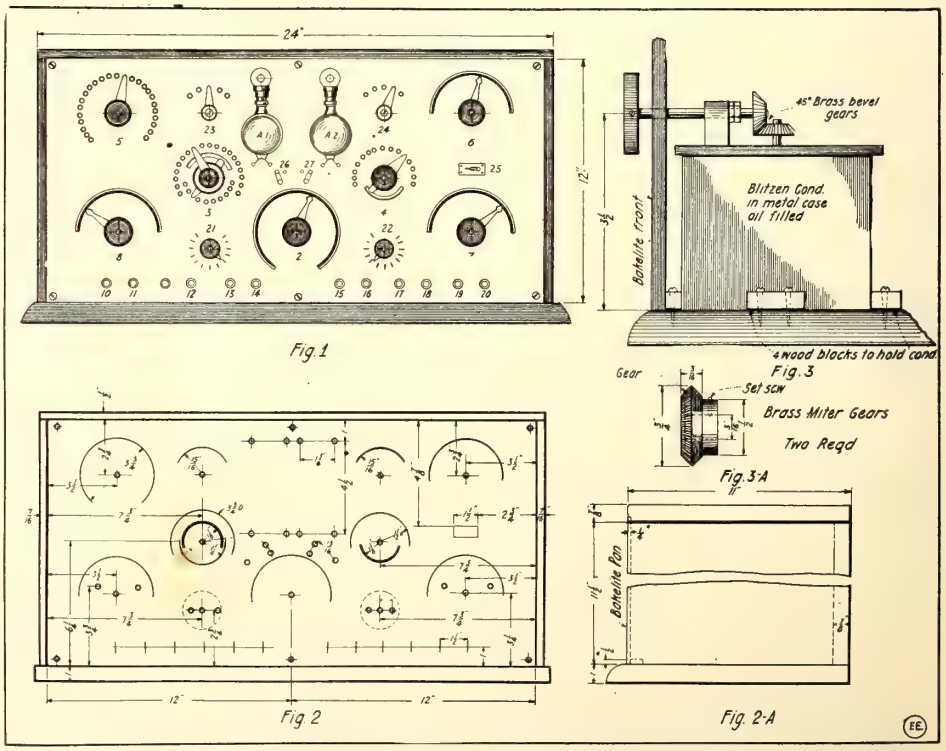
Figure 3 gives the details of the mounting of condenser No. 7. Two brass miter gears are used to work the shaft. Into the horizontal gear is fitted either by threads or set screw a rod threaded 8/32 by ¼ inch long. A brass rod, ½ inch square by 1¼ inches long, has a hole bored into it 3/16 inch in diameter to allow the rod to enter. This rod has a few threads on one end so as to allow the small threaded rod in the horizontal gear to be held together by the lock nuts. These lock nuts must be soldered together after the mounting is complete, to insure stability. Four wooden blocks hold the condenser to the base of the panel.

Figure 4 gives the details of the condenser mountings 6 and 8 as numbered, while Fig. 5 gives the details for the condenser bolts used in the above named condensers. The collars used on these condensers are ⅜ inch in diameter and are made by centering a ½-inch round brass rod in a lathe and drilling a 3/16-inch hole by means of a drill press chuck, fitted into the lathe tail-stock in place of the center. All the other collars are made in this same manner. A fine cutting tool can be used to cut the rod down a short way, after which a hack saw must be substituted. Be sure and keep the lathe in motion while the sawing is being done; otherwise a square cut cannot be obtained. In mounting these condensers to the panel, proceed as follows:—On the Blitzen condensers there are three screws which hold the stationary plates to the rubber top. Remove the two end ones and in their place fit 8/32 threaded rod which has one end threaded 6/32. Obtain a 6/32 threaded nut and and screw this on to that part of the rod threaded 6/32. Then it is only necessary to screw that part of the rod into one of the holes from which the original was taken. The nut acts as a lock to hold the condenser firmly to its top. The entire length of this threaded rod should be 1⅛ inches. If this form of fastening is used, the collars do not have to be but ½ inch in length. Two bolts threaded 8/32 by 1 inch in length are needed for the mounting of each condenser.

Rheostats.

The mountings for the rheostats are clearly given in Figure 6. The switch arm originally on the rheostat is taken off and connections made to a new shaft threaded 10/24. This shaft is 1¾ inches long. The collars on these rheostats are ½ inch high and are made in the same manner as given under "Condensers." Two brass machine bolts 1 inch long threaded 8/32 are needed for the mounting of each rheostat.

The detail mountings of switch 3, is given in Figure 7. This shaft is threaded 14/24 and is 2¼ inches long. It is necessary to drill a hole in the units switch arm considerably larger so as not to make contact with the shaft. Figure 8 gives the switch arm details which shows the brass sector needed for switches 3 and 4. The other switch details are given by Figures 10, 11 and 12. Instead of using small washers



Front View of Radio Receptor Cabinet, Showing Dimensions for Drilling Holes for Various Switches, Etc. Also Detail of Knob on Variable Condenser.

next to the back side of the panel, I prefer to drill a 3/16 inch hole in a small piece of brass sheeting ½ inch wide by about ¾ inch long as the wire connection can be soldered to the same much easier than by using small washers.

Inductance Coils.

The coil No. 3 or the primary is wound on a tube 4¾ inches in diameter by 6 inches long, with No. 26 D.C.C. wire. Fifteen taps of 10 turns each are taken off, as well as 10 taps of one turn each, for the units section of the Switch 3. The secondary coil No. 4, is wound on a tube 4¼ inches by 5 inches and contains a winding length of 4½ inches of No. 28 D.C.C. wire with 12 taps taken off. As it will be noted in the wiring diagram (Fig. 15), there is a *coupling coil* numbered 34, which is not contained in the cabinet. The outside coil of this coupler is 4½ inches in diameter by 6 inches long, wound full with No. 28 D.S.C. wire, and the inner coil is 4 inches in diameter by 6 inches long, wound with the same wire the full length of the coil. These coils are to be mounted on a separate base and arranged to slide in and out of one another. It should be possible to separate them about 2 inches. The Switch 35, shown in the diagram, can best be mounted on this base. The coil No. 5 is 6 inches in diameter and 11 inches long and is wound with No. 32 D.S.C. wire having 25 taps taken off. Figure 13 gives the necessary facts to be used in constructing the small loose coupler No. 2. In the construction of this coupler be sure and drill the holes in the wooden drum and in the support, as well as in the panel, larger than is necessary, since if a tight fit is obtained, trouble will be experienced with the nuts turning.

Conclusion.

A top view of the cabinet showing the method of placing some of the apparatus in the cabinet is given by Figure 14.

If the wiring diagram as shown in Figure 16 is used, it is necessary to obtain a "Blitzen" *amplifying coil,* while if the diagram as shown in Figure 15 is used, the auto-transformer can be constructed as follows:—A core 2 inches in diameter by 14 inches in length consisting of a bundle of very soft iron wires is wound with several layers of No. 34 S. S. C. wire. About 5 pounds of this wire will be necessary.

The condenser No. 28 should consist of two sheets of tin foil 2 inches by 3 inches separated by a piece of paraffined paper. The coupler No. 30 and 31 have the following dimensions. Winding length 12 inches, diameter 7⅞ inches, wound with No. 30 D. S. C. wire for the primary coil No. 30, while coil No. 31, the secondary has a winding length of 12 inches, diameter 6⅞ inches, wound with No. 32 D. S. C. wire. The primary has 25 taps, while the secondary has 18 taps taken off. It should be possible to separate them about 9 inches. The author's transformer is capable of being separated over 12 inches. Such loose coupling is quite imperative when receiving waves of the order of 6,000 meters to 12,000 meters. The "Cambridge" tuner is almost identical in construction to the one just described.

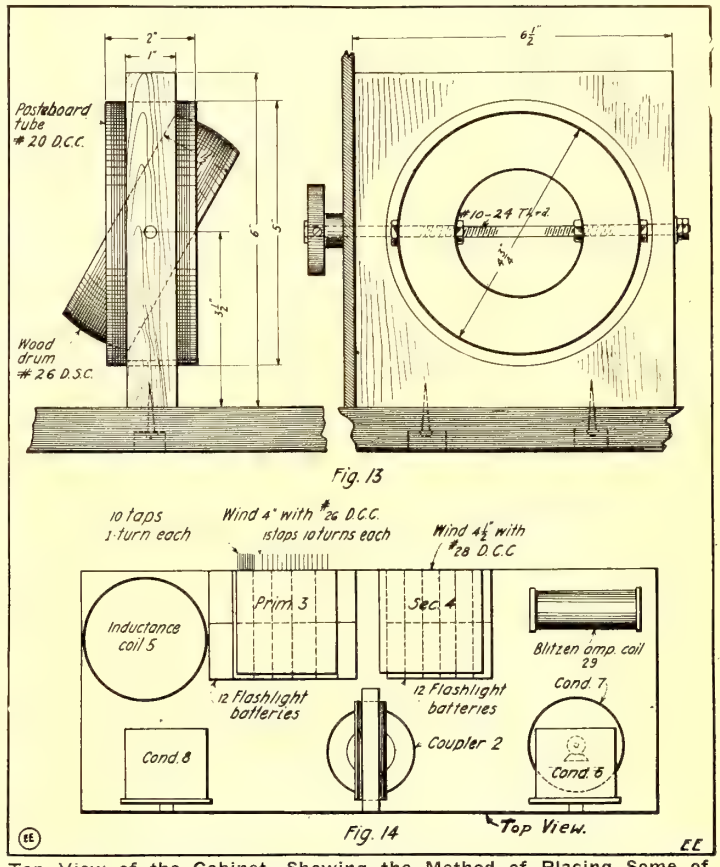
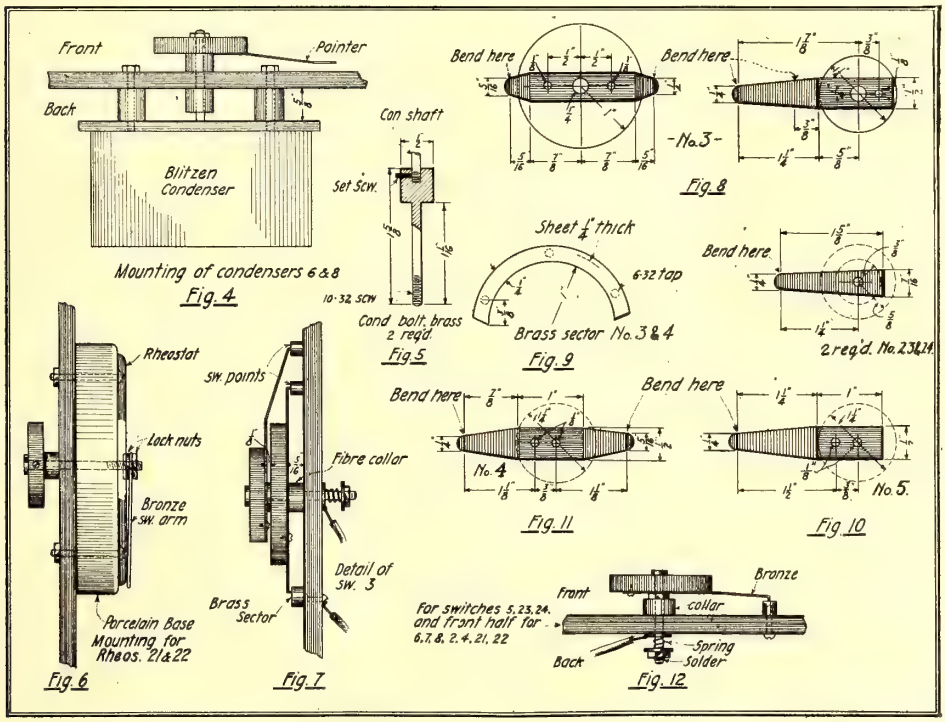


Fig. 13 Fig. 14

Top View of the Cabinet, Showing the Method of Placing Some of the Apparatus, Including Variometer Type Coupler.

The general idea involved in receiving sustained waves by the *heterodyne* or *beat* principle is to introduce into the receiving circuit a second or superimposed sustained, oscillating current of radio-frequency. These sustained waves are obtained from a sustained high-frequency generator at the receiving station. By obtaining a frequency of this local oscillation slightly different from the oscillation arriving, the two will interact, and produce a *beat* frequency which may be made quite low, and quite within the audible limits. This so-called beat frequency is then the difference be-

(*Continued on page* 720)



Various Details of Switch Parts, Variable Condenser Mountings, Rheostat Support, Etc. No Iron Screws Should Be Used in the Construction of This Receiving Set. Use Brass Instead.

HOW TO REMEMBER 3.14159

To some people the following dodge will doubtless prove useful. The factor 3.14159 is in constant use for obtaining the circumference of a circle (when multiplied by the diameter) and for other purposes. Those who cannot remember the figures in their proper order will find it much easier to memorize the sentence "Now I hope I shall recollect." The words in this sentence represent the figures by the number of letters they contain, thus—

3. 1 4 1 5 9
Now I hope I shall recollect

One-fourth of the above numbers, viz.: .7854, is also in frequent use for finding the areas of circle, etc., and may be committed to memory by means of the sentence—

.7 8 5 4
Squared diameter finds area

Contributed by H. J. GRAY.

AUTHORS!!!

All matter intended for publication—not only by us, but by any other magazine or newspaper as well—should be written on one side of the paper only and in ink. If it isn't, somebody else must copy part of it off on another sheet before it is given to the printer.

THE CONSTRUCTOR



Experimental Mechanics

By SAMUEL COHEN

LESSON II.

THE LATHE

THE lathe, the topic for this lesson, is the most important tool in the work-shop, and if one becomes a thoro master of this tool, he is practically a master of most of the tools used in modern machine shops. On the other hand, if an individual is thoroly familiar with another machine such as a drill-press, milling machine, etc., he would be entirely lost when placed before a modern lathe, the reason being that the lathe embodies practically all the fundamental operations of all other machine tools. It is for this reason that the author advises the novice to become as expert on the lathe as he possibly can.



Fig. 3. A "Turning Operation"—The Piece Being Machined is Held Between the "Live" and "Dead" Centers and Driven By Means of a "Dog" Attached to the Face Plate. About the First Job Lathe Hands Tackle.

Since the lathe is of such importance in the shop, the writer will endeavor to show the experimenter how he can utilize it for many purposes other than the turning of wood or metal. Eventually he will find that he can produce a great variety of work with this single machine by the aid of certain attachments which otherwise would require several individual machines.

Some of the work which can be satisfactorily carried out with a lathe provided with the proper attachments are:—drilling, grinding, screw cutting, milling and tapering. It is therefore clearly seen that by acquiring the necessary tools for an engine lathe, a complete machine shop can be had with that individual machine. At the beginning of this course the writer discust the manner of selecting and purchasing a lathe. Now for the sake of argument let us consider that we have decided upon and obtained the type of machine desired. Further, let us assume that the machine is a nine-inch swing screw-cutting engine lathe. When receiving the machine carefully unpack the crating and see that every part is shipt with the equipment. Usually a price list containing all the parts that are included in the set is given and it is advisable to check them up with the parts sent with the lathe.

When unwrapping the lathe it will be seen that the bright parts of the machine are thoroly covered with heavy grease in order to prevent rusting. To remove this grease use a rag that has been dipt in kerosene (or gasoline), then wipe the parts dry. Clean all the gears and the various other movable parts.

The next consideration is the location of the lathe and there are several factors entering into this problem, viz:—space available; position of driving shaft and the direction of the light. The first and second factors are left entirely to the amateur, while for the third it is advisable that the light for the lathe shall enter over the right shoulder of the operator in order to obtain best results. It is very important that proper illumination should be obtained if accurate and delicate work is to be carried out.

The foundation underneath the lathe should be very rigid and care should be taken to see that no shaking can occur when the machine is running.

Before delving into the workings of a lathe let us acquire some fundamentals with respect to this valuable machine. There are various forms of lathes, each of which have their particular value. 1—The first and most common one is the foot-lathe, which by its name signifies that the revolving member is driven by means of a foot treadle. 2—A hand-lathe; one which has no means of controlling the cutting tool by means of the operator's hand. 3—Self-acting lathe; one which has an attachment to hold the cutting tool and permitting said tool to travel and be fed across the lathe bed both transversely and laterally. This arrangement is found in practically all screw-cutting engine lathes.

For the benefit of those who are not familiar with the various parts of the lathe the skeleton drawing and its corresponding key shown herewith gives the proper names of the most important parts of the machine. (See Fig. 1.) This shows a standard screw-cutting engine lathe.

The next consideration in regards to the lathe is to make a suitable foundation for it and it is essential that the lathe be securely fastened to the floor. If it is to be secured where sound flooring is not available, it is advisable to thoroly strengthen the floor by bracing in order to prevent as much as possible any vibration when the lathe is in operation. The lathe should be carefully leveled up with an accurate spirit level. The levels should be placed across the width near the head stock. Several measurements at different points along the entire length of the bed should be taken in order to see that every point is properly leveled. The *counter-shaft* should be fastened in a position so that the belt between the pulleys of the counter-shaft and the lathe are in exact line. It is necessary that the axis of the lathe spindle be parallel to that of the counter-shaft. It is, of course, not necessary that the lathe spindle be directly underneath the counter-shaft. It can be from five to fifteen inches on either side, and a great deal of judgment must be exercised by the experimenter in this direction.

As soon as the counter-shaft and the spindle cones are in proper position so that the belts will run properly, fasten the lathe firmly, using lag bolts.

A few words relative to belts will be of value especially to the novice. Leather belting is always recommended. When belting the counter-shaft to the line shaft two belts are always used. The belt nearest the head end of the lathe is usually

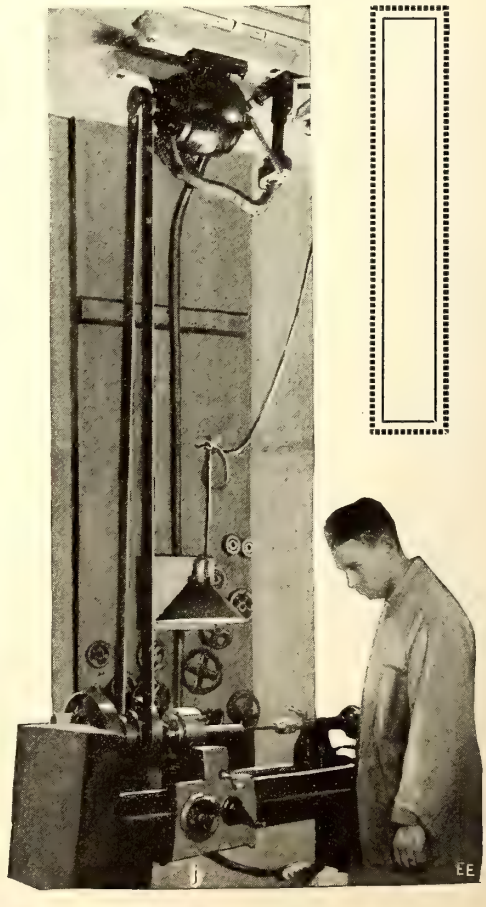


Fig. 4. A Good View of Actual Lathe Installation Equipt With Motor Drive. A Drilling Operation is Shown, the Drill Being Held In Tail Stock Chuck.

made straight. The other is reversed or a crost belt. The counter-shaft belt should be so arranged that when the shipper rod (the rod for changing the belt from the loose to the tight pulley) is thrown over in the direction of the lathe head spindle, the lathe will revolve so that the top of the spindle runs toward the operator when he is in front of the machine. The smooth side of the leather belt should be placed next to the pulley. The reason the belt is made smooth at one side is that in passing over the pulley there will be no air pockets. It is advisable to dress the belt frequently by means of a good belt dressing, in order that the flexibility of the belt may be retained and also to prevent slipping. In lining up two pulleys, such as those on a lathe and counter-shaft, it is the usual practise to use a piece of chalk-line. This cord is stretched taut and held against the outside edges of the pulley rims and the machine shifted until the line touches at four points, *i.e.*, both front and rear edges of both pulley rims. Pulleys of unequal face widths can be lined up thus and the narrower one reset afterward by measurement.

Having belted the lathe to the counter-shaft and secured the driving motor in its proper position, the next and most important thing is to go over carefully the various parts of the machine, and see that all the parts function properly. Every oil hole should be located and a generous supply of good quality machine oil poured in them, covering each revolving part, not only to give it a necessary oiling but to make sure that any dust or dirt in the bearings will be washed out.

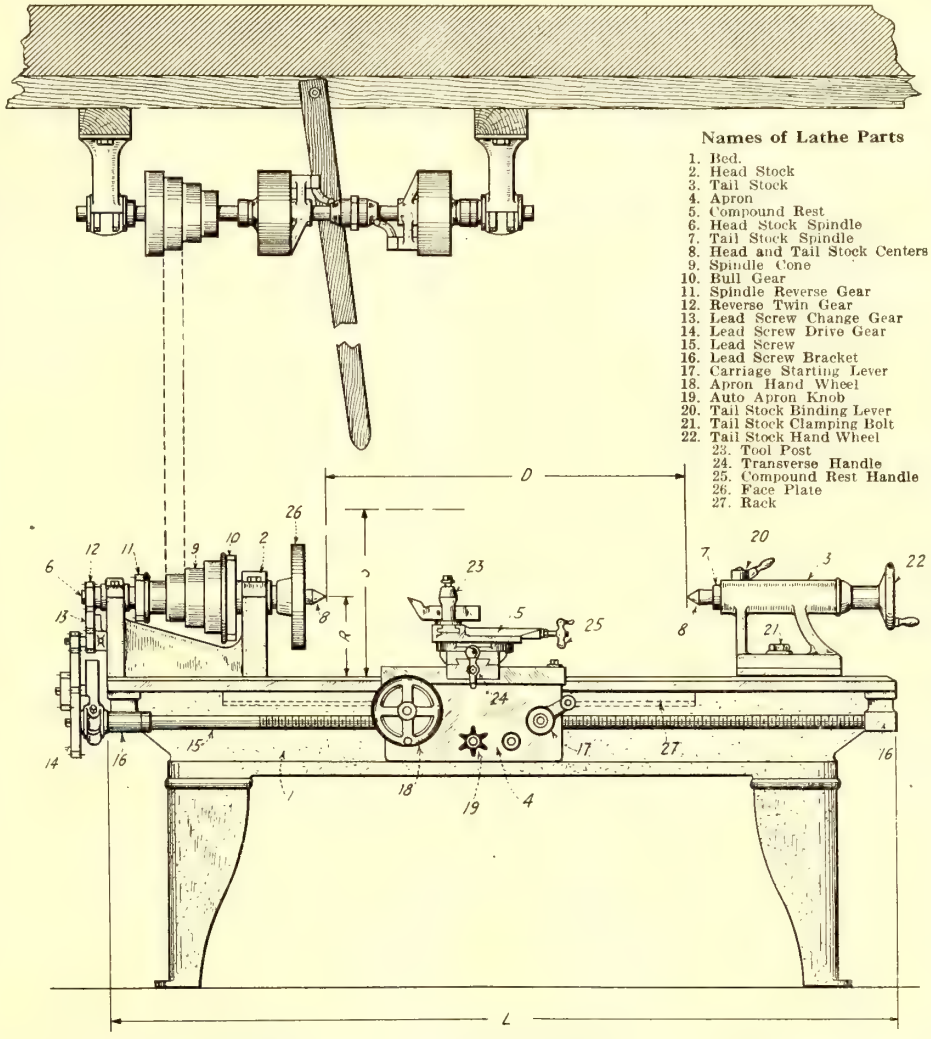


Fig. 1. This View of a Modern Lathe Shows All the Principal Parts With Their Names, As Well As the Counter-shaft With Belt Shift and Clutch Pulley.

A great deal of attention should be exercised in seeing that all the parts in the head stock spindle and the mechanism in apron and the lead-screw bearings are well oiled. It is advisable that the lathe should be gone over at least once a day to see that every revolving part is properly oiled.

We are now ready to start the lathe and before starting see that the shipper rod is properly adjusted. See that the spindle cone bearings are properly adjusted, so that the spindle can be revolved easily by hand or by means of the back gear. Then test the back gear connection with the gear clamp, and see that the spindle runs when the back gear is thrown into action.

A very good arrangement of the gears and the lathe in general is shown in Fig. 2. This is a standard 9-inch lathe, and it is this type of lathe that the author recommends the amateur to purchase. The gears are properly protected by means of a box made from tin or sheet iron. The various reduction gears are secured to a board on the wall. This lathe is driven by means of an electric motor, which is hung from the ceiling. The motor is rated at 110 volts, ¼ horse power, direct current. The various speeds are obtained by controlling the power supplied to this motor, and this controller is stationed underneath the lathe. This is very clearly seen in Fig. 2, at the lower right hand corner. The controller is operated by a foot treadle. The switch panel as seen contains two switches, one, the main control switch, and the other the *reversing* switch. This arrangement is very satisfactory, and is strongly recommend to the amateur, this scheme providing great flexibility.

The novice is advised to carefully study the manner in which the motor is mounted. Note the two small beams on which the

(*Continued on page* 717)

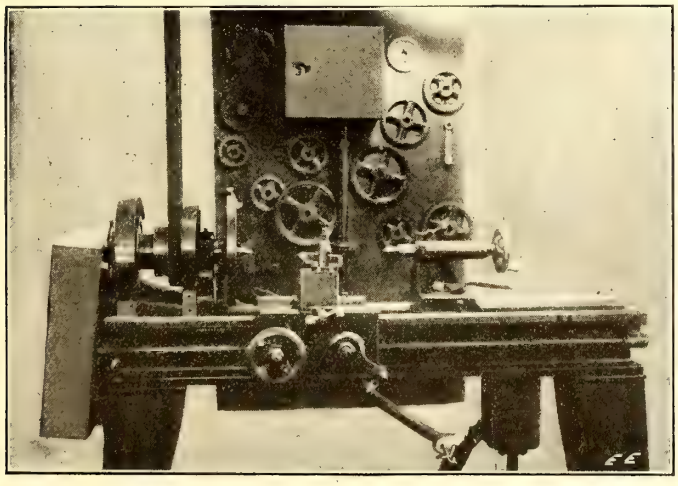


Fig. 2. General View of Lathe With Protected Gears (Left) and Foot Controlled Rheostat. An Efficient Arrangement.

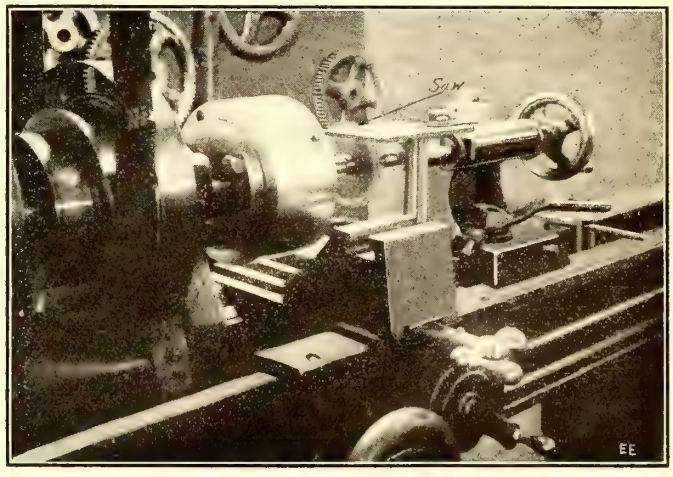
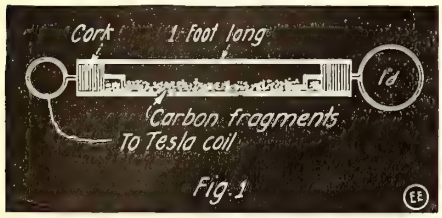


Fig. 5. This illustrates How the Amateur Can Rig Up a Circular Saw and Table On His Lathe.

High Frequency Phenomena and Experiments

By FREDERICK VON LICHTENOW

EXPERIMENTAL electricity in its various phases has always held an unresistable fascination for me. Under its captivating influence I find myself experimenting thruout the year, whenever time allows this, ever



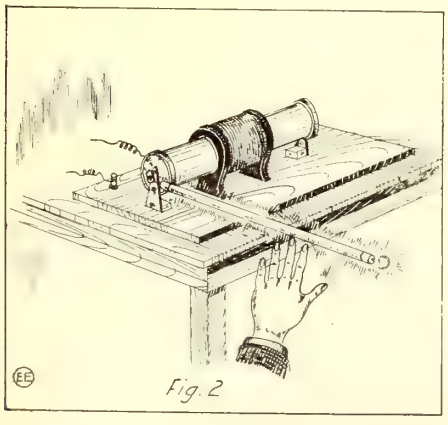
The High Frequency "Spark Tube"—It Comprises a Glass Tube Partially Filled with Powdered Carbon. It Is Charged by "Unipolar" Current from a Tesla Coil.

in search for the unknown trail leading to some new wonderland of electrical manifestations. This trail is exceedingly hard to find, not to speak of the wonderland beyond, in the shape of a "new discovery" The principles underlying the thousands of tried experiments are known to science; and in order to present something perfectly new, the principle involved must at the same time be a novel one. I have not succeeded that far, sorry to say, and the few experiments given here may be original only in the way in which they are offered. From a practical or mechanical standpoint they are worthless; in fact, they would cease to be experiments with the moment they could be put to a practical use.

EXPERIMENT No. 1.

A tube of glass about a foot long and one-half inch in diameter is filled with enough small fragments of carbon (those taken from an ordinary lead pencil or arc light carbon suffice) so that they cover its lower surface completely, when placed flat on the table. The openings at both ends of the tube are plugged up with corks, thru the centers of which short ends of brass or copper wire are inserted in order to make connection with the carbon particles. The outward protruding ends are shaped into rings, preferably soldered at the joints, (see Fig. 1). The smaller ring connects to one secondary post of the Tesla coil, while the larger one supports, and at the same time "grounds," the tube on the table.

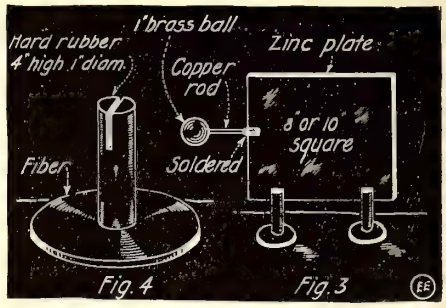
As indicated already *unipolar* current is employed. When the current passes, wonderfully blue-white sparks run in a steady stream over the carbon fragments, illuminating the whole tube, while the larger ring sends off a spray of violet light on its lower curve. Upon approaching the tube with the hand, fingers spread apart, violet streamers, accompanied by a sizzling noise, can be drawn thru the glass into each extended finger, (Fig. 2). The length of these streaming sparks depends naturally on the electrical output of the generating set used. With only a 1½ inch "Bulldog" spark coil and a standard "Electro" Tesla transformer of the same make, together with the proper condenser capacity and a spark gap provided with long, sharply pointed zinc electrodes, I was able to draw sparks one inch in length which were visible in a lighted room. However, the beauty of this experiment can be appreciated to the fullest in perfect darkness only, when the actual length of the sparks, which are really considerably longer, may be ascertained. To heighten the effect, the spark gap should be darkened also. I may add that the glass tube soon cracks under the electrical strain and has to be replaced by a new one.



If the Extended Fingers Are Approached to the "Spark Tube," Fine Sparks Will Be Drawn Thru the Glass to the Hand. These Are Harmless, Owing to the Very High Frequency. The Experiment Works Best in the Dark.

EXPERIMENT No. 2

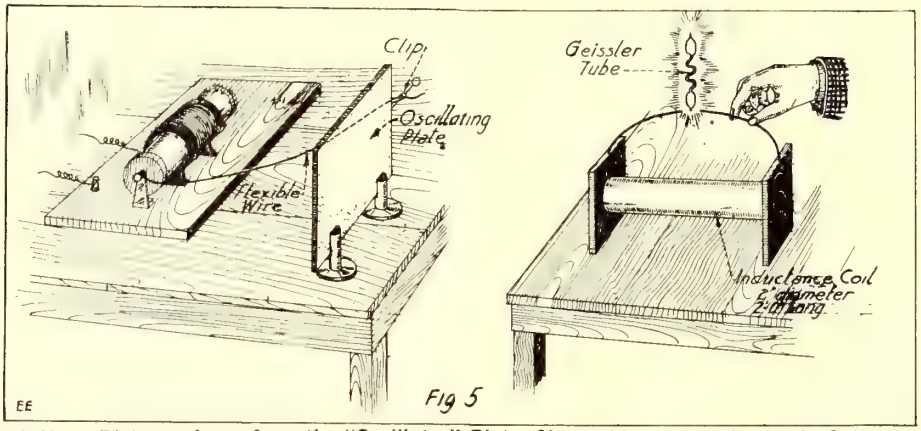
A flexible helix wire, having a clip on one end, is connected to one secondary binding post of the Tesla coil, while the clip engages in the copper rod attached to the oscillator. This latter consists of a plate of zinc 8 or 10 inches square and a heavy copper rod, carrying a 1 inch solid brass ball, brightly polished, on its end and soldered to it, (see Fig. 3.) Hard-rubber stands as shown in Fig. 4 support the oscillating plate and afford the proper insulation. In the plane of the waves oscillating from the sheet of zinc, a large inductance coil, about 2 feet long, 2 inches in diameter, and wound with a single layer of fine (No. 36 or 38 B. & S.) insulated magnet wire, is then placed. This coil has a binding post on either end, to which pieces of stout copper wire are fastened, and may be mounted on a separate table from the one holding the Tesla set (Fig. 5). Here again the power of the generating set regulates the distance between the oscillator and the inductance coil. With the aforementioned, comparatively small outfit, this distance was



An Interesting Tesla Current Experiment Can Be Made with the Aid of This Metal "Oscillator" Plate. It Is Charged by a Unipolar Current and Rests on Hard Rubber Insulators.

limited to a foot and a half on the outside.

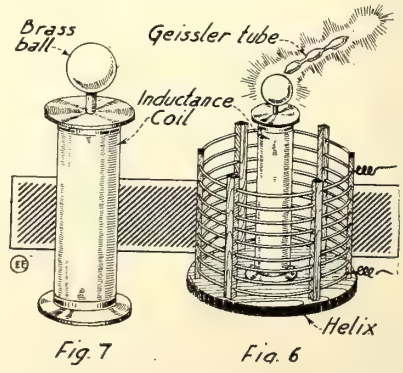
Upon the current being turned on and wires approached to within about ¼ inch, violet colored sparks will pass between their points. If the wire on the further end is now grounded by holding it in one hand, the sparks will be increased to more than *twice* their former length. This experiment affords a very spectacular way of lighting Geissler and other vacuum tubes. The coil ends should, for best results, be constructed of some insulating material, or if made of wood this should be thoroly coated with shellac, the same as the insulated wire windings.



A Short Distance Away from the "Oscillator" Plate, Charged by a Unipolar Tesla Current, There Is Placed an Inductance Coil. The Current Induced in It Will Light up a Geissler Tube.

EXPERIMENT No. 3

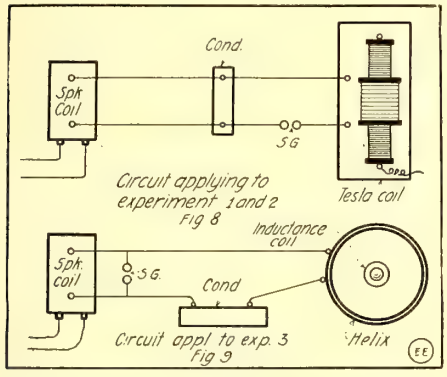
An inductance, resembling the secondary coil of an Oudin resonator is placed within the center of a helix, (see Fig. 6). At the time when this idea occurred to me, I employed a standard "Electro" helix, (after having the top removed) and a specially made inductance coil 8¼ inches in height, 2½ inches in diameter and wound with a single layer of very fine, (No. 36 or 38



An Unusual "Oudin" Coil Is Made from a Helix and a Small Inductance Coil Built as Shown. The Latter Has Brass End Cheeks Which Help to Pick up Energy from the Charged Helix, with Which It Has No Connection. The Smaller Coil Measures 8¼" by 2½".

B. & S.) silk covered, magnet wire, thoroly coated with shellac. The brass ball proper has a diameter of two inches. Both coil ends consist of solid brass instead of some insulating material for the sake of other experiments. (Fig. 7)

If the helix is now connected up as shown in diagram, sparks may be taken off at the coil terminal, Geissler tubes lighted, etc., altho this coil is in no wise connected to the circuit, both coil and helix merely working under the principle of the Tesla transformer. In all these experiments it is imperative to have the connecting wires as



Diagrams Showing How the High Frequency Apparatus Is Connected for the Experiments Here Described.

short and straight as possible and also heavy besides. Both the rubber-covered copper cable and the insulated flexible stranded copper wire are entirely satisfactory in this respect.

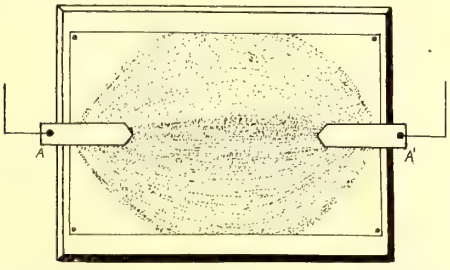
SHOWING FIELD OF STATIC CHARGE.

The following experiment to demonstrate the lines of force in a static charge can be performed by anyone having a Whimshurst static machine, such as the E. I. Co. type.

First buy or prepare some powdered glass by grinding up a few old test tubes in an iron mortar and sifting thru a fine screen. Dry a 10 x 14 inch (size need not be exact) pine board thoroly and tack a sheet of smooth drawing paper on it.

Prepare two pointed tinfoil strips AA[1] about 8 inches apart on paper and connect with the two rods of the static machine. Draw the balls on the machine far enough apart to prevent a discharge. Drive off all moisture from the powdered glass by heating it and sprinkle a light layer over paper. When the static machine is started, tap the board very lightly and the glass particles will form in curved lines, similar to the lines formed by iron filings and a magnet.

Contributed by GRANT JENKINS, JR.



The Extent of a "Static Field" May Be Illustrated by Means of Fine Glass Particles (Powdered Glass) Spread on a Piece of Drawing Paper. A Small Static Machine Will Serve to Supply the Charge.

TO PREVENT BABBITT METAL OR LEAD FROM EXPLODING.

Before pouring the babbitt metal, throw in a piece of resin the size of a walnut, and allow it to melt. This will keep the babbitt in the right shape, and if the bearings are warmed before pouring it will insure a better job.

To Mend Broken Oil-stones: A valuable oil-stone can usually be saved when broken, even if there are several pieces. The pieces must be thoroly cleaned and all oil driven from the fractures by heating on a hot plate. After this, dust powdered shellac over the broken places and heat again until the shellac melts and runs into the cracked places. The broken pieces should be heated very slowly on the hot-plate, as it is likely to burst in other places. When the shellac is well melted press the pieces together and clamp very tight. A joint so made will often last as long as the stone, and if made carefully, leaves no mar in the cutting surface.

To Keep Steel Tools in Their Handles: To keep steel tools in their handles, fill the handle with powdered resin and very fine sand. Heat the tang of the tool hot, and push it down hard into the handle. When it is cold it will be firmly set.

A Fine Lubricant for Lathe Centers: Mix together 1 part grafite and 4 parts tallow. Apply this to the moving surfaces.

To Write Black on Bright Metal or Glass: Mix 1 to 2 parts of silicate of soda with 10 parts of India ink (Higgins). Use a steel pen point and write very carefully.

Contributed by FORREST M. KIMBLE.

Amateurs! The "Smelloscope!" Your Nose Knows

Most everybody in these modern times is so accustomed to hearing of marvelous feats of science that they rarely stop to think of the whys and wherefores of things, taking much of it for granted, and forgetting the many years of toil and hardships that might have been necessary to bring the invention to perfection.

Then again there are many important developments that are doomed to pass into oblivion, owing to the fact that the inventors cannot secure sufficient capital and backing to make these inventions a success.

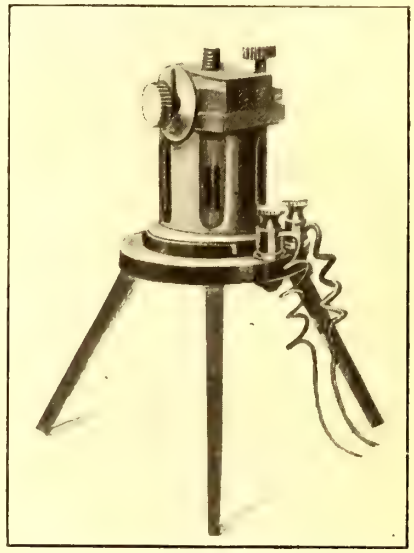
Of no man can this be said more truly than the hero of every experimenter, Mr. Thomas A. Edison. Volumes have been publisht on his early life, trials, and tribulations and the few amusing incidents that brightened his struggles.

In those days when a part such as a socket, switch or even wire was required, one had to make it and devise the machinery for making the same; nowadays, all one does it to drop in a supply store and secure almost anything wanted in the line of parts.

It is in such circumstances that the mind is given the chance for inventiveness, for "necessity is the mother of invention." Many useful and interesting things were brought out which were never brought to the public's attention, or if by chance the people saw any new development they were skeptical and soon forgot the incident.

A rather odd and little known about invention of his early work was the "odoroscope" or "smelloscope." A popular tobacco manufacturer's slogan at present to advertise his tobacco is "Rub, Smell; Your Nose Knows." Why do all this, when Edison's "smelloscope" is so handy and it saves the use of one's nose! The instrument is a modification of his tasimeter and has been named the "odoroscope" primarily from its ability to measure odors which may be inappreciable to the unaided senses. The conditions relating to the registration of moisture belong properly to the province of the odoroscope.

All odors naturally travel thru the air and the varying changes of density they impose upon the atmosphere changes the



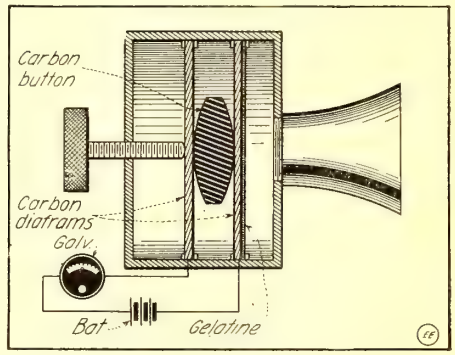
The "Smelloscope"—a Little-Known Instrument Devised by Thomas A. Edison Which Measures Smells by Electricity.

pressure, and on this principle the odoroscope works.

The instrument as may be seen from the illustration resembles very much the early type of telephone. It consists of a carbon button placed between two carbon plates. A current of electricity passes thru one plate, then thru the carbon button, and thence to the other plate. A piece of gelatine is supported so as to press against both plates. The whole is then placed in connection with a galvanometer and battery.

The action of the apparatus is as follows: Heat causes the strip of gelatine to expand and press the plates closer together on the carbon, allowing more current to pass thru and deflect the needle of a sensitive galvanometer. Cold decreases the pressure on the plates. Moisture, on which principle the odoroscope operates, if near the strip of gelatine, works the plates in the same manner by increasing or decreasing the pressure and accordingly deflecting the needle.

By means of this very sensitive arrangement of apparatus, combined with a sensitive galvanometer, it is possible to



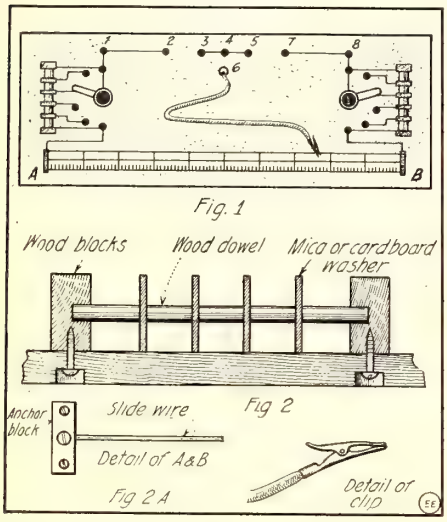
The "Insides" of the "Smelloscope"—It Comprises Two Carbon Diaframs Separated by a Carbon Button. A Gelatine Diafram Is Placed in Front of the Forward Carbon Diafram. Galvanometer and Battery Are Connected as Shown.

measure the *millionth part of a degree Fahrenheit.* Such being the case why not be conservative and use a machine to tell us what's going on in the region of smells.

The Construction of a Wheatstone Bridge

By THOMAS W. BENSON

OF the many methods devised for measuring electrical resistance the *Wheatstone bridge* has proven itself superior by every test. Utilizing the zero method, that is, a network of resistance that must be balanced so that no indication is given on the meter



View of Finished "Wheatstone Bridge" and Detail of Resistance Bobbin. This Bridge Is of the Well-Known Side-Wire Type.

or galvanometer, all errors due to unforeseen changes in the electromotive-force are effectively eliminated and a high degree of accuracy maintained.

Experimenters often have use for a Wheatstone bridge and too often fall into the belief that they are difficult to construct and handle. This is more or less true with the Post Office type using plugs in both the ratio and rheostat arms, but a slide-wire bridge as described herewith can be built at a small outlay and enables the experimenter to check accurately the resistance of various instruments and devices. It can also be used in determining capacities and inductances by using the proper standards in the rheostat arm.

Being of the slide-wire type the balances are quickly obtained with a minimum of trouble and the construction is simple and cheap. By a special design ratios as high as 50 to 1 are readily obtained which gives a resistance measuring range from 50,000 ohms to .02 ohms, with a high degree of accuracy. The above is accomplisht with a slide-wire but 20 inches long and a rheostat arm with a maximum resistance of 1,000 ohms.

At Fig. 1 is given the general layout of the base, which is 24 inches long and 8 inches wide. After smoothing up the surface and shellacking, holes are laid out and drilled for the two six point switches, the slide-wire blocks and the eight binding posts. The details of the blocks for the slide-wire is shown in Fig. 2 A. Two pieces of ¼ square brass rod each two inches long, are drilled with three holes as shown. The hole in the center is tapt for a No. 8-32 screw to hold the wire, the other two holes are for fastening to the base.

These blocks are mounted on the base exactly 20 inches apart. A scale is made from a strip of paper and divided up into 100 equal parts and numbered. This scale is fastened to the base between the blocks as shown.

The two six point switches illustrated control two sets of resistance coils that can be added to the slide-wire and thus give a greater range of ratios. The winding for each of these coils consists of exactly 20 inches of No. 24 S. C. C. Climax wire. The method of supporting the windings is shown in Fig. 2.

A piece of ⅜ inch wood dowel three inches long is fitted with square heads cut from wood. Holes drilled in the heads hold the dowel. Four washers made from fiber are slipt over the dowel and equally spaced. In winding the coils, first cut off exactly 22 inches of the wire, double it upon itself and wind into place on the dowel. When all five coils are wound the spool may be covered with tin or cardboard and painted if desired. The ends of the wire are carried to the contacts and soldered. Care should be taken that one inch of the wire is used for the purpose, thus leaving twenty inches in use. The coils are wired to the contacts so that they will be in series.

The wiring for the eight binding posts is shown in the illustration. The wire should be of fairly large size and soldered at all points to prevent poor contacts. It will be noted that the switch levers are connected so that they short-circuit the resistance coils. The movable contact for the slide-wire consists of a spring clip cut and filed to a point as illustrated. The flexible cable to which this is soldered can be made of lamp cord, the other end being fastened to the binding post 6.

The slide-wire itself consists of a length of No. 24 Climax wire, which is drawn taut (but *not stretched*) between the two brass blocks. This wire should be renewed when it shows signs of being scratched or badly stretched. This completes the bridge proper so we will turn our attention to the rheostat.

The details of the rheostat are shown in Figs. 3 and 4. Twelve resistance coils are required, namely, 1, 2, 2, 5, 10, 20, 20, 50, 100, 200, 200, 500 ohms respectively. This gives us a range up to 1,000 ohms in steps of 1 ohm. Instead of using plugs to vary this resistance use is made of spring binding posts, connected with flexible cords. In the figure the box is arranged for a resistance of 157 ohms. The coils are connected in series between the binding posts and by shunting out unwanted coils any desired resistance may be obtained.

The interior of the box is arranged as illustrated in the figures. The windings are supported on two wood dowels as in the previous case and separated by fiber washers. The box measures 7 by 7 by 3 inches inside. The strips 1 and 1 support the dowels, while strip 3 has contacts placed on it to which the ends of the windings are soldered.

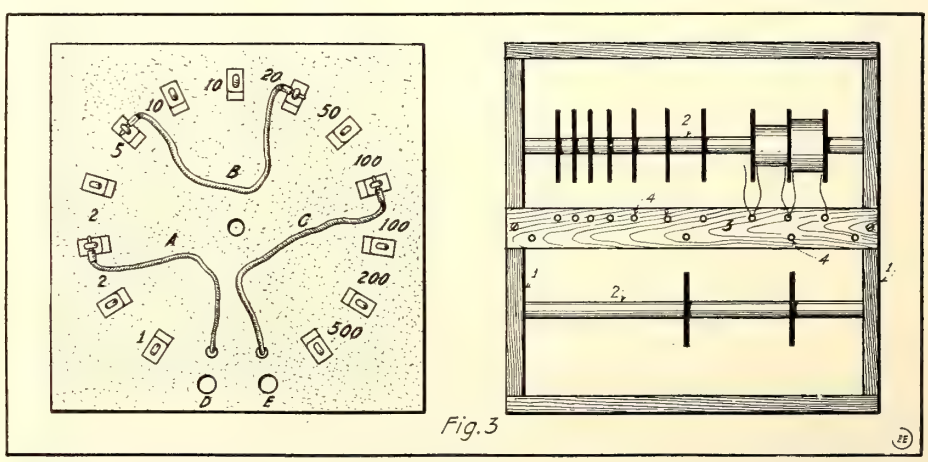
We now come to the most difficult part, that is the making of the coils which must have a known and accurate resistance. This is not so important in the ratio arms, since we can take it for granted that the resistance varies directly as the length, therefore units of length can be used in the formulas. Here, however, known resistances must be used.

To one having access to a standard bridge this is not difficult, but inasmuch as we have not a standard bridge we shall use the bridge just constructed to measure the coils for the known resistances.

To do this it is necessary to have a standard 1 ohm coil. This may be purchased or perhaps borrowed from some friend.* The resistance wire required should be No. 24; 1 lb. of this wire costing about $2.00 will be sufficient to build the rheostat. S. C. C. Climax wire is advised for the purpose.

To make the coils, wire the bridge as shown in Fig. 5, where Y is the known standard of 1 ohm. One or two dry cells will do for the battery; the galvanometer may be replaced with a telephone receiver and a balance is then obtained when *no click* is heard in the receiver when the contact is touched to the slide-wire. The switches are placed on the first point so the resistances are cut out and the movable contact is connected to the slide-wire over the middle of the scale.

The No. 24 Climax wire has nearly 1.3 ohms resistance per foot. Therefore for the 1 ohm coil take about 14 inches of the wire, double it and wind it on the dowel. Solder one end to one of the contacts on the strip 3, Fig. 3, and connect this contact to the post A, Fig. 5. A wire is carried from the other post B and is moved over the other end of the coil of wire under construction till the galvanometer indicates a balance by remaining stationary. The wire on the resistance coil up to the point where the heavier wire touches it, has a resistance of 1 ohm, it should be soldered at that point to another contact on strip 3, Fig. 3. We now have the first



Illustrating Resistance Box Containing Coils of Known Ohmic Resistance and Arrangement of Spring Binding Posts. By This Means it Becomes Possible to Readily Change the Resistance in Circuit.

*Write the Editor, inclosing stamped envelope, and address of concern supplying these coils will be furnished.

standard resistance coil of 1 ohm value.

This coil is now connected in series with the standard resistance to form a rheostat arm having 2 ohms resistance. By taking two feet of the wire, doubling it and winding on the dowels and proceeding as in the previous case to get a balance, the two ohm coils can be constructed. This process is continued till all the coils are made. By keeping the movable contact on the slide-wire at the center, the ratio of these arms is 1 to 1; therefore when the known resistances are put in one arm the same resistance will be in the other arm when a balance is obtained.

In making the larger coils it will be found advisable to wind them on a small paper tube that will slide over the dowels, thus making it easier to handle.

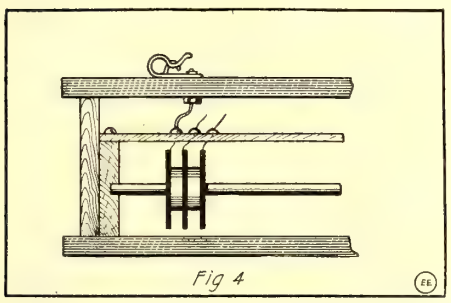
When all the coils are in place the contacts should be connected to the bolts holding the spring binding posts on the top of the box. This completes the rheostat.

The only other instrument that is used in connection with the bridge is the galvanometer. The construction of these have been described from time to time in the ELECTRICAL EXPERIMENTER, but the writer prefers to make use of a center zero ammeter with the shunt removed. These can be purchased quite cheaply, in fact, the one the writer is using for this kind of work at present cost but 50 cents. Telephone receivers can be used but have the disadvantage of not indicating whether the rheostat is of too high or too low a value; thus if the resistance to be measured is not known approximately it takes some time to get a balance.

As to using the bridge. The complete connections are shown in Fig. 6. After connecting as illustrated, resistance is plugged in on the rheostat to about the same value as the unknown or X resistance. The switches A1 and B1 are placed on the first point so as to cut out these coils. Touch the movable contact at several points along the length of the slide-wire. Should the galvanometer swing one way when the contact is at one end of the wire and the opposite way when it is at the other end, a balance will be obtained somewhere on the length of the wire. When the point is reached where the galvanometer gives no deflection the following formula applies:—

$$\left(X = \frac{B}{A} \times Y\right)$$

Where:—X is the unknown resistance.
B is the number of divisions between the movable contact and the right hand end of the slide-wire.



Resistance Unit in Place in Cabinet, Showing How Connection Is Made to the Spring Binding Post Terminals.

A is the number of divisions on the left hand side of the movable contact.
Y is the value of the known resistance.

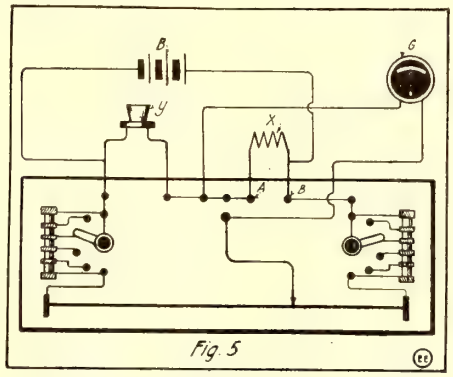
Sometimes it will be found that the galvanometer will show a deflection in the one direction when the contact is placed at either end of the wire. The method to remedy this and get a balance is as follows: Determine which end of the bridge the lowest reading on the galvanometer is obtained, then move the switch at the *opposite end* over one contact and try for a balance. Should it then be possible to balance it, add 100 divisions to the reading of side of the bridge on which the switch is moved.

When measuring resistances higher than 1,000 ohms, switch A1 is left on the first point and switch B1 is moved over a number of contacts to get a balance. When measuring resistances within the range of the rheostat both switches are on the first point and for resistances below 1 ohm, switch A1 will have to be moved and switch B1 left on the first point.

Always add 100 to the scale reading for each contact that the switch is moved over, or the calculated resistance will be wrong.

ELECTRICAL CONDUCTION IN METALS AT LOW TEMPERATURES.

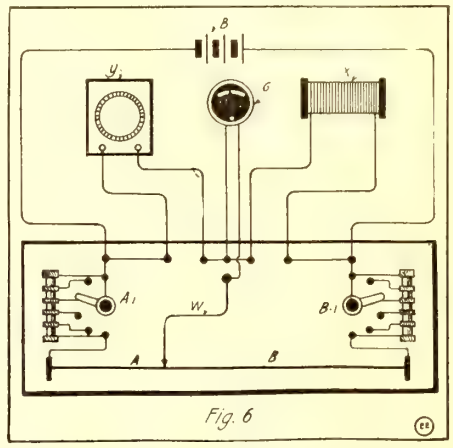
The experiments of H. Kamerlingh Onnes on the resistivity of metals at liquid helium temperatures have shown that certain metals possess an enormously increased conductivity when the temperature, current density, and magnetic field are less than certain critical values. It is pointed out by



One Connection of the Slide-Wire Bridge, Using Individual Resistance Units of Known Value at "y"; Unknown Resistance at "x".

Francis B. Silsbee, in a recent publication of the Bureau of Standards, that a definite relationship is to be expected between the values of critical current and critical field, and that this relation is in agreement with the experimental data available.

The present state of our experimental knowledge of this subject is somewhat as follows: Certain metals—mercury, tin, and lead—at the very low temperatures obtainable in a bath of liquid helium show a very greatly increased electrical conductivity, to which Onnes has given the name "superconductivity." The actual resistivity of the metal in this state is too small to measure but has been shown to be less than 2.10^{-11} times the resistivity at 0 ° C. As the temperature of any of these metals is lowered from room temperature the resistance decreases uniformly with the normal coefficient of about 0.4 per cent per degree until the temperature is very low, when the rate of decrease becomes for a time less rapid. At a certain critical temperature, however (4°.2 K for mercury, 3°.8 K for tin, and 6° K for lead), there is a sudden break in the curve connecting resistance and temperature, and within a temperature range of a few hundredths of a degree the resistance drops from about 10^{-5} times its value at 0 ° C to less than 10^{-10} times the same value. Other metals, such as gold, silver, platinum, iron, etc., do not show this phenomenon, and their resistivity tends to approach a constant value as the temperature is lowered to the lowest value (1°.6 K) at which such measurements have been made. The critical temperature at which the



Another Connection of the Resistance Bridge With the Home-Made Resistance Box of Known Values at "y" and Unknown Resistance Being Measured at "x."

change occurs is very definite when the current used to measure the resistance is small, but when the measuring current is very large the critical temperature is found to be definitely lower. Conversely, if the temperature of the bath be held constant some degrees below the critical value and the current be increased a certain "threshold" value of current will be found at which the resistance suddenly appears. The lower the temperature the greater the value of the critical current.

It is further found that when a superconductor is placed in a weak magnetic field it remains superconducting, *but that as the field is increased the normal resistance appears suddenly at a certain critical value of the magnetic field, and for still higher values of field increases slowly with the field.* The critical value is slightly less when the field is transverse to the direction of current flow than when it is longitudinal, but the difference is not great.

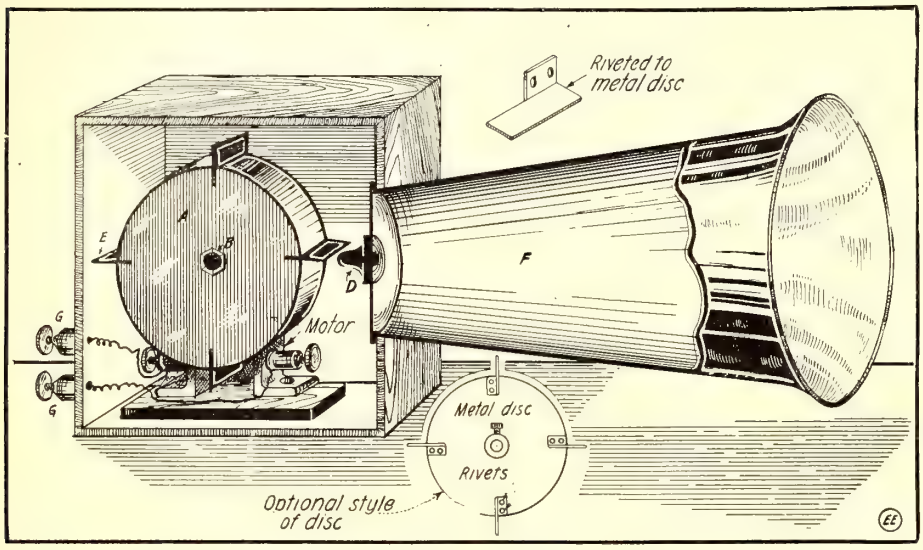
The particular point which is the subject of this discussion is that *the "threshold" value of current is that at which the magnetic field due to the current itself is equal to the critical magnetic field.* In other words, the phenomenon of threshold current need not be regarded as a distinct phenomenon to be explained by heating, etc., but is a direct result of the existence of the phenomenon of threshold magnetic field.

In case the specimen is in the form of a flat coil of wire it is evident that the inner turns are in a magnetic field, due to the current in the other turns, which is very similar to that due to an entirely external electromagnet. Consequently, when upon increasing the current this field reaches the critical value, first the inner turns will become resisting and, as the current is increased, more and more of the wire will cease to be super-conducting. Because of the enormous factor by which the conductivity decreases from the superconducting to the normal state most of this decrease will take place when only a small fraction of a turn of the coil ceases to be superconducting. Owing to the cumulative effect of the successive turns the field produced by a given current is much greater in the coil than in the same wire when straight and consequently the current required to give the critical field strength will be much less. This is verified by the results of Onnes on coils of lead and tin wire, which showed critical currents one-fifteenth and

(*Continued on page* 714)

A MOTOR-ACTUATED SIGNAL HORN.

Herewith is a diagram of an electric motor-actuated horn of my own design. At A we have a metal disk fastened to B, the pulley of the motor. D is a diafram fastened to an opening in a small box in which the motor is mounted.



Here Is an Electric Signal Horn Operated by a Motor. It's Right There with a Wallop. Can Be Used for Auto or Factory Signaling.

Small strips of heavy sheet metal, E, are fastened to the disk A, and of such a length that they will just hit the diafram in revolving. The rotating disc may be made of ¼ inch fiber, about 3 inches in diameter, the metal blades E being let into slots sawed on the periphery. If the disc is of metal then the strips E can either be soldered or riveted to it. G and G represent binding posts to which wires are attached from and connected with a battery and push button in the usual way. The faster the motor runs, the higher the tone. Contributed by BRIANT F. BRANTING.

ELECTRICAL PROPERTIES OF COPPER.

The following excerpt is taken from a very interesting pamphlet by courtesy of a well-known Copper Company:

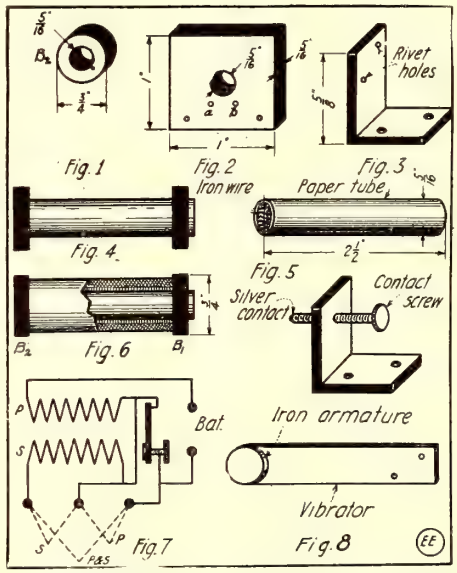
Density annealed copper at 20 deg. C..	8.89
Melting point Deg. C.	1083
Melting point Deg. F.	1981
Boiling point Deg. C.	2310
Latent heat of fusion	43.3 cal
Specific heat at 25 deg. C.	0.0917
Specific heat at t deg. C.	0.0917 + 0.000048 (t—25)
Thermal conductivity (Silver-100)	73.6
Vapor Tension at 1120 deg. C.	0.28 mm.
Co-efficient of linear expansion per Deg. C.	0.000017
Tensile strength No. O wire annealed pounds per sq. in.	32000.
Tensile strength No. O hard drawn wire pounds per sq. in.	54500.
Elastic limit No. 0 wire hard drawn pounds per sq. in.	30,000.
Tensile strength pounds per sq. in. for any given diameter (D") of hard drawn wire	70,000-45,000 D
Standard Resistivity annealed copper at 20 deg. C.	
Microhms—cm.	1.7241
Microhms—inch.	0.67879
Ohms (meter-gram)	0.15328
Ohms (mile-pound)	875.20
Resistivity Temp. constant per Deg. C.	
Microhms—cm.	0.00681
Microhms—inch.	0.00268
Ohms (meter-gram)	0.000597
Ohms (mile-pound)	3.41
One cubic inch cast copper weighs..	31 lbs.

How To Make a Medical Coil

By E. F. JASPERS

A MEDICAL coil, or shocking coil as it is commonly termed, is nothing more nor less than a small induction coil having a core, primary and secondary windings and an interrupter (vibrator).

The first step in constructing a medical coil is the making of the tube which holds the core. This tube is 2½" long and 5/16" in diameter. It is formed of ordinary paper rolled and glued together and is afterward filled with No. 22 B. & S. gage soft (annealed) iron wire, Fig. 1.



Details as Well as Connections for Medical Induction Coil. To Obtain Best Results the Vibrator Should Be Fitted with Platinum Contacts.

The ends of the coil are made out of a piece of fiber 1" square, with a 5/16" hole in the center, Fig. 2. The other end is ¾" round with a 5/16" hole in the center,, Fig. 3. These coil checks are glued to the core tube, leaving enough to project at one end for the interrupter, Fig. 4.

The core is then wound with four layers of No. 22 B. & S. gage single cotton covered magnet wire. The ends of the wire are led out of the holes A and B, which have been previously made. The primary should be covered with three layers of waxed paper, after which it should be wound to within 1/16" of the top of B, with No. 34 B. & S. gage single cotton covered magnet wire, Fig. 6. It is best, but not absolutely essential, to place a layer of thin waxed paper between every two layers. That known as onion-skin paper is excellent for small coils such as this.

The interrupter used on the medical coil is one of the simplest forms and can be best understood from the drawing. The contact points should be provided with a piece of silver which is taken from a ten-cent piece and soldered on. Platinum or tungsten points are best; for cheap coils nickel or German silver is often used.

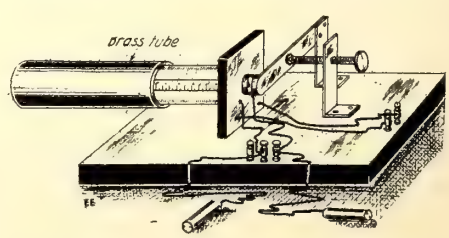
The medical coil parts are now ready for assembling. One wire of the primary should be connected to one of the battery binding posts, while the other should be connected to the vibrator. A jumper lead connects the contact screw and the remaining battery binding post. Thus, when a battery is connected to the two binding posts, the current will enter the primary and come thru the vibrator spring to the contact post and then back to the battery, forming a complete circuit.

As soon as the current flows it produces a magnetic field which attracts the vibrator spring, breaking the circuit; the core thus loses its magnetism and frees the vibrator spring, which flies back to the contact post, only to be drawn forward against the core once more, this action being repeated at a high rate of speed.

The secondary terminals are led out to two of three binding posts as shown, to which are connected two electrodes, which may be made out of the carbon from an old dry cell or a piece of copper or brass tubing. Refer to Fig. 7, for connections used whereby to obtain primary shock (two right-hand posts), secondary shock from two left-hand posts, and combined primary and secondary shock from two outer posts.

The medical coil is now completed, except for testing. If you grasp the electrodes while the battery is connected to the binding posts, a powerful shock will be felt. The shock can be regulated with a tin or brass tube, ⅞" inside diameter and 2" long.

When this tube is all the way off, the shock felt is the strongest, and when the tube is all the way over the coil, the shock is weakest. Of course, any shock between the two extremities can be had by sliding the tube in or near the middle. A graduated scale may be pasted on the coil so that the regulating tube as it slides off, will expose more and more of the scale—the figures reading in an ascending ratio.



View of Finished Medical and Shocking Coil. The Brass Current Regulating Tube Is Placed on the Outside of Both Primary and Secondary.

The secondary coil should be covered with a layer or two of paper, glued in place. A coil of this type is very useful.

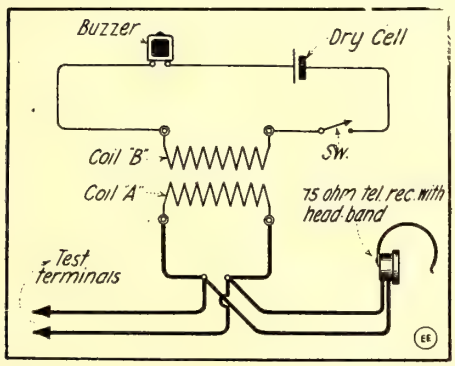
A Portable and Reliable Armature Test Set

By FRANK HUSKINSON

THE electrician frequently has a motor with the armature grounded; that is one or more of the armature wires or commutator bars are burnt and making contact with the iron core. This *ground* as it is called by electricians, has to be removed before the armature will run, the wires must be reinsulated so as to not make contact with the iron core, or in case the wires are in bad shape or the coil is *shorted* as well as grounded and can not be repaired, there being no time to put in a new coil, the remedy is to cut out the burnt or grounded coil and close the open circuit in the commutator. Armatures that are in use on commercial motors, may have several coils cut out and will give good service for an indefinite time; it is not always possible or advisable to rewind an armature, if the trouble is only due to one or more coils being grounded or short-circuited.

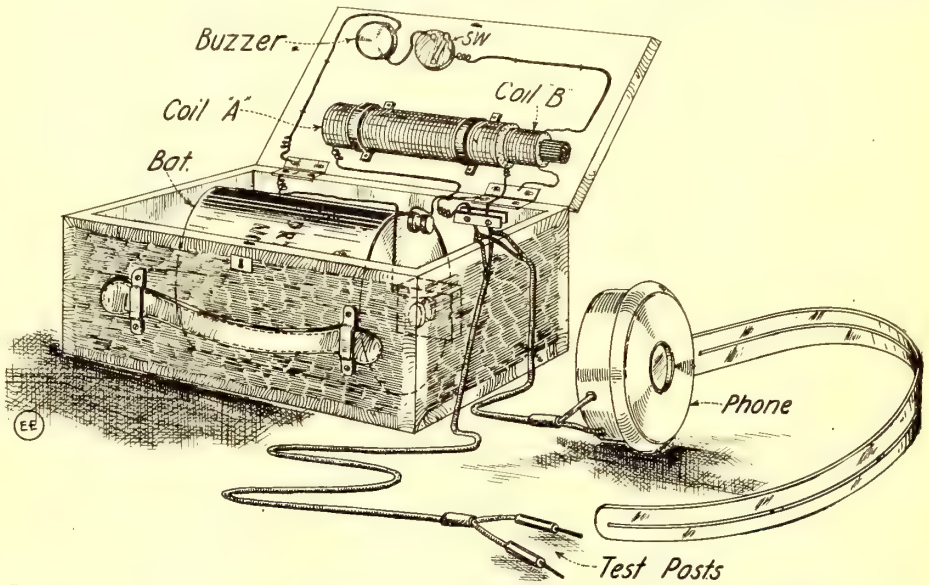
It frequently happens that an armature has a grounded coil and upon a very careful examination it does not show up on the visible parts of the armature, but by testing with a lamp between the armature shaft and the commutator the lamp will light up to its full candle-power. This indicates that the coils are grounded in some part of the armature. In order to find the exact coil that is grounded the old-time method was to remove all the wires from two or three commutator bars on each side of the commutator, then test with the lamp to find out if by chance the trouble was in one of the halves. It is very seldom that it is, then the next move is to remove all the wires from other sections of the commutator and keep this up and test with the lamp until the *exact coil is located.* This method takes considerable time and generally the band wire next to the commutator has to be removed so that after the coil that is grounded is located and cut out or repaired, all of the wires that have been removed from the commutator must be reinsulated, replaced and resoldered in the commutator and the band wires rewound on the armature. It is very seldom that an armature can be repaired and ready for use in less time than five to twenty-five hours by the old-time method.

The writer has a test set that he made several years ago and has used it at all times. It can be used to locate a grounded coil or commutator bar, or a coil that is short-circuited. The writer has often found that an armature that tested grounded and would not run, upon examination had no visible trace of the ground,



Connections Used in Portable Armature "Test Set." The Use of a Telephone Receiver Makes This Set Extremely Sensitive—It Being Possible to Check Up a Single Short-Circuited Turn.

but by using the test set shown he located the *exact coil* that was grounded. The wires are then removed from the commutator and tests made with a lamp to see if any other coils are grounded and to check the test; finding the other coils clear of a ground, the ends of the grounded coil are then cut off or bent back away from the commutator. The open circuit caused by the removal of the coil is then closed and the armature is ready for use again. The writer has on several occasions removed such grounds in the manner just described from armatures and had the motor back in operation in less than an hour.



Every Electrician Will Find It Worth While to Build This Small and Highly Effective Armature and Field Coil "Test Set." It Utilizes an Induction Coil, Battery, Buzzer and Telephone Receiver.

A complete description with diagram is given below so that any electrician can very easily make the set for his own use at a very small cost and will find it an indispensable aid in his daily work. It is absolutely reliable and in the use of it the condition of the coils is noted by the degree of sound heard in the receiver. This test set will instantly reveal the presence of short circuits and open circuits and of grounded coils in an armature. If the coil is open circuited the sound in the receiver is *very loud,* if the coil is short-circuited the sound is *very low;* the tests for opens and shorts are made by touching the test terminals on adjacent commutator bars. In testing for a ground, one of the test terminals is held on the armature shaft while the other one is touched to each commutator bar successively and as the grounded coil is approached, the sound in the receiver diminishes and when the exact commutator bar is touched that has the grounded coil connected to it, there is practically *no sound* at all in the receiver. Upon locating the ground this bar is marked, and then the test is continued around the commutator until the other side of the coil is located, then the wires are removed from the commutator, and the grounded coil repaired or cut out.

To make a Test Set.—In the diagram are shown the connections of the Test Set. To make coil A. wind enough No. 8 D. C. C. magnet wire on a wooden form ⅞" diam. to make a single layer coil 6" long; remove the form and you will have a hollow coil of wire. Form the ends to make a support as well as terminals. To make coil B, cut enough pieces of No. 18 soft iron wire to form a core 6½" long by ½" diam. Insulate this core and wind on it two layers of No. 20 or 22 D. C. C. magnet wire, leaving about ¼" of the core on each end without windings; this will bring the two ends of the wire out on the same end of the core; solder a flexible lead on each of the ends. Coil B, is made so as to slide inside of coil A. Mount coil A on a suitable base and place coil B, inside of coil A.

Arrange connections as per diagram. The battery current flows thru the watch-case buzzer and is converted into an alternating current; the buzzer is in series with coil B. The alternating current in coil B induces a current in coil A. The 75 ohm watch-case telephone receiver is fitted with a head-band so as to leave both hands free. The receiver is connected across the terminals of the coil A, and the test terminals are connected in parallel with the receiver. The strength of the sound in the receiver may be varied by moving the coil B, in or out of coil A. The amount of adjustment needed depends upon the size and the style of armature that is under test. One dry cell will operate the set and lasts for months; the writer has his Test Set arranged so that it is very compact, light, and handy. He has a light oak box large enough to hold one dry cell, the receiver with head-band and the test cords. The buzzer, switch, and terminals are all mounted on the inside of the top cover, which is hinged and has a lock on it. The outside is fitted with a leather handle for carrying.

HARD RUBBER FROM BATTERY CELLS.

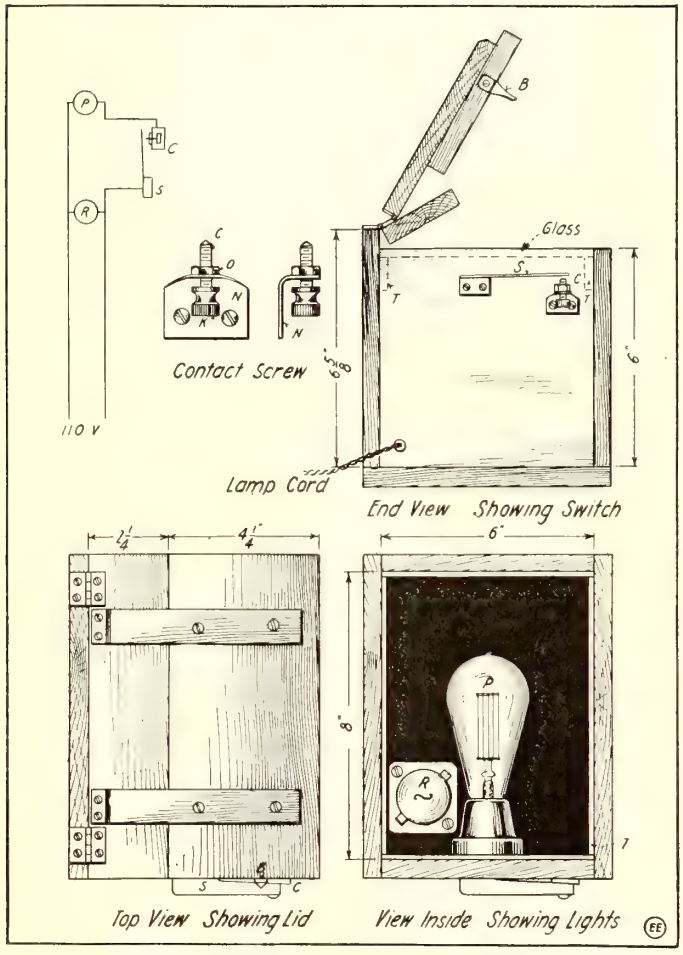
Experimenters residing in towns wherein a storage battery service or repair station is located, need never want for hard rubber sheets 3/16" or less in thickness, such as would be desired for small bases, panel fronts, etc., as the containers from worn out and broken storage batteries, which are made of hard rubber, can always be obtained for the asking, or at the most, for a few cents.

Saw the hard rubber container carefully down thru the corners, then by plunging in hot water it may be bent in any desired shape. If badly warped, place in hot water until it becomes flexible, clamp between two boards while still warm and leave it cool. All hard rubber sheet becomes quite flexible when warmed in a hot water bath but soon hardens when removed.

Contributed by L. HAGERMAN.

A Printing Box for the Amateur Photographer

THERE are few things that the amateur photographer uses that afford more pleasure than a good printer. The one herewith described and illustrated can be easily and economically made and is extremely useful to the amateur who has access to the electric lighting current. By using odds and ends that are usually found around the work shop the total cost of the printer would probably be less than one dollar. The box and lid are made of some soft wood, preferably poplar, one-half inch thick. It can be purchased from a lumber company or if the maker wishes to be economical, store boxes of the right kind of material can be used to a good advantage.



A Clever Electric Printer for Amateur Photographers. Closing the Outer Lid Causes a Switch to be Closed, Lighting the "Printing" Lamp. Raising the Lid Opens the Circuit. The Ruby Lamp Burns Steadily.

The lid is made in two pieces, so that the back piece can be lowered on to the paper and film when they are in place and held firmly until the outer part is lowered. On lowering the outer part and pressing it down firmly, the projecting point B strikes the spring S and forces it down on to the point C, thus closing the circuit and lighting the printing lamp P, as shown in the wiring diagram. The small ruby lamp R, burns all the time. If a small ruby lamp is not available, one can be made that answers the purpose very well by wrapping a small bulb of low candle-power with two or three thicknesses of red crepe paper. In fact the latter is to be preferred, as the intensity of the ruby lamp can be regulated to suit the needs by removing or adding extra thicknesses of the paper.

The under side of the lid is covered with some thin kind of felt, such as a good grade pennant felt or a good heavy grade of canton flannel. This felt should be glued on the lid smoothly in one piece and then cut along the line joining the two parts of the lid with a sharp knife. The glass which is supported by the thin strips T, tacked around on the inside of the box, should be strong and thick, preferably plate glass. If plate glass is not available some good strong window glass will do, care being taken that the bulge of the glass is upward. The spring S is made from a piece of sheet brass. The contact screw C can perhaps best be made from a piece of sheet brass, and a binding post from an old dry cell. The octagonal nut O can be soldered to the brass piece N, while the knurled nut K can be soldered fast to the bolt and the screw C formed by filing off the head. The position of both lamps is shown in the drawing; all the wiring is inside the box. The wires to the spring S and the screw C, can be brought thru the screw holes and thus kept hidden. The length of the lamp cord, which is provided with a plug, can be made to suit the needs of the individual.

The inside should be painted with some good light-reflecting paint, while the outside had best be painted some dark color.

Contributed by JOHN G. ALBRIGHT.

FREAK TROUBLE. TIPS TO "BUG" HUNTERS.

By Thomas W. Benson

Electrical apparatus seems to be subject to more trouble to the square inch than any other class of apparatus. Perhaps this may be due to the fact that I am more acquainted with trouble in this field than in any other, still I feel sure my statement is fairly correct. Common troubles are nothing unusual, but some of the "freak stuff" it has been my pleasure to "shoot" ought to be interesting news to my fellow sufferers.

One of the most puzzling perhaps was the affair of the power circuit that went dead and then alive in turn without rhyme or reason. In a certain plant a number of machines were driven by motors connected to this circuit. Suddenly all the machines would stop and before the electrician could get a test on the entire line the power would come on. This occurred so often and gave rise to so much trouble that the man stayed with a motor till it went dead.

All the fuses were intact, the line fuses and motor fuses, and this was as far as he would get with his test before the power returned. Well, he started to trace out the line, inch by inch, thru floors, across ceilings, clean down to the switch-board without finding a single thing the matter with it. A circuit-breaker was connected in the circuit to protect the fuses on the board. As an after-thought the trouble man remarked to the engineer of the plant:

"Gus, does that breaker ever let go?"

"Oh, yeah, every hour or so. I just slam it in every time I notice it out," was the quiet reply.

There you are. Where can you place the blame?

Then again, a large generator was being overhauled. The armature had been taken out and the fields retaped and painted. The repairman made a ground test with a meter connected to the power mains. And the meter said—*grounded*—perfectly and securely. The connecting wires between each of the fields were removed and each field tested separately. Each and every field coil to all appearances was grounded. Oh, beautiful sight for the junk man.

When,—as a matter of fact all of them were clear. The false meter reading was finally discovered and the explanation was simple as A B C.

The machine made connection to the ground, being in contact with an iron post. One test lead was connected to the center wire of the three-wire power mains. A wire was run from one outside leg to the meter and the other terminal of the meter was connected to the other test lead.

On applying the test leads, the first to the field coil terminals and the second to the frame of the machine, the meter would register full voltage. But the current was not flowing from the field coil into the frame. Oh, no; it was flowing from the outside leg of the mains, thru the meter, into the frame of the machine, thence to ground. The center wire of the system being grounded at the power station resulted in a complete circuit being formed.

Why, even a "Doorbell Engineer" has his troubles. A certain calling system comprising twelve push-buttons, two bells and an annunciator was dead. A test of the batteries showed them rather weak. A set of nice new dry cells was obtained and cheerfully wired into the circuit—but the system remained dead as the proverbial door-nail.

Shunting the master leads behind the annunciator and cutting out the push buttons resulted in a signal at the bells, which indicated that the trouble was between the annunciator and the bells.

The annunciator was examined carefully but everything was in perfect condition. The leads between the annunciator and the push-buttons all tested clear. Where was the trouble?

Briefly, the man who designed the annunciator was at fault. The type used is no doubt familiar to most trouble-men. One board in the back of the apparatus supports the coils and indicators. The back of this board is fitted with a series of springs that push outward and make connection with a number of screws attached to a second board. The wires from the push-buttons are connected to the screws on the latter board. And the whole trouble was caused by the springs not making good contact with the screws. This would not be noticeable because there is no way of determining this fact when the boards are in place except that the device tests open, and when taken apart appears to be all right. Of such things "troubles" are made.

Now let me tell you of the freakiest bit of trouble it has ever been my pleasure to hear of. First let me assure you that the

(*Continued on page 734*)

HOW TO MAKE IT



This department will award the following monthly prizes: First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

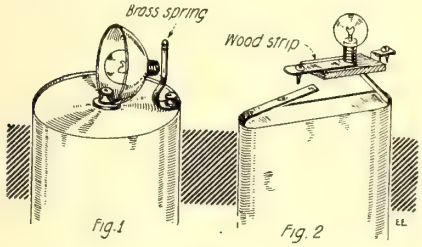
FIRST PRIZE, $3.00

SIMPLE FLASHLIGHT AND BATTERY TESTER.

The illustration, Fig. 1, explains itself. The material for the flash-light was an old reflector, a piece of very thin brass and a 1.5 volt bulb. A hole was bored in the reflector to accommodate the center binding post of the dry cell, and the spring brass strip was cut out and bent to suit. The light can be switched on by pressing the spring against the lamp base.

The "battery and lamp tester" shown in Fig. 2, was made from a broken miniature socket by merely fixing it on to a thin strip of wood and screwing in the right size bulb; a 1.5 volt bulb was used for testing the single cells of tubular batteries and a 3.5 volt lamp for the flat 3 cell, etc. It can also be used for testing lamps.

Contributed by DONALD HOUSTON.



Simple Battery Flash-light and Battery Tester Which Anyone Can Make in a Few Minutes Without Any Tools.

MEASURING SMALL QUANTITIES OF LIQUIDS.

Small quantities of acids and other liquids cannot be accurately measured in a wide glass, while the practise of quoting quantities in "teaspoons" which is still followed by some writers is altogether unsatisfactory. Not only does the quantity of liquid contained by different teaspoons vary, but if the liquid happens to be a strong acid the spoon will be attacked and partially dissolved.

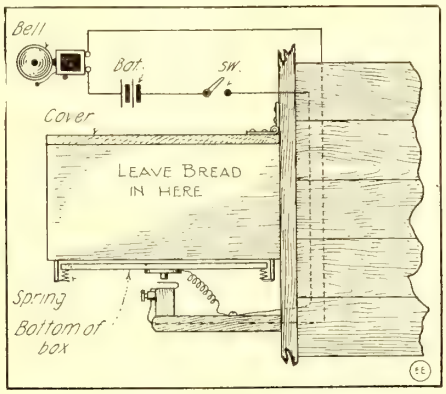
A convenient pipette for measuring small quantities, up to a few cubic centimetres, can be made from a fountain pen filler. Paste a narror strip of paper along the glass tube, making two marks, one just above the tapered end and another near the rubber bulb. By filling the tube up to the upper mark 20 times and emptying into any available graduated measure until the water reaches the lower mark, the cubic capacity of twenty times the length of straight tube between the marks will be found with sufficient accuracy. Dividing this by 20 gives the actual capacity of one length, any error in the original observation having been reduced by division to a practically negligible quantity. It only remains to divide up the space between the two marks so as to show ¼ cb. cm. or .5 cb. cm., and the measure is complete.

Contributed by H. J. GRAY.

SECOND PRIZE, $2.00

LET THE BREADMAN WAKE YOU WITH THIS ALARM.

I herewith submit an alarm system which is very easily constructed and installed. By



With This Simple Alarm Bell Attached to the Bread Box, the Breadman Wakes You on His Morning Round.

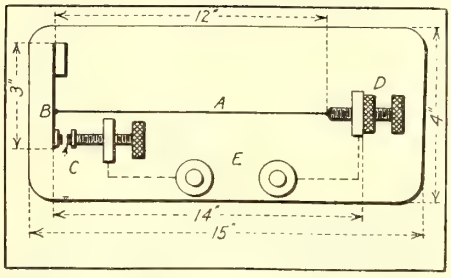
the use of it one can arise every morning at a regular time, when either the milkman or bread-man arrives, or any other form of early delivery.

I noticed in the September edition you considered the Rain Alarm of value, so I thought this form of alarm would meet with the approval of the "E. E." readers.

Contributed by E. T. JONES.

A SIMPLE THERMOSTAT.

Contrary to general practise, in this thermostat the resistance wire itself is the "expanding" unit. The base and supports may be of any insulating material. A, is



A Somewhat Different Thermostat for Amateurs to Make. The Expansion Unit is Made of Wire.

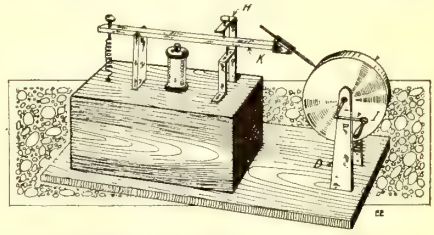
the resistance wire. It may be any kind, even iron. The size required varies for different temperatures. For one or two lamps, Nos. 30 to 32 wire should be used. For 2 amperes No. 28 is right. B, is the brass spring that keeps the wire taut. It is 3" x ½" x 1/32". C, represents the contacts. They are made by cutting off two flashlight battery carbons ⅛" from the brass caps. One should be fastened to spring B, and the other movably mounted on the base. D is the wire adjustment. The bolt slips loosely thru the support. Wire A is fastened to its head. The nut is screwed on the other end for adjustment. E represents the binding posts. Note series connections.

Contributed by CLINTON SIMPSON.

THIRD PRIZE, $1.00

A FOUNTAIN PEN TELEGRAPH RECORDER.

An ordinary telegraph sounder is used to build this recorder with, but the standard H is changed somewhat, as is plainly seen in sketch. To the hammer is attached an extension—K. At the end of K, at the correct angle a fountain pen is fastened so that when the circuit is closed it marks the dots and dashes on the drum J. This is made of a pasteboard tube or a baking-powder can. The drum turns on a brass rod which is supported by standards D. The paper is held on the drum by rubber bands, clips, etc. A handle I is mounted at the end of the rod, to turn the drum. By turning the handle slowly, a fairly long message may be recorded, and by mounting the drum on a threaded rod, so as to make it move from left to right, as it rotates, a very lengthy



A Telegraph Recorder Made From an Old Sounder and a Fountain Pen.

message can be recorded. It is a simple matter to rig up this drum to be driven by a spring or electric motor.

Contributed by CHARLES FRANK.

A GOOD DIELECTRIC FOR A FIXT CONDENSER.

Paper is some times not entirely satisfactory for condensers. Owing to this fact I got to looking for something else and ran across three old pieces of photographic film which had been spoiled in the making. A condenser made from it and some tinfoil proved entirely satisfactory in every way.

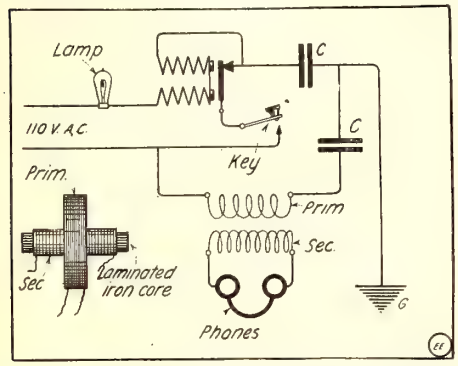
Contributed by T. S. LIVELY.

EXPERIMENTERS!!!

Don't forget to write up that little "stunt." It may win a prize. Address all manuscripts to the Editor, Electrical Experimenter, 233 Fulton Street, New York City.

IMPROVED NON-RADIO SIGNALING SCHEME.

After having experimented a while with my non-radio communication set, I have devised a new scheme for receiving; it both amplifies and protects the 'phones against damage from the 100-volt circuit,



The Radio Amateur Will Find of Interest This Improved 110-volt Buzzer System for Short-Range "Non-Radio" Communication.

should the condensers become punctured. It also brings into use apparatus or parts of the same which are on the shelf, due to the ban on the amateurs by the Government.

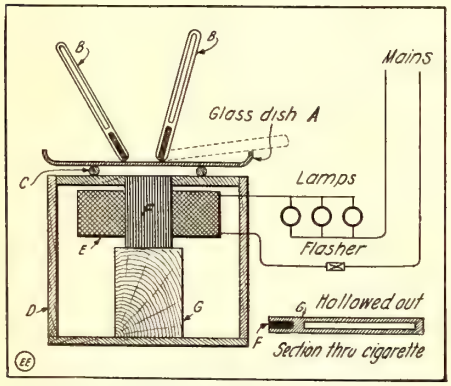
As you will notice where the 'phones were connected I have inserted what I may call the primary, which is composed of about 100 turns of No. 22 S.C.C. magnet wire on a laminated core. Over this, after insulating it well I take an old secondary unit of my transformer and place it in the middle of the primary winding on the core. Now we have what I might call a small open-core transformer. This as you will notice protects the 'phones as they are now bridged across the secondary and are inductively connected to the power line. It also amplifies the signals.

Contributed by E. T. JONES.

HOOK-UP CORRECTION

While looking thru the September issue of THE EXPERIMENTER, I noticed a mistake. On page 327, the article, "A Home-Made Magnetic Window Attraction," it says that the lamps should be connected in series with the electro-magnet, but the diagram shows them connected across the main line. In this way they would have no effect on the magnet whatever and fuses would be blown every time the magnet was connected.

Contributed by GUY A. KENNEDY.



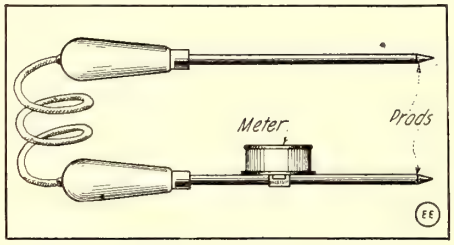
The Lamp Bank Shown Controls the Amount of Current Thru the Magnet Coil. The Flasher Opens and Closes the Circuit, Causing the Cigarettes to Dance.

TAKING STORAGE BATTERY READINGS.

The voltage of a storage battery is a fair indication of its condition. Faulty cells in a series of batteries can be detected by taking individual voltage readings of the cells.

A device that makes these tests easy when a large number of cells has to be tested is shown in the illustration. Two iron rods, 12 inches long and ⅜ inch in diameter are pointed at one end and fitted with wooden handles at the other end. A small voltmeter, with a scale reading 0-3 volts in 10ths is mounted on one rod near the handle. One terminal from the voltmeter is connected to the rod on which it is mounted, while the other terminal is connected to the other rod by means of a two-foot length of flexible lamp cord. The rods should be well taped to prevent them short-circuiting any cells should they accidently come in contact with the terminals.

To take readings on the cells the load *must be switched on* and then by forcing the points of the iron rods into the soft lead of the binding posts on the cells the voltage can be read. A cell showing less than 1.7 volts should be charged separately until up to the voltage of the other cells in the set. No reading or a reverse reading



A Good Place for the Voltmeter in Battery Testing is on One of the Test Prods.

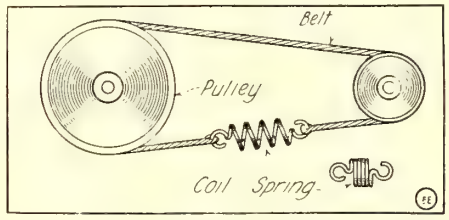
indicates a shorted cell. This should be removed and examined for the trouble.

It is well to take hydrometer readings on storage cells at regular periods and to examine the height of the solution, keeping it at all times about one inch above the plates.

Contributed by THOS. W. BENSON.

SPRING DEVICE FOR TIGHTENING BELTS.

For those who experience annoyance from slipping of leather belts on static machines, I would suggest that they connect the ends of the same by a small coil spring, (see Fig.), such as can be easily procured from a typewriter or purchased at any hardware store for a few cents a piece. This will serve to take in whatever slack there may be and thus keep the belt at an even tension when revolving.



A Spiral Spring Forms an Ideal Automatic Belt-Tension Adjuster.

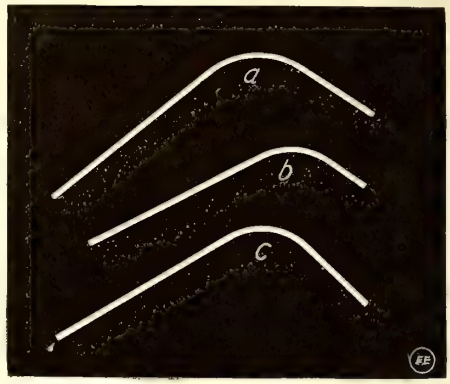
Contributed by JOHN T. DWYER.

MAKING FRENCH CURVES FROM COPPER WIRE.

Here is an efficient substitute for the French curve. I often have occasion to plot curves for efficiency, watt loss, terminal volts, etc., and find they do not bend much. The curvature of the average French curve is too great. So I stript the insulation from a 12 inch piece of B. and S. No. 6, soft drawn copper wire, being careful not to injure its surface. Laying it on a flat surface I approximated the general shape of the curves shown and used it as a French curve.

It is superior to the French curve also, because if the ink runs to the ruling edge its shape prevents the ink reaching the paper and smearing. Hence work may be done quickly and neatly.

Contributed by ROBERT VALVERDE.



"French" Curves of Various Intricate Shapes are Easily Made from Heavy Copper Wire.

A GOOD CLEANING SOLUTION FOR GLASSWARE.

A good cleaning solution (chromic acid) may be made by dissolving potassium or sodium chromat in concentrated sulfuric acid, until a saturated solution results. Apparatus to be cleaned should be covered with a thin layer of this solution, and rinsed with water.

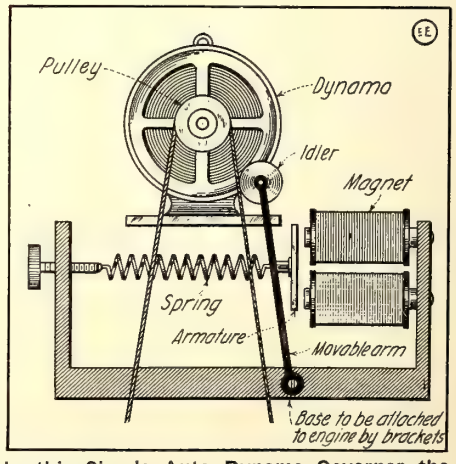
Contributed by H. C. KIHLSTROM.

A BELT "GOVERNOR" FOR REGULATING AUTO DYNAMOS.

It is a well known fact that a small dynamo connected direct to an automobile motor, without a governor of some kind, will burn out its armature or the lights with which it is connected, due to the rise of the voltage when the motor is speeded up.

The accompanying illustration shows a device which prevents this and answers all the purposes of a speed regulator. An idler pulley mounted on a movable arm, controlled by an adjustable spring, furnishes the necessary tension to the belt driving the dynamo. A flat iron armature mounted on the opposite side of the movable arm is controlled by an electro-magnet wired in series with the dynamo and lights.

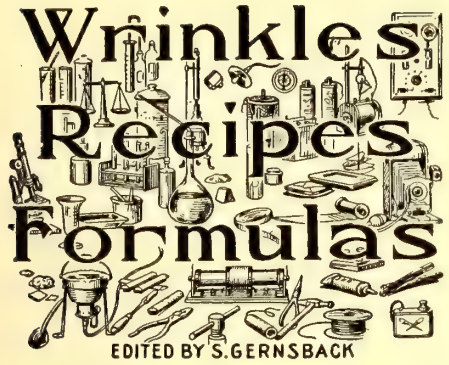
As the current increases the magnet



In this Simple Auto Dynamo Governor the Variations of the Current Act Thru an Electro-Magnet to Regulate the Belt Tension by Means of an Idler Pulley.

draws the idler back and allows the belt to slip until the dynamo speed returns to normal.

Contributed by
HARRY R. WHITEHEAD.



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

EXPERIMENTERS' APHORISMS

In the following, we wish to give to the Experimenter some hints as to the use of the different ingredients and how to work them:

(1) Always bear in mind that exact working of a formula requires ACCURACY, CLEANLINESS, PATIENCE, and SKILL.

(2) Know what you are about, before you start to experiment.

(3) "THE HISTORY OF FAILURES IS THE HISTORY OF SUCCESS" goes an old adage, and it applies well to the experimenter.

(4) Many times impure, wrong or deteriorated raw materials, spell FAILURE instead of SUCCESS.

(5) A great many of the chemicals and ingredients required, cannot be obtained from drug stores; buy them at a reputable supply house.

(6) BEFORE CONDEMNING A FORMULA, be sure the fault does not lie with the manner of handling it, or the purity of the ingredients.

(7) Be sure to mix the materials comprising a certain formula in the proper sequence.

(8) When starting to prepare a mixture, especially one containing liquids, ask yourself: "IS THE SPECIFIC GRAVITY CORRECT, AS INDICATED BY A HYDROMETER? IS THE TEMPERATURE RIGHT? IS THE QUANTITY OR WEIGHT RIGHT?

(9) Acids and water, when mixed, should be manipulated in the proper manner, i. e., THE ACID SHOULD BE POURED INTO THE WATER, and not vise versa, as the solution is liable to be forcibly ejected from the containing vessel and into the mixer's face.

(10) For any kind of SYSTEMATIC WORK, a floating THERMOMETER and HYDROMETER, as well as measuring glasses and scales, should always be provided, as GUESSWORK is EXPENSIVE, and SOMETIMES FATAL.

(11) Put labels on ALL bottles, boxes and packages with FULL INSCRIPTION as to their contents, it will avoid troubles and mistakes.

(12) Remember that a beginner cannot expect to make articles AT FIRST, which will compare with regular manufactured products.

METALLIC TREES.

To make a silver tree, dissolve two ten-cent pieces in 2 fluid drams (about a dessertspoonful or two teaspoonfuls) of concentrated nitric acid, evaporating nearly to dryness to drive off excess of acid (evaporate by holding solution over a flame). Cool, and dissolve the resulting crystalline salts in sufficient distilled water to make a saturated solution. This solution will be slightly blue on account of the copper which is alloyed with coin silver. Place the solution in a glass vessel having a curved bottom. Add a drop of mercury the size of a large pea and set aside for a day. A large growth of mercury and silver amalgam will be produced which may be kept indefinitely.

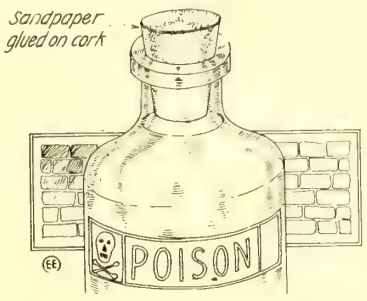
To make a lead tree, place in a tall jar (a quart preserving bottle will answer the purpose) a solution made by dissolving 4 ounces of lead acetate in one quart of water. Place the bottle where it will not be subject to vibration and suspend in it a strip or cylinder of zinc; battery zinc will answer the purpose very well. An abundant growth of crystalline spangles will collect on the zinc within ten days.

To grow a tin tree, dilute commercial tin chlorid solution with forty times its bulk of water and proceed the same as when making the lead tree.

Contributed by ALBERT W. PUTLAND.

MARKING POISON BOTTLES.

A very convenient way to mark bottles containing poisons so that they can readily be distinguished in dark rooms or closets



Take a Disc of Sand-paper or Emery Paper and Glue It on Top of Your Poison Bottle Cork—a Cheap Yet Efficient Marker Which You Can't Miss in the Dark.

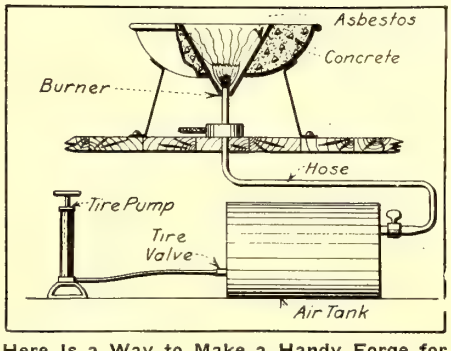
is to cut a piece of heavy, coarse sand-paper the size of the top of the cork and paste or glue the piece on the top of the cork or stopper of the poison bottle. As one's hand invariably comes in contact with the top of the cork in opening a bottle, this simple device will prevent mistaking a bottle containing poison for another.

Contributed by J. EDWARD WHITE.

A SMALL FORGE FOR THE AMATEUR.

While engaged in some experimental work at home, I needed a small forge, and proceeded to make one myself. Its construction is very simple. An old granite basin from the sink was filled with cement and a hole left for the fire box. While the concrete was still damp a sheet of asbestos was laid around the inside. This is to keep the heat in. A small tin funnel was put on the inside and the spout arranged to stick out underneath. Some rubber tubing was connected to this and thence to an old gasoline tank under the table thru a stop cock to regulate the flow of air. The other end of the tank was fitted with a tire valve and an ordinary tire pump connected up as shown. Charcoal or coke may be used in this furnace.

Contributed by M. C. CAMPBELL.



Here Is a Way to Make a Handy Forge for Amateur Shop-work.

HOW TO FROST OR COLOR LAMP BULBS.

Dip the bulb in a thin solution of white shellac and alcohol, which gives it a frosted appearance. Add diamond dyes of the desired shade to the solution for colors.

Contributed by WADE ROBINSON.

AMATEUR "KNICK-KNACKS."

THIEF CATCHER—Last summer we were bothered by nocturnal cherry thieves. So I contrived a trap by annealing one end of a clock spring and puncturing it with two screws. I next screwed it to a wooden base so that the free end clamped to the base with a little pressure. I then screwed a piece of metal on the base so that the spring rested on it. The spring and metal were connected so as to close a bell circuit. A small block of non-conducting material was placed between the spring and metal contacts and a thread tied around the block, so that the pulling of the thread would pull the block out and cause the circuit to be closed. The thread encircled the tree and the thief walking into it rang the bell. This device costs practically nothing and may save many dollars worth of fruit or poultry.

INK THINNER—If your drawing ink clots or gets lumpy from standing open, add some aqua-ammonia and shake well.

DRAWING CLEANER—When your drawing-board or drawing becomes dirty from grafite and finger marks, etc., it may be cleaned by rubbing with stale bread. Wall paper may be cleaned the same way.

CLEANING BLACKBOARDS—A little "3 in 1 oil" or similar oil on a rag will free blackboards of chalk.

KEROSENE TORCH—By placing a blotter in a bottle partly filled with kerosene and lighting the protruding end, one has a good improvised light or stove.

Contributed by EMERSON ESTERLING.

HOW TO PREPARE PURE SILVER FROM COIN SILVER.

Silver coins are not pure silver, but contain copper to make them harder. Canadian silver coins contain 925 parts of silver and 75 parts of copper to each 1000 parts, and the metal is called Sterling Silver. United States silver coins contain 900 parts silver and 100 parts copper to each 1000 parts, and the metal is called "900 fine."

In order to prepare the pure silver and to get rid of the copper, a silver coin is dissolved in dilute nitric acid (HNO_3). The solution is then diluted with hot water to 200 or 300 cubic centimeters (approximately 7 or 10 ounces). To this add a solution (hot) of sodium chlorid (common salt) which will throw down an insoluble precipitat of silver chlorid. Wash the precipitat thoroly by decantation; that is, by successively pouring on hot water and allowing the precipitat to settle, then pouring off the clear liquid. After a thoro washing in this manner, filter the solution thru filter paper and dry it carefully in warm air. Remove the precipitat from the filter paper and place it in a porcelain crucible. Heat gently with a small flame until the silver chlorid is melted then let it cool.

Cut out a piece of sheet zinc large enough to cover the bottom of the crucible and lay it on the silver chlorid. Now add a little water and a few drops of dilute sulfuric acid (H_2SO_4) and let the whole stand for twenty-four hours. The silver chlorid will be reduced to silver and zinc chlorid is formed. Take out the piece of zinc and wash the silver with a little dilute sulfuric acid and then with water. This finely divided silver may be fused in a crucible by drying it and mixing with half its weight of sodium carbonat and apply sufficient heat.

Contributed by D. J. THOMSON.

[Ed. Note: There is a statute law against destroying or mutilating U. S. money.]

Experimental Chemistry

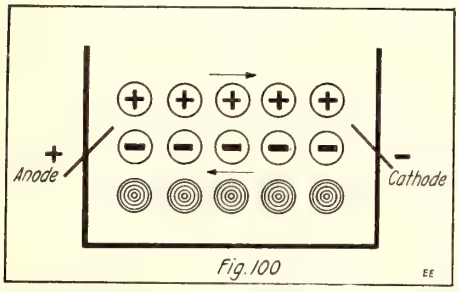
By ALBERT W. WILSDON

Twenty-first Lesson

ELECTRO-CHEMISTRY

LAWS AND CONDITIONS

WITH the aid of the induction coil spark, or electric arc, chemical combination as well as decomposition can be produced. But the Galvanic current induces chemican decomposition only. Decomposition



Illustrating Ions and Molecules: Upper Line + Ions; Middle Line — Ions; Lower Line Undissociated Molecules. Arrows Indicate Direction of Anions to Anode and Cations to Cathode.

which is caused by the galvanic current is termed *electrolytic decomposition,* which operation is termed *electrolysis.* All substances do not conduct the electric current, and for this reason they are classified as follows:

1. *ELECTROLYTES,* which are substances which quite readily conduct electricity, and,

2. *NON-ELECTROLYTES,* which conduct it with great difficulty, or not at all. Each of these divisions may be classified as follows:

Electrolytes of the first class, these usually being metals, such as silver, copper, platinum, etc. These may be in any convenient form as sheets, wires, etc.

Electrolytes of the second class, are generally acids, bases and salts, either fused or in solution. We shall chiefly deal with this class.

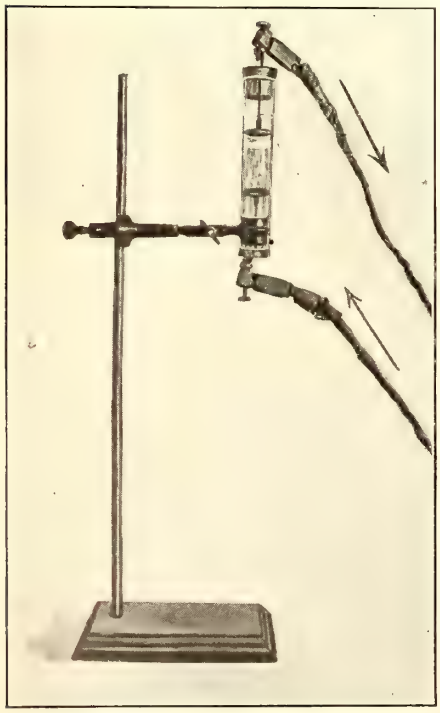


Fig. 102. Photo of Actual Apparatus Set Up for Experiment With Migration of Ions.

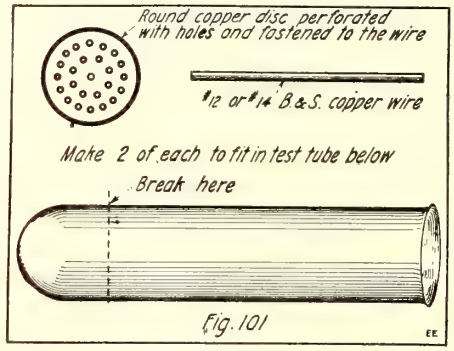
Non electrolytes of the first class, may be illustrated by such substances as rock salt, and solid salts generally, which resist an electric current, tho in some cases they are melted by the current and thus become electrolytes.

Non-electrolytes of the second class are liquids, or substances in solution or fusion that offer great resistance to the current, or if they conduct at all, very slightly.

The wires which carry the current into and out of the electrolytes are called the *electrodes.* There must be two electrodes in order that electrolytic action take place, one of these, the positive (+) carries the current into the electrolyte and is called the *anode,* while the other carrying the negative current (—) is the *cathode.*

THE IONIC THEORY:

We now approach a new phase of a solution. When an electrolyte of the second



Details of Electrolytic Apparatus Shown in Photo Fig. 102.

class is dissolved in a solvent like water, a certain amount of it is believed to be dissociated or broken up into its *positive* and

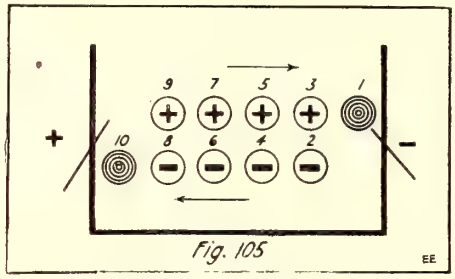


Diagram Showing Ions in Motion Under Effect of Electric Current. Atoms Are Formed in This Process.

negative constituents. When sodium chlorid (common salt) dissolves to saturation in water, a certain portion goes into solution without being broken up into its elements or having the size of the molecule changed; but a certain other large part splits up into sodium ions which are charged with *positive* electricity, and chlorin *ions,* charged with *negative* electricity, which exists intermingled in the solution with the undissociated sodium chlorid molecules. In the same way, when silver nitrat ($AgNO_3$) is dissolved, a portion is broken up into silver (Ag) ions and NO_3 ions. The process is called *ionization.* Fig. 100 may represent ionized and non-ionized particles of NaCl. We have seen that elements and compounds of an opposite nature attract each other more than those of like properties; metals have affinity for non-metals, acids for bases. In a similar way *opposite* electricities attract, and vice versa; like repel like, or, put in another way, substances charged with negative electricity are attracted to the positive electrode, or anode, and those with positive electricity to the negative electrode, or cathode. Thus metallic or positively charged ions are attracted to the cathode and non-metallic or negatively charged ions to the anode, whenever a current passes

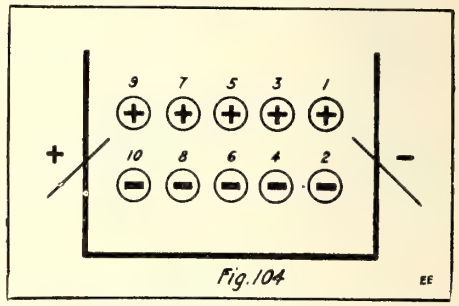
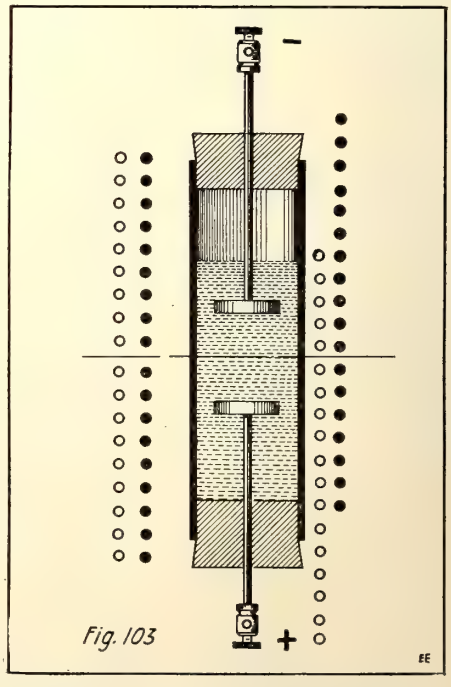


Diagram Representing Ions At Rest in Solution; each + Ion Balanced By a — Ion.

thru an ionized solution. This is a modification of Faraday's theory of direction of current.

An *ion* is, by derivation, a traveler. During the passage of a current those ions that travel towards the anode are called *anions* or upward travelers, those moving to the cathode are called *cations* (or Kations), or downward travelers (see Fig. 100). Anions are, therefore, metallic or *minus* ions, while cations are metals or *plus* ions, their destination giving the prefix of their names. These terms were assigned by Faraday about 1833. He thought the electric current produced the ionization, but Arrhenius, a Swedish chemist, in 1887, announced the present theory, namely, *that the act of dissolving an electrolyte produces the ionization,* and that the current, whenever it is applied, simply sets the ions in motion toward their respective electrodes. On arrival there, they part with their charges of electricity and become atoms or atomic groups (radicals and molecules).

(*Continued on page* 724)



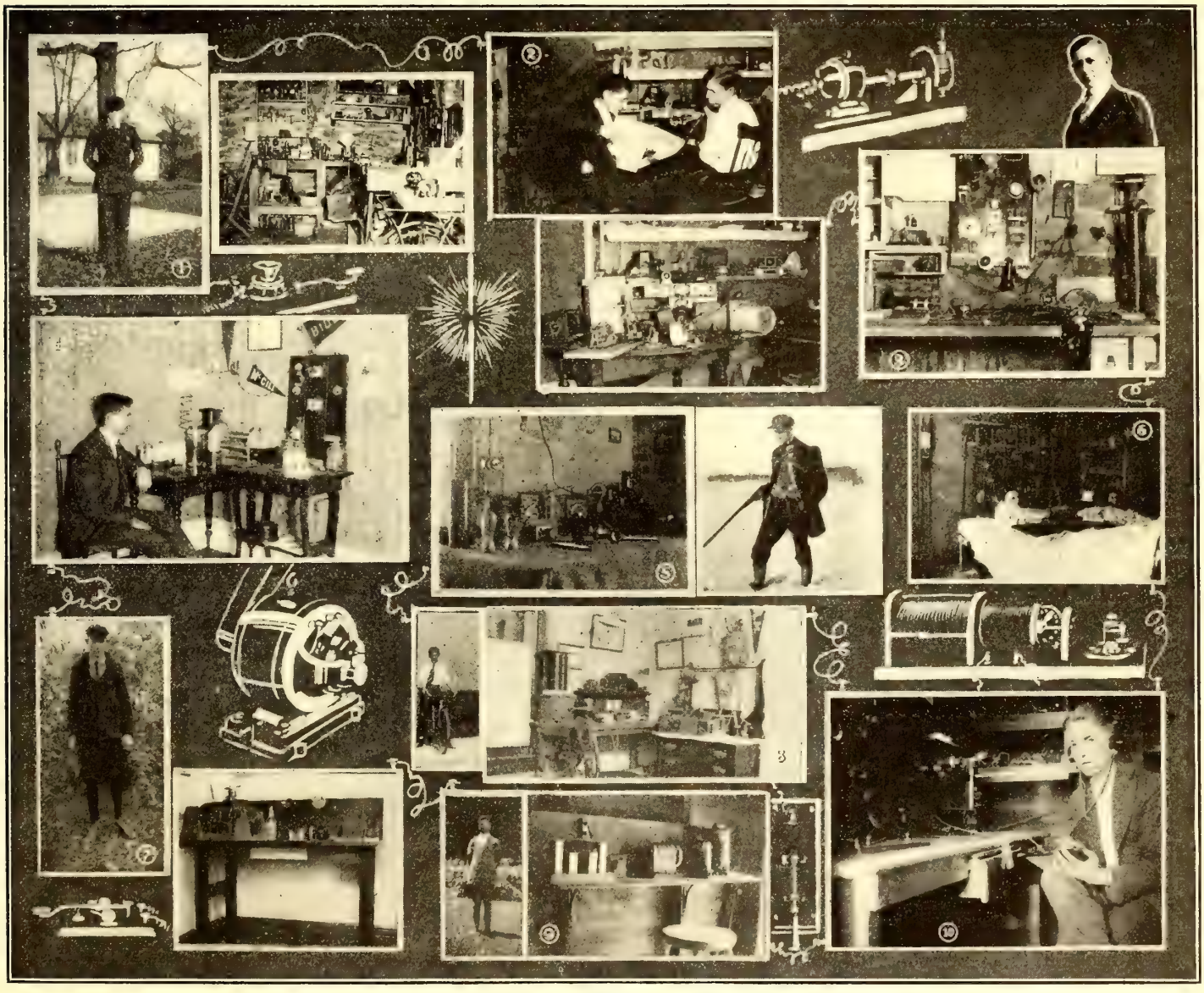
Another View of the Electrolytic Apparatus Illustrated in Fig. 102, With Schematic Arrangement of the Ions At Each Electrode.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month $3.00 prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

"Electrical Laboratory" Contest

In the March issue we will publish an interesting story with a number of interesting photos, describing one Amateur Electrician's experimental laboratory. Now "Bugs"—we want to publish a similar article each month. Here's our proposition: Why not write up your "Electrical Lab.," in not more than 500 words. Dress it up with several good clear photographs. If we think it good enough we will publish the article in display style and pay you well for it. The remuneration for such articles will range from $5.00 to $10.00. And "Bugs"—don't forget to make your article interesting. Don't write—"I have a voltmeter, an ammeter, a switchboard," etc., *ad infinitum*. For the love of Pete put some punch in it! Tell us what you do with your instruments and apparatus. You don't mean to tell us that every Experimenter does exactly the same thing. "We" know different—but from the general run of such articles which we have received in the past, one would naturally think every "Lab.," exactly alike. Remember—send a photo of YOURSELF along. Typewritten articles preferred. Tell us the facts and don't send in photos smaller than 3¼" by 4¼". They must be sharp and clear—not veritable "picture puzzles." We can read—but we are not mind-readers. Address the Editor "With the Amateurs Prize Contest."



A GROUP OF REPRESENTATIVE AMERICAN AMATEUR LABORATORIES.

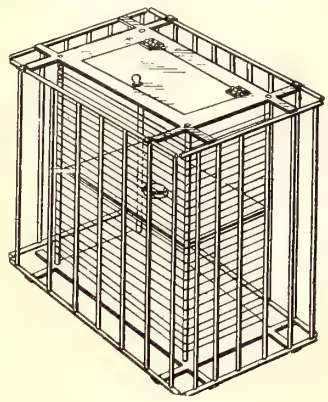
Electrical Laboratories of, 1—Phil Krippner, Green Bay, Wis.; 2—Frank Sloan, San Diego, Calif.; 3—Raymond E. Snyder, Akron, Ohio; 4—J. Hustic Holden, Westmount, Que., Can.; 5—Herbert M. Maus, Milton, Pa.; 6—R. E. Breunig, Chicago, Ill.; 7—Hugh Stevenson, Rochester, N. Y.; 8—D. Kenneth Auck, Bucyrus, Ohio; 9—Harold H. Wilson, Silver Creek, N. Y.; 10—Everett E. Twombly, Pasadena, Calif.

LATEST PATENTS

Electric Fly Trap

(No. 1,247,488; issued to William A. Bass.)

An improvement in electric fly traps which provides an outer pro-

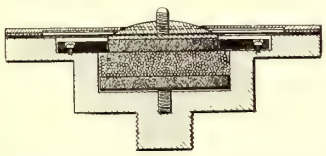


tective cage designed to prevent anyone from getting in contact with the live wires of the inner cage, in the manner shown. There is also provided an electric light either in the lower or upper compartment of the fly trap, to attract the flies or other insects. This lamp is connected in the circuit with the alternately charged wires of the inner cage, and these wires are spaced the proper distance so that an insect or fly passing betwen them will touch both wires, and thus be electrocuted.

New Microphone

(No. 1,245,218; issued to Felix Gottschalk.)

An improved form of electric microphone for telephonic and other purposes, comprising a movable

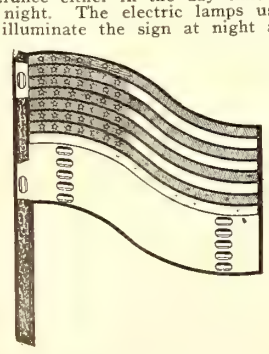


front electrode which is attached to the center of a vibrating diafram in the usual manner, and so arranged in the opening provided in a circular template, that the carbon granules in the cup chamber cannot in any way get out of this chamber, and thus cause rattling or other noises in the microphone. Also a perfect contact with the inner face of the vibrating electrode is provided for, without interfering with the free movement thereof.

Electric Flag Sign

(No. 1,246,847; issued to Paul J. Berg.)

A clever elctrical flag sign device adapted to be made in such a way that it will present an attractive appearance either in the day time or at night. The electric lamps used to illuminate the sign at night are

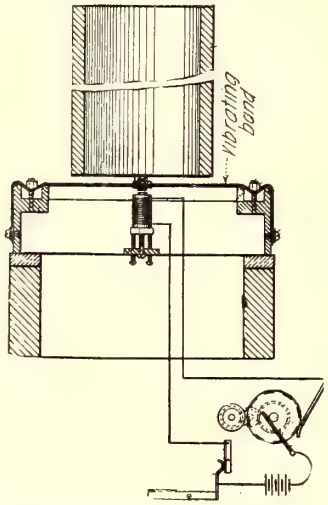


placed behind a glass surfaced, ridged field, provided with the desired surface-coloring on the glass either by incorporating the color or colors in the nature or construction of the glass or by application of stain to the glass. Each of the lamp tubes used in this device contains a multiplicity of filaments regularly spaced and by the special means of construction here employed for obtaining the color effects, etc., the location or shape of the incandescent filaments are not discernible.

Electric Musical Instrument

(No. 1,245,517; issued to Harold Scuterud.)

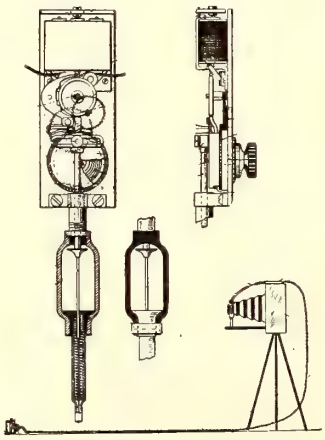
An improved musical instrument which is said to be free from ob-



jectionable harmonics when the special tension band in the instrument is vibrated electro-magnetically by the means shown in the drawing. A sonorous body in the form of a sheet metal band is mounted upon a stiff frame or support, and beneath this band there is placed a suitable electro-magnet connected with the proper circuit interrupting devices, including a battery and controlling key similar to that on a piano.

Electric Camera Shutter Trip

(No. 1,247,902; issued to Karl W. Thalhammer.)

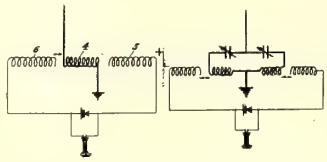


The inventor here provides a suitable device for actuating the camera shutter in any manner desired, the shutter trip being controlled by a reciprocating shaft driven by means of a spring motor on the device. This spring motor is released or retarded by an electro-magnet connected with a portable battery and push button. The battery and control button may be placed at any distance desired from the camera. The outfit is light and unobtrusive, and may be readily carried in the coat-pocket.

Radio Telegraph and Telephone Receiver

(No. 1,245,266; issued to Grenleaf Whittier Pickard.)

This patent provides a simplified form of radio telegraph and tele-

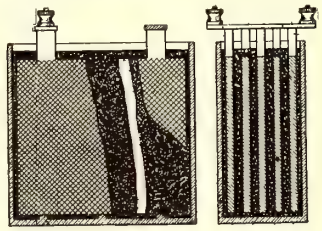


phone receiver having an inductance connected between the aerial and ground in the manner indicated, and which is caused to transfer the oscillatory energy in the antenna circuit to two secondary inductances, connected in a unipolar manner to a crystal or other detector shunted by a sensitive telephone receiver. Secondary coils 5 and 6 are connected together and are wound in such directions that their outside ends are of opposite potentials.

Storage Battery Construction

(No. 1,246,595; issued to Harry S. Hawkins.)

In assembling the cells, plates are spaced about 1/16 of an inch apart, and the inventor then places in the assembled battery a sufficient quantity of granulated sugar to approximately one-fourth fill the spaces between the spaces and around them. After the cell has been assembled

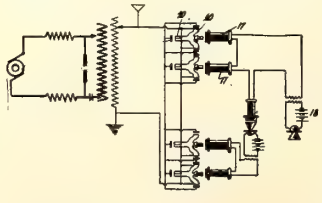


in this manner, it is placed in an oven and baked at a temperature of 380 to 410 degrees Fah., for from three to six hours. During the baking operation the sugar is completely fused and flows about and over the plates so as to completely surround them.

Wireless Telephone Modulator

(No. 1,246,420; issued to Paul J. Hackett.)

The aerial and ground terminals from oscillation transformer are connected to a series of one or more specially devised air-gap condensers. Each condenser unit is actuated by an ordinary telephone or other receiver, which receivers are connected up with a special high-power microphone apparatus in the manner shown in diagram. It will thus be understood how one voice or source

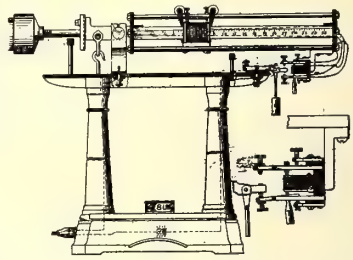


of sound waves talking into the transmitter (18) will actuate a plurality of receivers (17), each of which actuates a four-diafram air-gap condenser (10), thus greatly increasing the strength of the sound waves before applying them to the condenser units.

Electric Automatic Scale

(No. 1,248,273; issued to Samuel G. Crane.)

One of the objects of this invention is to provide an automatic scale with electrically-actuated poise mechanism, whereby the weight of an article or articles placed upon the scale platform is offset and indicated by an automatic movement of the poise along the scale beam. The device is arranged with a pair of electro-magnetic solenoids which may travel along the scale beam and be automatically governed and controlled by the balance weight at the end of the beam by means of special contacts arranged at that point. This electric scale operates on a very unique principle, viz., that whenever

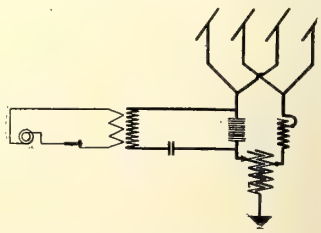


a solenoid coil is energized, it will attract a movable core or be attracted by a fixt core if the coil is movable; also the core and the solenoid will be moved relatively to each other until the center of mass of the core and solenoid coincide. By making the scale beams of tapering magnetic material so as to bring their centers of mass adjacent to the ends thereof, each solenoid is thereby provided with a separate core, and the solenoids being connected together to act as a single poise, will move along the scale beams in a forward or reverse direction when one or the other of the solenoids is energized.

Radio Oscillator

(No. 1,246,626; issued to David G. McCaa.)

This idea provides for an improved radio oscillation generator and radiator by virtue of increasing the energy storage function of the elevated conductors in the open oscillatory system. The idea also covers a system of producing sustained oscillations of low decrement and of emitting electro-magnetic waves



having good tuning qualities. As indicated there is provided an auxiliary grounded conductor parallel to and intermeshing with the main antenna conductors and helix, the inventor having found that it is thus possible to transfer the energy in the spark-gap-aerial circuit to the auxiliary tuned circuit, and in this way to store much greater energy and to radiate the same than without such an arrangement. When a maximum current is radiated in the auxiliary antenna circuit, the spark-gap-aerial circuit shows a minimum of current, and vice versa.

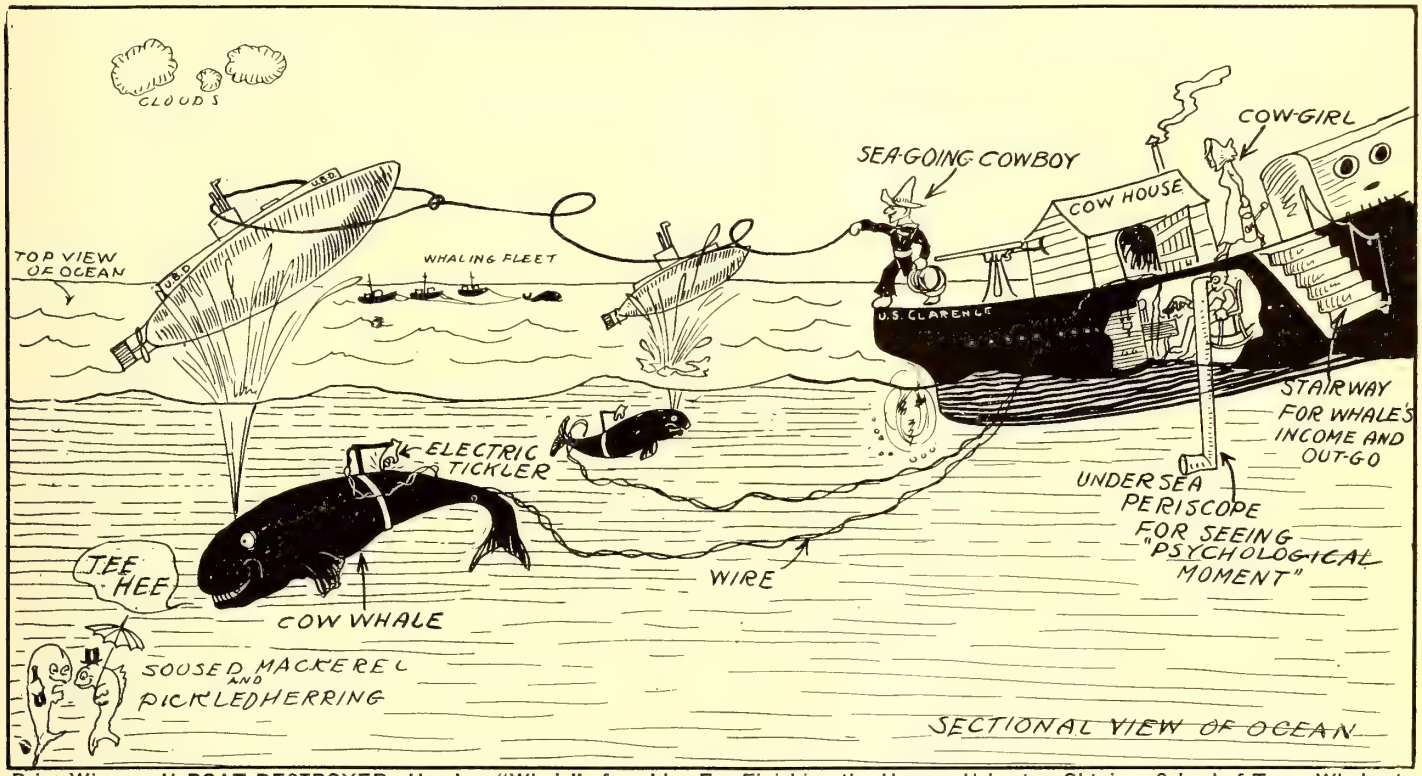
COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c EACH.

Phoney Patents

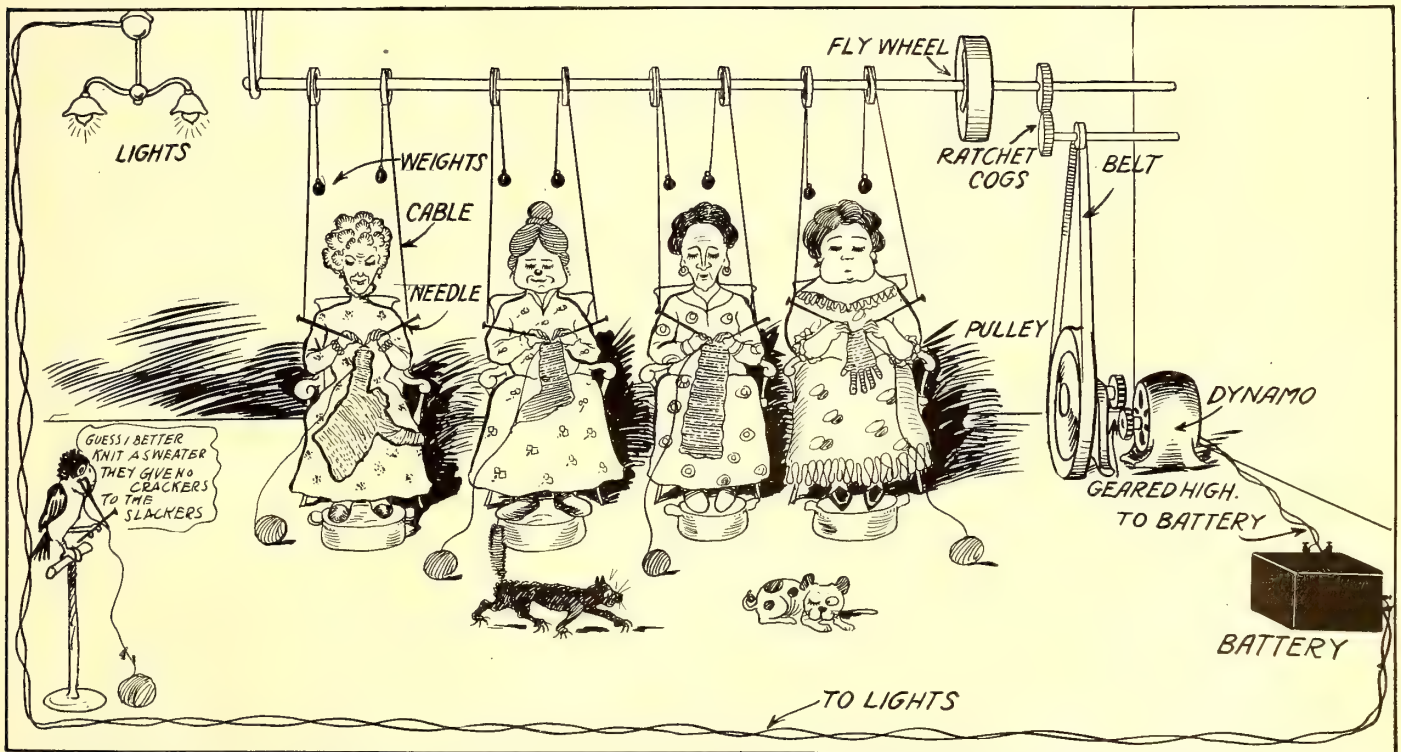
Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for the entire universe.

We are revolutionizing the Patent business and OFFER YOU THREE DOLLARS ($3.00) FOR THE BEST PATENT. If you take your Phoney Patent to Washington, they charge you $20.00 for the initial fee and then you haven't a smell of the Patent yet. After they have allowed the Patent, you must pay another $20.00 as a final fee. That's $40.00! WE PAY YOU $3.00 and grant you a Phoney Patent in the bargain, so you have $43.000!! When sending in your Phoney Patent application, be sure that it is as daffy as a lovesick bat. The daffier, the better. Simple sketches and a short description will help our staff of Phoney Patent examiners to issue a Phoney Patent on your invention in a jiffy.

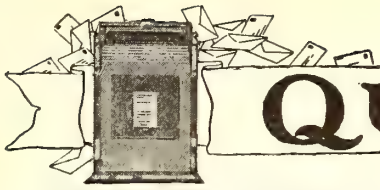
PHONEY PATENT OFFIZZ



Prize Winner. U-BOAT DESTROYER. Here's a "Whale" of an Idea For Finishing the Hungry U-boats. Obtain a School of Tame Whales to Convoy Our Troop-ships to France. When a Flock of "Subs" Are Located, Chase the Whales Over-board; When Under the Sub-sea Fighter, the Commander of the Whale-boat Presses An Electric Button. The Electric Tickler Attached to Each Cow Whale Tickles Her; She Becomes Peevish—"Blows"—and Up Comes the U-boat, Which Is Lassoed By the Ever-watchful "Sea-going Cowboy"! That Sounds Simple; Doesn't It? Inventor, J. W. Hanson, Roseville, Calif.



ELECTRIC KNITTING ECONOMIZER. Mother Knits; Sister Knits; Wifie Knits; and Several Dozen Other Branches of the Family. Have You Ever Sat and Wondered Just How Much Energy Is Expended By the Female Knitting Element of Our Population? It Would Amount to Over 1,000,000,000 H. P. Annually If Conserved. Wherefore I Have Invented My "Electric Knitting Economizer" Here Shown in Detail. The Knitting Needles Are All Attached to a Common Shaft Connected With a Dynamo; the Dynamo Charges a Storage Battery, Which Supplies Electric Light and Heat in Abundance. This Is What I would Call "Hooverizing Hoover." The Coal, Gas and Electric Purveyors Will Now Proceed to Faint. Inventor, John J. Loehle, Jr., Lebanon, Pa.



QUESTION BOX

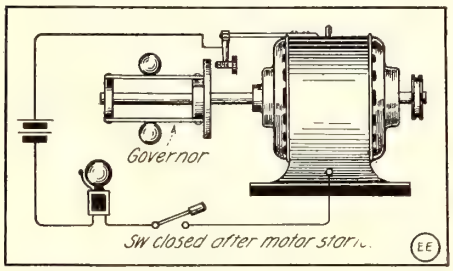
This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

WIRING DIAGRAM.

(881) T. G. Rogers, Nobel, Can., states:

Q. 1. I would like to know if you could suggest something in the shape of an electric bell or light signal to give warning that a belt had broke, or that a motor had stopt on an acid pump. Motor drives the



A Simple, Positive Alarm for Use on a Motor Driving An Acid Pump. As Soon as the Pump Stops the Bell Rings.

pump by belt, and the idea is to notify a person in a building 60 feet away that the pump has stopt. A bell would be the most suitable, or a red light to light up would do.

A. 1. We give herewith one suggestion from which you can obtain pointers on the building of such a device.

This scheme utilizes a small governor secured to the motor shaft which operates thru a lever as indicated. A contact which is closed operates the electric bell thru the electrical circuit as shown. Another method by which you can obtain the same results is to introduce in the motor circuit an automatic circuit breaker which, when the motor will stop, trips the circuit breaker, and then automatically closes the external bell circuit for signal purposes.

ELECTROLYTIC FURNACE.

(882) O. R. Dixon, Portland, Ore., says:

Q. 1. I very much desire to get data on an electrolytic furnace and thought perhaps you would be able to tell me where I can obtain such information either in book form or otherwise.

A. 1. We regret to say that the information which you ask in reference to the Electrolytic Furnace cannot be had as this data is still in the hands of the inventors, and is not disclosed for public use at the present time.

TELEPHONE ACROSS THE OCEAN.

(883) F. Brown, Jacksonville, Fla., asks:

Q. 1. Why cannot speech be transmitted by cable across the ocean?

A. 1. The reason why it is not possible at the present time to communicate telephonically across the ocean is due to the fact that high capacity in the cables distort tremendously the wave shape of the telephonic waves, which naturally destroys the effects of speech, and thus it does not permit true speech to be carried on thru such a line.

Another reason that prohibits such a project is due to the inherent high resistance of such cables which reduces the electrical current necessary to operate the receiving equipment, and as you perhaps may know, the current used in telephonic work is very minute. Thus any obstacles tending to destroy their intensity would naturally destroy the intensity of speech. However, the former reason is the greater obstacle which prevents the use of these cables for telephoning across the ocean.

LOOSE COUPLER.

(884) Geo. M. Phillips, Washington, D. C., asks:

ODD PHOTOS WANTED AT $1.00 EACH ! ! !

Now is the time to make your Kodak pay for itself in a real practical way. We are after interesting photographs of out-of-the-ordinary electrical, radio and scientific subjects and are willing to pay $1.00 *cash for every one we can use. Please bear in mind that for half-tone reproduction in a magazine, a photograph should be particularly sharp and clear. Of course, if a subject happens to interest us particularly well, we can have the photo retouched. For the general run of subjects, however, it does not pay to go to such expense. Therefore, please take pains to properly focus and expose your pictures. It often happens that a really mediocre subject well photographed wins approval over an excellent subject poorly photographed. And don't send us plate or film "negatives"; send unmounted or mounted "prints," perferably a light and a dark one.*

As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 *to* 150 *words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.*

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, *233 Fulton Street, New York City.*

Q. 1. I am making a loose coupler and want to know if the secondary is wound opposite to the direction of the primary.

A. 1. We would inform you that the direction of winding of the secondary with respect to that of the primary must both be in the same direction, as this tends to mutually couple these two coils with a minimum loss due to counter-electromotive forces which may be set up due to opposite windings.

MOTOR DESIGN.

(885) W. F. S. Jr., Corregidor, Philippine Islands, would like to know:

Q. 1. Kindly explain the general principles governing the design of small fan motors which will operate on either A.C. or D.C. of 110 volts?

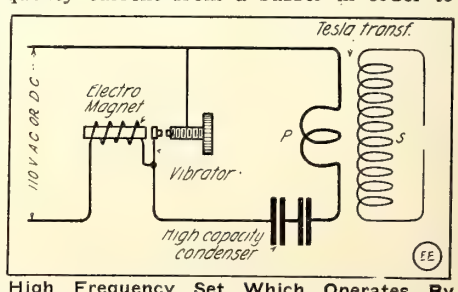
A. 1. There are several factors which control the design of a small motor, and the following must first be known before the procedure of design for such a motor is undertaken, *viz.*, the physical size of the machine, that is, over-all dimensions, and the power which the machine is to deliver (in this case about 1/32 of a horse power would be sufficient.) Another point which must be considered is the general shape of the magnet field; for good practise the bipolar circular field is advisable. The size of the magnet field-poles may be either circular or square in form, but the former is preferable as it gives better winding facilities than the latter type. The shape of the pole-pieces is controlled by the diameter of the machine. Also, the field winding is controlled by the depth of the winding space. The resistance of such a field when employing a series type of motor is very low, while a high resistance field is employed in shunt machines.

This, of course, is controlled by the external conditions of the machine. For the class of machine which you mention, the series type is preferable, as in this case both alternating and direct currents can be used for operating it. The armature magnetic circuit depends upon the internal diameter, and the magnetic field in which this armature is to be rotated. The armature should be made of a number of laminated soft iron discs; the number of slots on the armature is dependent upon several factors which we cannot discuss in detail here. However, for the size of motor in question, a six-slot armature would suffice. The number of field poles for this machine would depend entirely upon the speed of the machine, and upon the magnetic flux density of the magnetic circuit. The commutator should contain six sections.

HIGH FREQUENCY SET.

(886) John Ives, Chicago, Ill., writes:

Q. 1. Is it possible to obtain high frequency current from a buzzer in order to



High Frequency Set Which Operates By Means of a Buzzer, Shunted by a High Capacity Condenser, on 110 Volt A. C. or D. C. Circuits.

operate an Oudin or Tesla transformer? If it is possible to operate one, kindly give wiring diagram.

(*Continued on page* 711)

Turning 8c Cotton Into $4.50 Silk

World-Famous Chemist Has Stolen Secrets of the Silkworm—Mechanical Silkworm Now Takes Poor Grades of Cotton and Turns It Into Lustrous Silk—An Invention That Should Revolutionize the World's Silk Industry.

By A. A. ALVORD

Contributing Editor Farmer's Fireside Bulletin, Official Organ of the Texas Farmers' Union.

Mr. Alvord's article, part of which has appeared in the Farmer's Fireside Bulletin, the Official Organ of the Texas agriculturists, reveals a wonderful new industry which has been added to the many industrial enterprises of Texas. This invention has been investigated by Prof. J. B. Bagley, head of the department of Textile Engineering of the Agricultural and Mechanical College of Texas, who has reported the invention to be absolutely practical and feasible. The story of Frederick Wide's process, which turns the cheapest grades of cotton, as well as the better grades, into fine silk worth $4.50 a pound is of paramount interest, as silk is a world-wide necessity the supply of which has been greatly curtailed by the European war.

I have seen with my own eyes a modern miracle of science.

I confess freely that had anyone told me beforehand what I was going to see I should probably have been so convinced that what was claimed could not be done that I might not have witnessed this marvelous demonstration of the wonders science can produce. But I went and I CAN NOT DOUBT THE EVIDENCE OF MY OWN EYES. Even now I am a good deal like the farmer at the circus who gazed on the long-necked giraffe intently for half an hour, then scratching his head, turned away, saying: "Shucks, there ain't no such animile."

Incidentally my brain is still dizzy from trying to calculate the simply unbelievable profits that this invention is bound to make. When my brain had soared into millions—more millions than I care to enumerate—I realized that the wealth-creating possibilities of this modern miracle of science meant fortunes for scores.

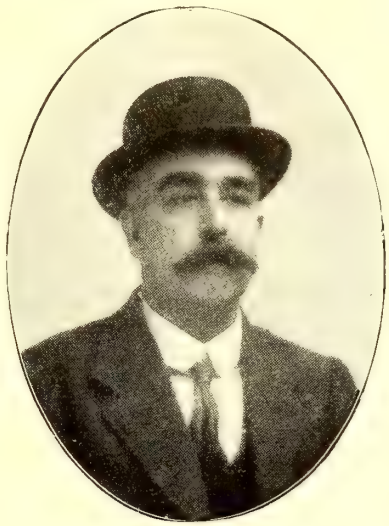
In a nutshell here is what I saw:

I saw refuse cotton, what is known in the cotton trade as "Linters," worth ordinarily from SEVEN TO EIGHT CENTS A POUND turned into exquisite, lustrous, shimmering silk worth at present quotations $4.50 A POUND AS YARN for textile or thread making.

Before I go any further let me tell you something about silk.

WORLD FACES SHORTAGE OF SILK

Silk is to-day of practically universal use. There is hardly a man, woman or child in the United States that doesn't use silk in some form. It is used for hosiery, for dresses, for underwear, for linings, for trimmings, for ribbons, for all kinds of draperies as well as for hundreds of commercial purposes in industries of various kinds.



MR. FREDERICK WIDE

Mr. Wide has invented and perfected a process for manufacturing silk from cotton. By this process cotton worth 8 cents a pound is turned into silk for which there is a ready sale at $4.50 or more per pound. Read the wonderful story of this great invention.

A great part of the world's supply of silk is produced by Italy and France. The war has practically stopped this production. The great plains of Northern Italy which have recently been devastated by the Teuton armies produced countless tons of the beautiful product. We must now look to Japan for our silks, and so vividly does Japan realize the importance of its silk industry that to carry silk worms out of the country is punished most severely by the Japanese authorities.

In the last few years a silk substitute has been manufactured in Germany, Belgium and England. This has been enormously successful and has made fortunes. But Germany, Belgium and England have turned their artificial silk factories into gun cotton plants and practically none comes from there any more. So the problem of producing silk enough to meet the world's demands is a vital one.

This wonderful invention is a great stride towards the solution of this big problem.

A MECHANICAL SILK WORM

Back of most of the great utilitarian inventions of to-day is the mighty brain of some chemist.

Back of the new silk is the genius of a great chemist.

Frederick Wide. Write this name on your memory tablets, and write it deep, for it is the name you will hear much of in the future, as he is the man who has found a way to turn eight-cent cotton into silk worth $4.50 a pound.

If you could talk to Mr. Wide, and if you had a sufficient knowledge of the science of chemistry necessary to understand what he told you, he could show you, step by step, how science learned from the silk worm the secrets of silk making.

He could tell you how scientists studied the silk worm, its habits, its methods, its foods, the processes of evolving the secretions which it spins into those gossamer filaments, so slender yet so strong and so wonderfully lustrous.

He could tell you how those secretions were analyzed until they had no more secrets to conceal.

He could tell you why those secretions flowing from the cocoon hardened on contact with the air, becoming so wondrously strong and lovely.

He would tell you all these things in language overloaded with words and names, verbs and adjectives you had never heard before and probably would never hear gain. He would tell you how science



PROF. J. B. BAGLEY.

Prof. Bagley is a graduate of Wake Forrest College, N. C., and one of the foremost cotton mill experts of the world. He was with the North Carolina Cotton Mills '01-'02; North Carolina Textile '01, '04; Instructor in Texas Textile School, '05-'07; Instructor in Mississippi Textile School, '07-'08; Professor of Textile Engineering, Texas Agricultural and Mechanical College since 1908.

studied the chemical reactions which occur in the stomach of the silk worm and change its food of mulberry leaves into the juices that become silk.

Then he would tell you how science, working from known facts, devised a purely mechanical means of doing that which the silk worm has been doing without knowing why, since the beginning of time. He would tell you of the mechanical silk worm which is revolutionizing the silk industry.

MAKING SILK OUT OF COTTON

Perhaps Mr. Wide would tell you that the chemical components of silk and cotton and wood are practically the same, just as he could tell you that science is bending its efforts to turn many substances of which we have quantities into other articles of which we need quantities. He could tell you how chemists have taken the refuse of the gas plants—known as coal tar—and made from it wonderful dyes, exquisite perfumes, powerful medicines. He could tell you how the waste of scores of industries has been turned into fortunes. And then he could explain to you why the same component elements in different combinations make wood, and sugar and cotton and silk and other substances.

Then he could tell you of the experiments covering years of effort that had as their object the discovery of the processes by which silk is formed in the body of the silk worm and how to obtain the right combination of elements into a genuine silk, real as the silk of the silk worm, with all its wonderful lustre and strength and qualities. He could tell you that years ago the chemists had succeeded in making silk out of cotton, but that they had made a silk that was as inflammable and explosive as gun cotton, which in fact it was. And then he could tell you how experiments by the thousands were made before the secret of making a silk from cotton that was neither explosive nor inflammable was obtained. It would take a book many times larger than this magazine to tell that story in full. So to keep this article in the brief confines of a magazine story we will let you guess at all those transitions and come down to the secret of turning cheap cotton into expensive silk. It is a story worth telling. I will try and tell it to you simply, just as it impressed my non-technical mind.

DISSOLVING COTTON LIKE SUGAR

Any kind of cotton can be used in making silk. The cheaper grade—what is known as "linters" and "short staple"—is used for two reasons: because it is cheaper and just as good, and because it is practically a waste product, while the long-staple cotton is useful and necessary to humanity. The true scientific chemist is ever a utilitarian, seeking to use that which seems useless.

This cotton "linters" comes generally from the cotton seed mills, being a by-product of the seed, from which it is removed by mechanical processes before the seed is milled into oil. This short-staple cotton is a dirty yellowish color and carries more or less impurities. It is therefore submitted first of all to a thorough cleansing process and then is bleached white as driven snow. When these first processes are completed the cotton is in a soft, fluffy mass. It is like the absorbent cotton used by physicians and it is ready for processing into silk.

Incidentally you may be interested to know that Mr. Wide is planning to manufacture thousands of pounds of cotton for medical purposes as well as silk.

This cotton is then plunged into glass or porcelain-lined vats which contain a solution which is the secret of the process. This solution contains many chemical ingredients. In these vats take place the chemical actions which turn the cotton into silk, just as the contents of the stomach of the little silk worm turn the mulberry leaves into silk.

THE MECHANICAL SILK WORM

As soon as the cotton is completely immersed in the solution it melts just like a lump of sugar plunged into water will melt. Then a curious thing happens. The whole mass turns a beautiful blue, clear and sparkling as an Italian sky. When the correct proportion of cotton has been added to the solution to properly impregnate it, then the contents of the vat, which are now thick like syrup, are poured into a machine. This machine is the mechanical silk worm.

If you have ever been through a factory where silk is manufactured from the silk worm you will have seen bundles of cocoons, each cocoon yielding a tenuous thread like the diaphanous web woven



UNION NATIONAL BANK BUILDING.

This is one of the fine office buildings of Houston, Texas. It is the home of the Houston Bank & Trust Company, of which Mr. Ben N. Garrett is president. The executive offices of the Texas Textile Company are also located in this building.

by a spider. These many threads are gathered to one reel by the deft fingers of girls, who keep it ever twisting and turning into a soft, golden-colored yarn.

The mechanical silk worm has hundreds of tiny glass tubes, each ending in a point pierced with a microscopically small perforation. The bright blue, syrupy cotton solution is forced out through these myriad minute tubes, flowing out in a fairy web so fine that each thread is hardly visible, yet when gathered together these threads make a soft, bright blue yarn, as silky as any silk spun by mulberry-fed silk worms. Practically the only difference is that instead of being golden yellow, like natural silk, this artificial silk is bright blue. The silk is gathered on spools that wind the soft filaments into a glossy yarn. This web hardens on contact with the air.

There is still one more process before the yarn is ready for shipment to the textile manufacturers to be made into all kinds of varieties of silk goods. This is the bleaching process. The bright blue yarn is given another bath, this time in a bleaching agent, and it comes out white as the purest mountain snowdrifts.

WONDERFUL ECONOMY OF PROCESS

The most wonderful part of this whole process is that in none of the operations is there any waste.

A pound of the cleansed cotton yields a pound of silk and even the ingredients of the solution that effects the magic change in the character of the cotton are recovered from the bleaching bath to be used over and over again.

This man-made silk has all the characteristics of natural silk. It is strong



MR. BEN N. GARRETT.

Mr. Garrett is the successful Texas banker who has associated himself with Mr. Wide in the Texas Textile Company, which has been organized to develop Mr. Wide's great invention. He is the head of two other great corporations which have been most successful.

and durable like silk. It takes any dye like real silk. It is as white and remains as white as natural silk. It is non-inflammable like real silk. It has all the sheen, lustre, softness and radiance of natural silk. It wears like real silk and holds its glossiness like real silk. It can be laundered over and over again without losing its color, or the lustrous beauty of the fabric or the softness of texture. IT IS SILK, a man-made silk, another triumph of human brains and ingenuity, of scientific skill and industry.

The chemical change that occurs in the stomach of the silkworm that turns the fibrous mulberry leaves into silk is practically the same chemical change that turns the cotton of our great cotton fields into this silk.

Do you wonder that I read FORTUNE in those filaments of bright blue as they shredded from the mechanical silkworm?

Do you wonder how big that fortune may be when I tell you that this eight-cent cotton is turned into silk worth $4.50 a pound?

That was the recent price, but this price is going up all the time owing to the shortage of silk from Italy, France, Japan and China! What it may go to no one can tell. Shortage of supply of any article of great demand always results in higher prices. Natural silk is worth over $7 a pound right now, I am told; $4.50 is the price for the manufactured article such as Germany and Belgium and England had been sending us. Experts who have examined the imported manufactured silks and the silk made by the Wide process say the Wide silk is a big improvement on the old world product.

WAR HAS HELPED DEVELOP INDUSTRIES

The war has been a big thing for American industry in many ways besides making fortunes in war brides, as they playfully call the ammunition and arms companies that have made phenomenal fortunes in providing the fighting nations with arms, ammunition, etc.

Before the war we bought our natural and manufactured silks abroad. Before the war we bought all our dyes from Germany. Before the war we bought all our lenses and watch crystals from Germany. Before the war we bought all our potash fertilizers from Germany. Hundreds of chemicals, acids, fabrics, manufactured metals, pigments, machines, textiles, etc., came to us from abroad. War closed the ocean lanes to the importation of these goods and American inventiveness and enterprise, forced to exert themselves, have remedied the shortage by duplicating these necessaries of life and in many cases we have improved on the originals.

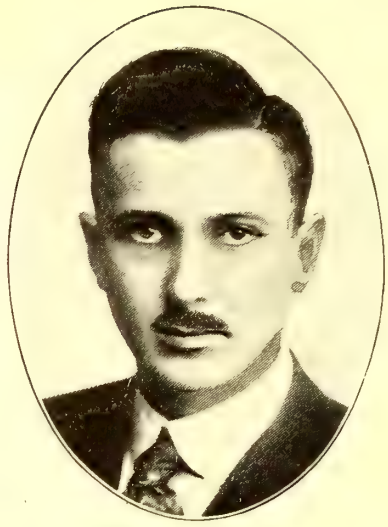
Mr. Wide is an Englishman. He has been one of the biggest men of the man-made silk industry in England. He was one of the pioneer chemists in this field working hand and glove with the chemists of Belgium and Germany who were striving to produce an artificial silk to meet the world's demand for this product. When war was declared he was at the head of one of the biggest artificial silk manufacturing companies in England. With the coming of war the factory was turned into a munition plant. With his plant closed, as far as the manufacturing of silk, Mr. Wide decided to come to America. He knew the world needed absorbent cotton for treating wounds and for dressings. He came here to make his knowledge and experience valuable. Probably the first work the new factory will do will be to turn out great quantities of absorbent cotton, which will be one of the important by-products of the Texas Textile Company, as will be explained further along.

He had Texas in view as the place of opportunity. Texas, the wonderful Lone Star State, which produces one-fourth of all the cotton produced in the world and which offers greater investment opportunities than any other state in the Union.

GENIUS AND POWER JOIN HANDS

What more natural, once he had cast his far-seeing eyes on Texas, than that he should gravitate towards that organizing and developing genius of Texas, Ben N. Garrett, the young giant of industry with the touch of Midas. In Texas they liken this young genius of finance to the god of ancient mythology, whose touch turned things to gold. In Houston they will tell you that everything Ben Garrett touches turns to gold, that he has made a record of success in financing propositions that has been the amazement of the financial world.

So the genius of science and the genius of finance met on common ground and from the union of these two geniuses has been born an enterprise that promises to add tremendously to the industrial importance of Texas and that should earn fortunes for the lucky ones who "string along" with Ben Garrett.



MR. C. A. LEWIS.

Mr Lewis is cashier of one of Houston's largest banks and a member of the Board of Directors of two large Texas Corporations. He was formerly with the Security National Bank of Dallas, Texas. He is a man who has risen to the front ranks in the Banking Fraternity.

When Mr. Wide and Mr. Garrett met neither knew very much about the other and each tells now, laughingly, what elaborate precautions each took to find out about the other.

Garrett's first thought was to find out how much of the wonderful story he had heard from the lips of Wide was to be credited. Wide set about finding out whether Garrett was the right man to tie up to. For a few days they sparred around in New York, each making excuses to the other to avoid coming to a decision. Garrett corroborated Wide's statements by cablegrams from American consular officers in England and from other reliable sources of information in London. When both had arrived at the conclusion that the other was the right man to tie up to further details were soon settled.

FAMOUS COTTON EXPERT CONSULTED

Among the men Mr. Garrett consulted was Professor J. B. Bagley, head of the department of Textile Engineering at the Texas Agricultural and Mechanical College. Prof. Bagley is probably the greatest cotton expert in the country, if not in the world. Prof. Bagley's report was not only satisfactory, it was enthusiastic. He was so enthusiastic that his first thought was to invest in the company which Mr. Garrett was planning to organize. He has since become a large stockholder and is Vice-President of the company, but that is going ahead of my story.

Mr. Wide accompanied Mr. Garrett back to Texas and immediately set about establishing his laboratory, which he had brought with him from England. This laboratory contains a complete equipment,

on a small scale, for turning cotton into silk.

Once the laboratory was set up, Mr. Wide invited Mr. Garrett, Prof. Bagley, the writer and a few other associates of Mr. Garrett to a demonstration of the process.

I have already described to you how he took the cotton and plunged it into the vat of solution, how he poured the syrupy melted cotton into the mechanical silkworm and how the filaments of the pure bright blue silk were pressed out of the needle-like points of the capillary tubes, hardening as they struck the air into web-like threads of lovely silk.

The demonstration was so convincing that it was practically decided at that time to go ahead with the proposition. Mr. Garrett, however, whose successes have been won by combining a splendid daring with a wonderful caution and almost superhuman sense of opportunism, wanted to be absolutely sure before he went ahead.

Here was an industry that meant much to the state if it was successful, he argued. Hence, he told himself, it was essential to get the public attitude towards such a proposition. So he compiled a report of all that he had seen, all that he had learned of the process, its possibilities, the market for the product and the costs of production, the raw material, everything, in fact, that could throw any light on the proposition, and made this up into a circular, which he submitted to the leading bank directors of the state of Texas. He wanted a consensus of opinion. HE GOT IT. From all parts of the state came most favorable reports. "Texas wants your silk plant," is what they told him, and many of these big banking men, the most solid and responsible element in the state, volunteered to subscribe for stock in the company once it was formed.

Satisfied now that he was right, Mr. Garrett went ahead and organized the TEXAS TEXTILE COMPANY.

The TEXAS TEXTILE COMPANY is organized in a similar manner to many of the largest concerns in the United States, such as the Magnolia Petroleum Co., the Long-Bell Lumber Co., the Pierce-Fordyce Oil Association, etc. The articles creating this organization vest control of its affairs in a board of trustees, pledge the assets of the organization for its liabilities, and exempt the stockholders and trustees from personal liability for same. This is a powerful safeguard of the interests of all stockholders. No bonds of any kind have been issued and there is no preferred stock. All stock is common stock, fully paid up and non-assessable. Every shareholder in the business will hold exactly the same kind of stock and participate in the profits in exactly the same ratio as every other stockholder. This, Mr. Garrett believes, is the fairest and safest type of organization for all interested.



COTTON READY FOR SHIPMENT.

One-third of the world's total production of cotton is shipped through the Houston gateway to foreign countries. This is a typical scene at a cotton wharf where the huge 500-pound bales of cotton are assembled ready for shipment on steamers to foreign ports. This cotton, ranging in price from 8 to 20 cents a pound, can all be converted into silk worth $4.50 a pound, or more, by the Wide processes.

He personally advanced all the necessary funds for organization work. He personally bought and paid for, in the name of the company, the rights to Mr. Wide's process, and he also bought Mr. Wide's laboratory equipment, his supplies, machinery, etc., advancing the necessary funds for all expenses.

COMPANY SECURES FACTORY SITE

It was decided to locate the factory in the outskirts of Houston on the Houston ship channel, that great inland waterway which leads from the heart of this beautiful city to the Gulf of Mexico and which is navigable by the big ocean ships.

The factory site was bought. It has 300 feet of frontage on the ship channel with its own docking facilities, a great advantage, as water routes are always the cheapest for shipping goods.

Jno. W. Maxey, one of the great efficiency engineering experts of the South, was engaged to plan the factory in conjunction with Mr. Wide, so as to make it as efficiently perfect as possible. The first of these buildings is now in course of construction. It is of brick and concrete, absolutely fireproof. Mr. Wide was immediately sent to Philadelphia to get together his machinery. Part of this is standard equipment which is used in all cotton mills for cleansing and bleaching the cotton. The rest is now being built under Mr. Wide's own supervision from his own plans.

So efficient and methodical has been the work of development of the company's plans that in less than ninety days from this publication the factory should be in operation, turning the cotton of Texas into silk fit to grace an imperial queen. They say up North that we of the South are slow. The New South—especially the South of Texas, is anything but slow. This achievement proves it.

COMPANY IS MODESTLY CAPITALIZED

When I asked Mr. Garrett particulars about the capitalization of the company he smiled. "The Texas Textile Company is only capitalized for $250,000," he said. "You may be surprised at this modest capitalization, but we do not need a great deal of money to put this proposition on its feet and the smaller the capitalization the bigger the dividends. The stock is all common stock, fully paid up, full profit-sharing and non-assessable."

I asked him what the company was going to earn. Again he smiled. "Dividends are pretty hard things to predict," he said, "but let us consider a few facts. We have planned a factory that will start with a machinery equipment capable of handling from 600 to 1,000 pounds of cotton a day; 600 pounds a day would mean 600 pounds of silk produced a day. This has a value of $4.50 a pound in its yarn form. The cotton should not cost over 10 cents a pound, perhaps 6 to 8 cents. Even by allowing a very liberal margin for expense, overhead, labor, selling costs, etc., the total expense of producing a pound of silk, including the cost of the cotton, should not possibly exceed $1. That leaves us a profit of more than $3.50 a pound of cotton handled. If you figure what 600 pounds a day at $3.50 a pound profit means you will get a fair estimate of what our earnings ought to be. As a matter of fact, we expect to be handling 1,000 pounds of cotton a day very soon after we get started. Then as we get into the swing of the thing and profits begin to accumulate, we plan to enlarge our capacity to 2,000, 5,000, 10,000 pounds a day. The additional investment will not be large and the greater the production the lower the overhead costs so, as we increase our production, we should also increase our profits proportionately. 10,000 pounds a day, even at a profit of only $3.50 a pound would make a very nice income. Don't you think so?"

PROFITS FROM BY-PRODUCTS

I certainly agreed with him. Then he added:

"In addition to producing silk we shall have several by-products that ought to increase our earnings quite substantially. We shall probably start right out making absorbent cotton. There is a great need for it in the army hospitals. In fact, the government and the Red Cross are urging all cotton manufacturers to give them all they can turn out. Cotton batting is another by-product that we can manufacture with our equipment. Medicated cotton is another. Gun cotton base is another in great demand by powder works. Another good by-product will be artificial horsehair cloth for the tailoring trade which we shall be able to make in a very superior quality, much better than the real horsehair cloth the tailors and dressmakers use now because we can spin a thread like horsehair a mile long if necessary, so that there will be no raw hairs sticking out of the fabric, as is the case with the short horsehairs they have to use now. There are other by-products which the market will give us an opportunity to make and which will add to our profits. So you see our little company should be a very nice income-maker."

STRONG MEN DIRECT THE COMPANY

No matter how great the opportunities of an enterprise may be it is, after all, the HUMAN ELEMENT that makes or unmakes success. The genius of men like John D. Rockefeller, J. Pierpont Morgan, Andrew Carnegie, E. H. Gary, Henry Ford, Westinghouse, Vail, Marshall Field, has been the deciding factor in creating the success of the enterprises their brain, energy and enterprise has created.

The TEXAS TEXTILE COMPANY is managed by men of KNOWN SKILL and ability whose success INSURES the success of this company.

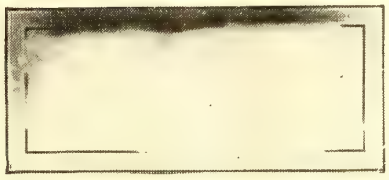
BEN GARRETT, President of the company, is one of Houston's prosperous financial men. He is the executive head of two corporations with a combined capital of $600,000, and during the past year these two companies have disbursed to their stockholders $360,000 in cash dividends and disbursements, with over $100,000 yet on hand to be distributed this year. Just think of it! $360,000 in dividends in one year for companies with a capitalization of only $600,000. Isn't that PROOF of the financial genius of this man?

Prof. J. B. BAGLEY, Vice-President, is, as I have already told you, head of the department of Textile Engineering of the Texas Agricultural and Mechanical College, a position he has held for the past twelve years. The company is particularly fortunate in securing this eminent expert as an officer. His valuable knowledge and wide experience will be of inestimable value to the company.

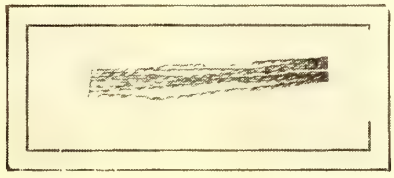
FREDERICK WIDE, Managing Director, was for many years superintendent of textile factories in Belgium, Holland and France. He was superintendent in charge of the Thos. A. Edison and Swan Company, manufacturers of phonographs and electrical equipment at Cologne, Germany. For the six years prior to his coming to the United States Mr. Wide was in charge of a large silk factory in England and considered one of the foremost chemists and manufacturing experts in Great Britain.

C. A. LEWIS, Secretary and Treasurer, was formerly connected with the Security National Bank of Dallas, Texas, and an active director of two large Texas corporations. He is now cashier of one of the largest private banking institutions in the Southwest.

HOW COTTON IS MADE INTO SILK



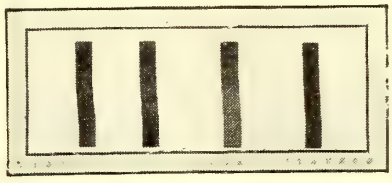
This is the raw cotton after being cleaned and bleached ready for making into silk.



This is the same cotton turned into silk yarn by the Wide process and with the Wide machine, which has been called the Mechanical Silkworm. This is the way it looks before bleaching.



The Wide silk woven into rich silk fabrics. It has all the sheen and lustre of natural silk and will take any dye.



Another sample of silk made from the yarn manufactured by the Wide process. It takes the most delicate dyes and can be laundered over and over again without losing its sheen or color.

With such men at its head the TEXAS TEXTILE COMPANY is well officered indeed and its prospects are more than promising.

POSSIBILITIES OF THE COMPANY

The possibilities of the company are so large that even a cursory examination reveals opportunities of dazzling dimensions. It is a well-known fact that the world's greatest entomologists and silk worm experts have exhausted all known means of increasing natural silk production. The demand for silk is growing greater every day. We live in a luxurious age. The world demands silk and MUST HAVE IT. There is no way to escape the fact. The war has not only curtailed the production of silk, but it is quite probable that irremediable losses in silk worms have been sustained in the invaded Italian plains where this industry thrived.

Mr. Wide has given us a process of manufacturing silk in unheard of quantities from a staple article of very low price. SCIENCE HAS MET THE CALL OF DEMAND.

With the artificial silk factories of Europe closed down we have practically a MONOPOLY OF THE PRODUCTION.

The supply of raw material of this cheap grade is practically inexhaustible. There are known to be from 3,000,000 to 4,000,000 bales of low grade cotton produced EVERY YEAR. Each bale weighs 500 pounds; 4,000,000 bales means TWO BILLION POUNDS of low grade cotton which can be converted into silk, and that's EVERY YEAR.

We have now over 100,000,000 people in the United States and all of them, from the babe in its cradle to the ancient tottering to the grave, use silk in some form or other.

That's only in THIS COUNTRY, but the WHOLE WORLD is clamoring for silk.

IS THERE A MARKET FOR THIS PRODUCT?

The question is futile. If we didn't know anything about silk at all we could easily guess the answer. But we do know. We know also that the present price—now about $4.50 a pound for textile silk—is apt to grow much higher very soon as the pinch of shortage is felt more keenly. Indeed, it has increased in the last month from $3.85 to $4.50 a pound.

Houston, Texas, is the ideal location for the factory. It is the gateway of the Southwest. Through this gateway are shipped annually to foreign ports ONE-THIRD OF THE WORLD'S PRODUCTION OF COTTON. Houston is the radiating center of a network of railroads and waterways that traverse the entire Southwestern section. Within ten miles of the TEXAS TEXTILE COMPANY'S factory is one of the greatest oil producing districts in the country, the famous Goose Creek field. That means VERY CHEAP FUEL for power.

Labor is cheaper and more abundant in Texas today than anywhere else in the country. Living is cheaper here. Freight rates are cheaper owing to the competition of rail and water routes.

Why shouldn't this company set records in earnings to make the biggest dividend payers in the history of industry seem puerile?

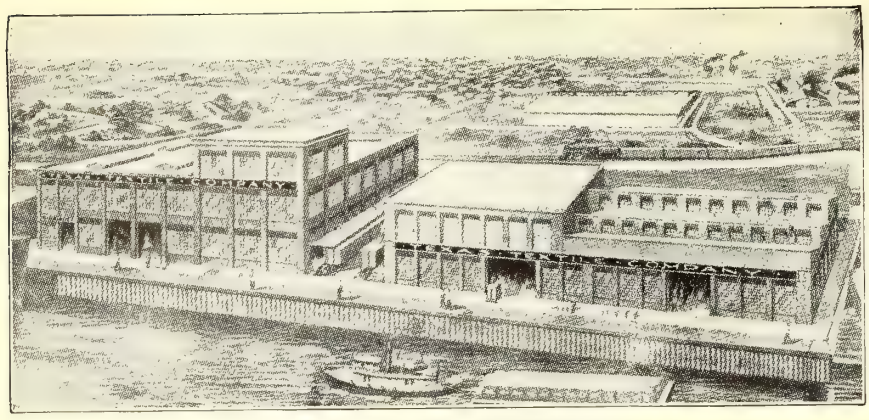
WHY YOU ARE OFFERED THIS STOCK

The natural question that must arise in your mind is: "Why, if this proposition is so good, do Mr. Garrett and the Texas Textile Company invite subscriptions from me and other investors? Why not take it all to the bankers who recommend it so strongly? Why doesn't Mr. Garrett keep it all himself?

The question is a natural one. It is a question every man asks who is offerred a specially favorable opportunity to invest. But did you ever stop to think that even rich men have their money invested, often where they can't easily realize on it? Did you ever stop to think that the Eastman Kodak Co., which has earned enormous dividends, has over 1,600 stockholders; that the Goodrich Tire Co., another phenomenal earner, has nearly 4,000 stockholders; that the Pennsylvania Railroad has over 90,000 stockholders; the National Biscuit Co. over 7,000 stockholders, and so on?

Mr. Garrett had faith in the company enough to advance to it thousands of dollars before he even had a contract with Mr. Wide for his process. His banker friends had enough faith in Mr. Garrett to back him with thousands more that have been spent in bringing the company to its present development when a few more weeks will see it housed and equipped ready to start manufacturing.

Then, another thing, you should know Mr. Garrett, as his friends know him, to understand why he wants other people interested in the company. Mr. Garrett has been the financial guardian angel of hundreds of investors for whom he has made money. He is not a philanthropist,



FACTORY OF TEXAS TEXTILE CO.

This factory is now in course of erection. It is located on the Houston Ship Channel, which connects Houston with the Gulf of Mexico, and which is navigable to the big ocean freighters. The factory is being rushed and all machinery and equipment are now on the way. The factory should be running inside of 90 days.

but he likes to make money for his clients because he wants their aid in financing propositions. He knows that the only way to build up a strong list of investing clients who will "string along with him," as the saying goes, is to make money for them. If he can put YOU in the way of making money the next time he needs financial support to back some new enterprise you will be ready to go in with him, won't you? Yes, of course. I'll tell you the story of one of his clients that I happen to know about. The man's name is Kavanaugh, Claude Kavanaugh. A year ago last Summer Mr. Garrett advised him to invest in an enterprise financed by the Garrett interests. Mr. Kavanaugh couldn't realize on his own resources immediately so he borrowed $3,590.00 which he invested with Mr. Garrett. This investment has paid Mr. Kavanaugh, as he told me himself, $34,428.00 in cash dividends in a little over a year and the market value of the investment is, according to Mr. Kavanaugh, approximately $51,000.00. A total return of over $85,000.00 in ONE YEAR'S TIME, and all from an investment of only $3,590.00.

FORTUNES FROM SMALL INVESTMENTS

It was Jay Gould who said: "A hundred dollars invested in the right place at the right time, will earn as much as one man steadily employed." And Andrew Carnegie, who is said to have founded his fortune running into hundreds of millions by investing $250 of borrowed money in an invention that made him a little fortune, said once that the biggest difference between a good business man and a poor one is that the good business man goes ahead and does a thing while the other is thinking about it. These are two wonderful business precepts that every man should bear in mind.

Little investments grow into big fortunes just like little acorns grow into stately trees. BUT YOU MUST MAKE THE INVESTMENT. The acorn in the bin won't grow into a tree any more than the uninvested money will grow into a fortune. Just to give you an idea of how little money acorns grow into big profit trees:

George Westinghouse is said to have offered a half interest in his airbrake for $2,500. Westinghouse Airbrake earned $6,500,000.00 in the fiscal year ending July 31, 1917.

James Couzens is said to have borrowed $100 from his sister to invest it in Henry Ford's "dream company," as they called it a few years ago. That $100 has drawn in CASH over $47,000.00 and the hundred dollars' worth of stock is now worth over $50,000.00.

The Postum Cereal Co. started 16 years ago with $750.00. Three years ago, 13 years after it was founded, the company's assets were $20,000,000.00 and Post left an estate of $22,000,000.00.

If you had invested $100 in the original capital of the Gillette Safety Razor Co. your stock would now be worth $52,000.00 and your annual income from it would be $3,640.00. All from an original investment of $100. Here is a little list compiled from Moody's Manual showing briefly what $100 invested in some well-known companies would be worth today:

$100 invested in Bell Telephone has returned	$ 54,000.00
$100 invested in Cream of Wheat now represents	10,000.00
$100 invested in Prestolite has returned	100,000.00
$100 invested in Burroughs Adding Machine has returned	41,340.00
$100 invested in National Cash Register has returned	42,870.00
$100 in Welsbach Mantles has returned	50,000.00

And this list could be continued for pages showing how small investments in the right thing at the right time have grown into fortunes.

The TEXAS TEXTILE COMPANY is capitalized for only $250,000, divided into 2,500 shares of the par value of $100 each, full paid, non-assessable and full profit-sharing. These shares are now offered at $110 per share.

If you take President Garrett's estimate of possible earnings and profits you find that 600 pounds a day at a profit of $3.50 a pound means a profit, over and above all probable costs, of $630,000.00 a year, or over 250% profits on the total capitalization of the company. Here you see the great advantage of a small capitalization. If the company had been incorporated for $1,000,000.00 this would represent a profit of 63% instead of nearly over 250%.

These profit possibilities are not offered as a definite statement of anticipated profits, because no one can predict the future nor foretell the events of life. They are merely estimated from known, definite factors. If the production should reach 1,000 pounds a day—as it is predicted it soon will—the profits would be, at this basis of estimating, $3,500.00 daily and on a basis of 300 working days a year $1,050,000.00 a year, or over 400% on the total capitalization. By setting aside a portion of the profits for surplus and for factory development it would soon be possible to increase the capacity of the factory to 10,000 pounds a day which at the old basis of estimating earnings would mean profits of $10,500,000.00 a year, or 4,000% on the capitalization.

NEVER SUCH AN OPPORTUNITY

Even a casual study will reveal that this is one opportunity such as very few men have ever had offered them. Knowing the demand there is for silk and the enormous shortage, no one interested in the company believes that it will stop at even a production of 10,000 pounds a day. Its ultimate production may run into many times ten thousand pounds a day. Who shall estimate what the profits would be once the company has reached such a development? It doesn't take a prophet or a man of very wide vision to see what this stock will be worth some day. That's why I said at the beginning of this article that the profit possibilities were so big that they were dizzying. I got into such big figures that my brain was swimming in millions. And the strange part of it is that, exaggerated as these figures may seem, they are probably TOO CONSERVATIVE.

Can you think of any other opportunity to invest money with enormous chances of success equal to these? The European silk companies have made enormous profits. The English company's profits increased from $174,375.00 in 1908 to $2,371,000.00 in 1913. This company had much experimental work to do at first and it wasn't until the later years that its product was perfected and its methods of manufacturing improved to modern efficiency. This company made these enormous profits in spite of paying two or three times as much for raw material as the Texas company has to pay and having to export its product or sell it at much lower prices than now prevail. These figures are believed to be official, as they are taken from authoritative English publications.

We do things on a much bigger scale in America. We leap ahead where others crawl. The growth the English company worked up to in six years this company will probably span in one-third the time.

If you have an ounce of vision, if you are not one of the short-sighted men who can never see beyond the ends of their noses, if you have a speck of imagination, if you have a spark of daring you'll invest all you can afford to in this company. Mr. Garrett has provided for carrying the stock of those who cannot afford to pay in full for their stock. A reservation payment will hold the stock you want. You can pay down $12 on every share you want and pay the balance $14 a month until you have paid the full price of $110 a share. This offer will not be repeated. This stock should advance rapidly. In 90 days the factory should be in operation and the stock should begin earning dividends. It may be earning dividends before you have finished paying for it.

With only a limited number of shares available it is likely that this allotment will all be subscribed for in a few days. It is necessary therefore not to delay. ACT QUICKLY by filling out the coupon below and mailing NOW with your reservation remittance of $12 for each share you want. Then you can pay the balance at the rate of $14 a share per month for seven months.

But unless you expect to be disappointed ACT NOW.

You may never have such another opportunity. It is the ONE opportunity of a lifetime and no man or woman can afford to ignore it. Here you have an absolute necessity, a tremendous profit margin, a wonderful market, strong, clean, honest, business men behind the company, complete and efficient management, an almost unlimited supply of raw material, cheapness and economy of manufacturing costs. If you have a few hundred or a few thousand dollars to invest you might wait all your life and not get such another chance to put your money where it has such splendid opportunities for turning a small investment into a good sized fortune.

You will have to hurry. The capitalization of the company is small, a great deal of the stock has already been subscribed for, the plans of the company are progressing so fast that soon this stock will advance in price very materially. The remaining shares should be snapped up in a few days.

SO ACT AT ONCE. Advt

STOCK AND BOND DEPARTMENT E. E.

HOUSTON BANK AND TRUST COMPANY

Not Inc.

MEMBERS { AMERICAN BANKERS ASSOCIATION / TEXAS BANKERS ASSOCIATION

HOUSTON, TEXAS.

Please purchase for me.....shares of the stock of the Texas Textile Company at $110 per share. I enclose $..... payment in {part / full} for same. Terms to be $12 per share down, $14 per share per month for seven months; 3% discount for cash in full.

Name .....

Address .....

Postoffice ..... State.....

QUESTION BOX.

(*Continued from page* 704)

A. 1. It is certainly possible to operate a Tesla transformer with a buzzer providing that the vibrator of the buzzer is sufficiently large and is capable of being run on 110 volts either D.C. or A.C.

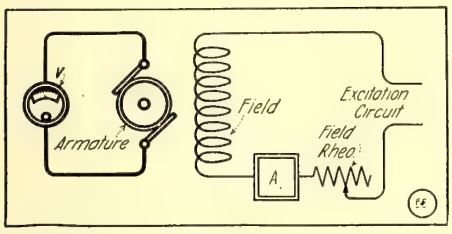
The diagram here gives the proper connections. The oscillatory condenser must be of high capacity or in the neighborhood of .01 mfd.

DYNAMO QUERY.

(887) John Russell, Omaha, Nebraska, wishes to know:

Q. 1. Kindly advise me how to connect a shunt-wound dynamo, so that the field magnetization can be tested.

A. 1. We give wiring diagram herewith.



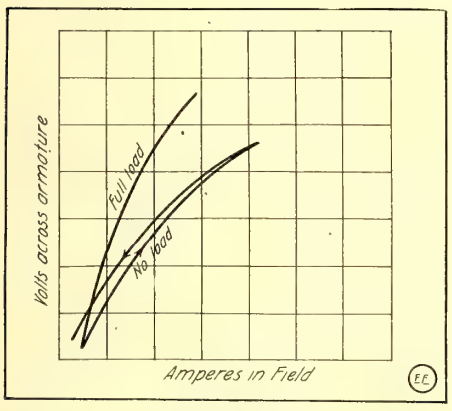
Connection of Shunt-wound Dynamo for Testing Field Magnetization.

Q. 2. What general type of curves does the field magnetization follow?

A. 2. The typical curves obtained from such a test are herewith given.

Q. 3. Upon what does the percentage of saturation in the field depend.

A. 3. This factor depends upon the rate of graph curvature increase that the current and voltage take, and it is a ratio between a small amount of field excitation and that of a small amount of electromotive force produced in the armature circuit. This ratio gives the percentage of magnetic saturation in the field.



Curves of Field Magnetization for Shunt-wound Dynamo.

FORM FACTOR

(888) John Henley, Detroit, Mich., wishes to know:

Q. 1. How is it possible to determine the average and effective values of an alternating current which is not a sine wave?

A. 1. The problem of determining the average and effective values of an alternating current circuit of non-sine wave form is difficult, as several factors must be considered before such determination

(*Continued on page* 712)

BOOK REVIEW

THE PRINCIPLES OF ELECTRIC WAVE TELEGRAPHY AND TELEPHONY, By J. A. Fleming; 911 pages with numerous illustrations; size, 6 x 9"; Publisht by Longmans, Green & Co., New York and London. Third Edition. Price, $10.00.

This excellent and large volume might readily be called the "Bible" of Radio-telegraphy. An untold wealth of information and data is covered in nearly a thousand pages, and represents a book that will find its value constantly by the ready reference it gives on all matter pertaining to Radio, both practical and theoretical.

This third edition has been thoroly revised and rearranged and some new and interesting chapters have been added. The author's aim has been to deal more fully with principles than to give elaborate accounts of actual apparatus, altho much standard equipment is shown and described.

The work is really a comprehensive view of the entire subject of Radio from its scientific side, and much space has been devoted to quantitative measurements, their theory and how to make such measurements.

The following outline gives some idea of the many phases and subjects covered:

High Frequency Electric Currents, Damped and Undamped Electric Oscillations, Graphic Representations of Undamped and Damped Electric Oscillations, Mathematical Expressions for same, High Frequency Alternators, including those of Thomson, Tesla, Fessenden, Goldschmidt and others; Theory of the Discharge of a Condenser, Mathematical Expressions for Dead Beat Oscillation Discharges, Objective Representation of Electric Oscillation with numerous notes, theories and experiments in this direction; Induction Coils and Methods of Winding with numerous types of interrupters and breaks; Condenser Construction, both Leyden jars and glass-plate condensers, comprest air, oil immersed and other forms; Oscillation Transformers, arrangement of apparatus, various forms of discharges; Disc-ball and Air blast for cooling; also exhaustive data on the arc transmitter and the quenched gap.

Further subjects cover High Frequency Electric Measurements, Theoretical and Practical Measurements for Resistance, Induction, Capacities, etc., and all others connected with Radio circuits, Strengths of Various Dielectrics, Measurement of Spark Frequency and Spark Counting, Damping, Resonance, Logarithmic Decrement, Damping, and their application to all forms of Radio Circuits.

Then we find chapters on Aerials, Radiation, Detection and Measurement of Electric Waves, Commercial Radio Apparatus, Early Ideas and Experiments, and various phases of the art are covered from the simple apparatus to the most modern apparatus.

Further sections treat on Practical Radio-telegraphic Stations, Commercial, Experimental, Transatlantic, Government and the Types of Apparatus employed in each, with a discourse on Undamped Wave and Arc systems.

The final chapter covers all important experiments and the practical applications of "Radio-telephony," and should prove of great interest.

The work has a number of interesting photos of Spark discharges and Oscillatory discharges of a Condenser.

The book is of such large proportion and the data so varied that it is almost impossible to discuss in detail the remarkable fund of information contained therein. Suffice it to say that its value will prove itself daily in the constant and ready reference it will give to radio students and engineers alike and to all those interested in the radio art.

PRACTICAL WIRELESS TELEGRAPHY, By Elmer E. Bucher. Fully Illustrated; 322 pages, size 6¼ x 9½"; cloth bound. Publisht by Wireless Press, Inc., New York, 1917. Price, $1.50.

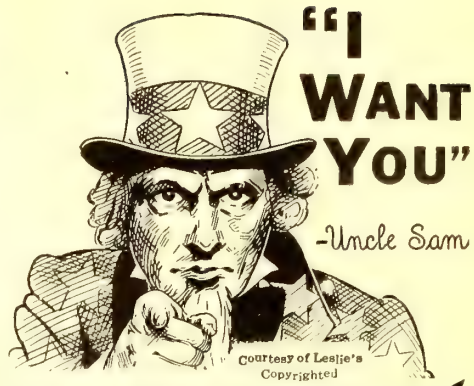
An excellent work is this latest book on Radio and it should find a host of readers, especially those who intend taking assignments in the Signal or Flying Corps and the Navy.

The book is written in a practical manner, covering the various fields of commercial as well as advanced radio, giving the student an opportunity to acquaint himself with standard practise.

The author has treated all subjects without rigid scientific accuracy or completeness, but nevertheless in such a manner as to enable one to grasp the fundamental electrical and magnetic principles, and consequently when these simple laws are learned the rest comes in easy stages, step by step, so that the student gets the why and wherefore of things.

By no means must it be interred that this book is an elementary work for data of great interest to the advanced and professional man is contained therein.

(*Continued on page* 713)



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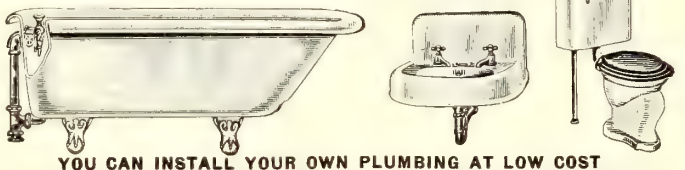
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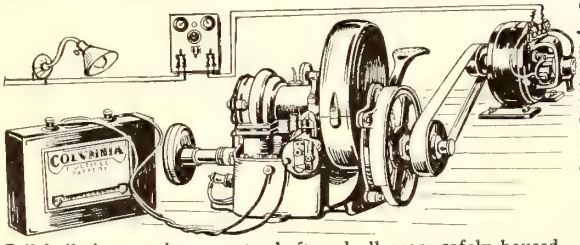
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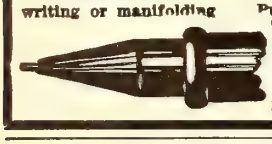
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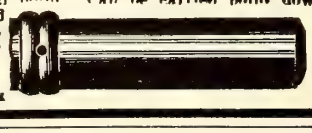
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QUESTION BOX.

(*Continued from page* 711)

can be made, *viz.*, the shape of the curve must first be obtained, either by pure oscillografic means or by obtaining the various values of current or voltages at various times, and plotting a curve. This curve should extend between two limits, that is, between the starting of the current and that of ending, or between starting and the maximum. In other words, expressing this relation mathematically, the current must pass thru π radians, or in other words, thru 180 electrical degrees. The area inside this curve must be measured either by a planimeter or by carefully erecting small squares of known lengths and determining the area of these individual squares, and multiplying the area of them by the total number of squares inscribed inside of the curve.

This would give an approximate area of the curve. Having obtained this area, the next thing is to carefully measure the length of the datum or base line of this curve, and divide this value into the area. The quotient of this will give the average current value. The effective value is obtained by squaring the ordinates and abscissae as originally obtained, and plotting a new curve with these values. The area of this new curve is determined the same as the first, and dividing this area by the new base, and the square root is subtracted of this quotient which will give the effective value of the curve, which may either be current or volts.

Q. 2. What is the form factor?

A. 2. The form factor is the ratio between the average current and that of the effective current, and is exprest in the following relation:

$$\text{Form factor} = \frac{\text{Effective E.M.F}}{\text{Average E.M.F}}$$

HIGH FREQUENCY ALTERNATOR.

(889) J. Pignone, Bronx, N. Y., asks:

Q. 1. Kindly state thru the "Question Box" how many volts and amperes the best selenium cells can withstand.

A. 1. The voltage necessary for operating a selenium cell is variable, as the general physical properties which is dependent upon the construction of the cell, control generally the voltage necessary to operate this device at its maximum efficiency. There are no definite rules from which one can determine theoretically the voltage necessary to operate satisfactorily any selenium cell. It must be found experimentally.

Q. 2. What size wire and how much should be used in coils A and B in my diagram of a high frequency alternator, capable of exciting an arc for a wireless telephone?

A. 2. The winding for the excitation currents of an alternator which you show in your illustration should consist of 250 feet of No. 26 B & S magnet wire. This amount should be wound on each of the coils between the receiving current coils. These latter coils are wound with 10 to 12 feet of No. 20 wire. This small amount is used in order to diminish the skin resistance when operating at high frequencies. However, the flux density produced by the former coils must be very large so as to obtain the maximum E.M.F. when the device is in operation.

VARIOMETER QUESTION.

(890) Fred Stanford, of Louisville, Ill., wishes to know:

Q. 1. Will you kindly inform me as to the construction of a variometer?

A. 1. There are several means by which you can construct a variometer. One of the simplest involves the use of two con-

centric tubes, each of which is wound with the same size wire. The winding of one tube should be opposite to the other.

A good variometer can be made by obtaining two cardboard tubes, one of which is 5 inches in diameter, while the other is 5½ inches. The width of both tubes should not exceed one inch. A single layer of No. 20 insulated magnet wire is wound on both tubes, and the winding is properly shellacked. Both tubes are electrically interconnected, while the terminals are obtained from the inner and outer coils. The inner coil is permitted to revolve 180 geometrical degrees, and this is obtained by means of a rod protruding thru the coils, to which a handle is attached for properly rotating the inner tube. On page 685 of this issue you will find a complete treatise on the operation of this instrument.

SELENIUM CELL QUERY.

(891) W. M. Van Dusen, of Akron, O., wishes to know:

Q. 1. What is the formula for designing selenium cells; also what size wire should be used for different voltages.

A. 1 There is no formula at the present time for the design of selenium cells to perform certain operations, as the subject is still in its infancy, and the data is still in the hands of the scientists. We can refer you, however, to the September, 1917, issue of THE ELECTRICAL EXPERIMENTER.

VACUUM PUMP.

(892) E. S. Rogers, of Toronto, Can., inquires:

Q. 1. Could the laboratory vacuum pump described by R. F. Yates in the November issue, be used to create a high enough vacuum for an Audion bulb?

A. 1. The vacuum pump as described by Raymond Francis Yates in the November issue of THE ELECTRICAL EXPERIMENTER, can be successfully utilized for the exhaustion of Audion bulbs, providing that the exhaustion is continued for a considerable period. This is due to the fact that a column of mercury in a glass tube is of insufficient size to exhaust the air within the tube completely. You can of course construct a special pump, so that you can evacuate the air chamber within the tube in one operation. This can be done by increasing the dia. of mercury column.

Q. 2. Where can I obtain information regarding the amount of vacuum in the Audion?

A. 2. We refer you to the September, 1915, issue of the Proceedings of the Institute of Radio Engineers in which you will find an article by Doctor Irving Langmuir which treates extensively on the subject of relative values of vacuum in tubes of this type.

Q. 3. Why is it that when a permanent magnet is moved around near the Audion, signals can be tuned in and out by its different positions. I don't understand the phenomena taking place in the tube.

A. 3. The reason why a permanent magnet will tune and dëtune the radio signals is that the electronic discharge of the cathode or hot filament is directed and redirected from the course which it takes to the wing circuit, and by changing the *concentration* of the electronic stream to this plate you are changing the flow of a current which is taking place betwen the hot cathode filament and the anode plate—thereby causing a variation in the strength of signals.

Actually, you are not tuning or dëtuning the signals by resonance means, but purely by changing the conductance within the Audion, thus changing the strength of current thru the audio-telephone circuit.

(*Continued on page* 714)

BOOK REVIEW

(*Continued from page* 711)

Among the various chapters may be noted excellent discourses on Magnetic Circuits, Electromotive Force and Induction, Motor Generators, Storage Batteries, Transmitters, Receivers, Circuits, Auxiliary Apparatus, Radio Measurements, Standard Sets, Direction Finders, also Transmitters and Receivers of Undamped Oscillations. The various Armstrong vacuum valve circuits for producing "beats" in the reception of undamped waves are illustrated and described in a very creditable manner, as well as an explanation of the principal radio-frequency alternators.

The appendix contains various formulas, and a complete set of questions such as might be asked of those taking examinations for licenses.

TRENCH WARFARE, by J. S. Smith; cloth bound; 6½ x 4¼"; pocket size; 144 pages; 17 illustrations. Price $2.00. Publisht by E. P. Dutton & Co., New York, N. Y., 1917.

The author of this interesting little book is an American, serving with the British Expeditionary forces as Second Lieutenant. Mr. Smith having enlisted early in the war has had much opportunity of studying modern trench warfare in the British trenches in Flanders and Northern France.

While the volume contains not a very great abundance of new matter, the author has endeavored to condense into a small volume quite a good deal of valuable information that will be welcomed by our officers and privates alike. There are many interesting chapters, such as: Dugouts, Latrines, "Sand Bags," Support Points, Communication Trenches, Obstacles and Entanglements, Explosives, etc. The chapters treating on Listening Posts, Sketch of Trench System and Bombs, are perhaps the best. The illustrations are clear and leave nothing to be desired. The book can be warmly recommended to all students of trench warfare. The only thing we find fault with is the peculiar dry style in which the author writes.

THE WIZARD OF THE ISLAND, by F. G. Winger. Cloth bound; 160 pages; 7¾ x 5½"; 3 illustrations. Price 50 cents. Publisht by Winger Publishing Co., Chicago, Ill., 1917.

The author who terms his book a "Pseudo-Scientific Novel," has produced an interesting addition to our rapidly growing scientific fiction. The story treats on the "Vindication of Prof. Waldinger" living in the year 2015, who having been misunderstood by his fellow scientists retreats to a wonderful island where he succeeds in actually demonstrating the truth of his former wild-appearing theories. Several of his scientific opponents are subsequently wrecked on the Wizard's island, due to the latter's mysterious machinations and now the wizard begins to lead them a merry scientific dance. Prof. Waldinger introduces us to his "Vibrometer" by means of which we are made to "see sound," "hear colors" and witness other startling—as yet to be invented—phenomena. While this chapter, supposedly the most important one, is very interesting, the author has neglected to show in a plausible manner just how these various means are produced.

Most of it is too vague and kept too general, not in keeping with the style of first-class scientific stories—as for instance those of Jules Verne—where all, as yet unknown phenomena or effects are always explained in a plausible manner. The other chapters of the book do not lack this essential as for instance the "steam mountain"—a novel idea, by the way—which sounds quite plausible.

The story is well written and keeps your interest till the end. The only fault we find are the illustrations which are rather amateurish. If you are interested in a good scientific story, read the "Wizard of the Island." You will like it.



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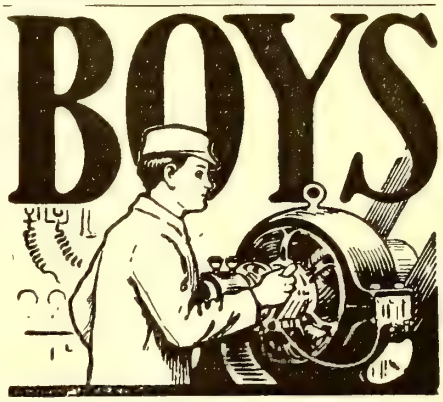
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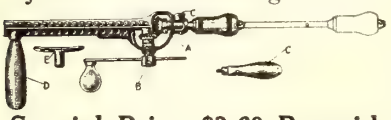
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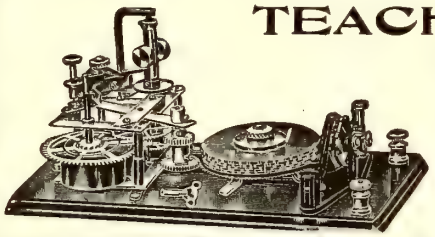
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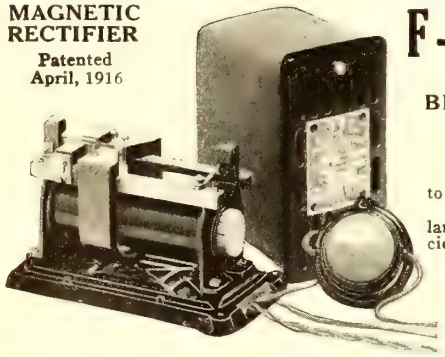


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ELECTRICAL CONDUCTION IN METALS AT LOW TEMPERATURES.

(*Continued from page* 693)

one-eighth, respectively, of those for the same wire when straight. No attempt has yet been made to measure the gradual further increase of resistance which would be expected on this theory as the current is further increased and more and more turns become resisting.

The following table contains in condensed form the observed values of threshold current for various wires at different temperatures as published by the Leiden Laboratory. Since the threshold values depend considerably on temperature, a comparison is possible only when observations were made on two wires at the same temperature, and the table contains the results of practically all such observations published.

In the last column is given the maximum value of magnetic field in any part of the conductor—that is, the field at the surface of a straight wire or at the inner turns of a coil (the computations for the latter case being only approximate)—due to its own threshold current. It is seen from the table that at each temperature this magnetic field is much more nearly a constant of the material than either the current or current density. In the case of mercury the effect of a magnetic field on the resistance in the superconducting state has not been measured. For tin the threshold value at 2° K. is about 200 gausses, which is in good agreement with the slightly larger values computed from the threshold current corresponding to a slightly lower temperature. In the case of lead the agreement of the observed critical field (600 gausses at 4° K.) with the computed values is not so good, particularly in the case of the straight wire. Any discrepancy here, however, is easily explained by the possibility (frequently referred to by Onnes) of the existence of thin spots in the wire where the field intensity would be much greater for a short length.

Critical Values of Current for Various Metals and Temperatures
[From data by H. K. Onnes]

Temperature degrees K	Area	Threshold current	Threshold-current density	Maximum magnetic field
	mm²	amp.	amp./mm²	gausses
MERCURY				
4.1	0.0016	0.17	107	15
	.0025	.17	69	12
	.0055	.23	42	11
	.0055	.32	58	15
3.6	.0016	1.00	625	89
	.0025	1.07	427	76
	.004	>1.04	>260	>59
	.0052	.78	151	39
TIN. Hcrit. =200 at 2° K				
1.6	.0143	1.0	70	*a*430
	.0143	8.0	560	*b*240
LEAD. Hcrit. =600 at 4°.2 K				
4.25	.025	9	680	*b*385
	.014	>4	>300	*c*>110
	.014	.6	41	*a*375
1.7	.014	.84	60	*a*550
	.014	11.1	790	*b*330

a Coil. *b* Straight wire. *c* In vacuo.

Further experiments which immediately suggest themselves are measurements on the critical magnetic field for mercury. The relation here advanced would indicate a critical field of only about 15 gausses at 4°.1K and less than 100 gausses at 3°.6 K. It would also be of interest to observe the threshold value of current when the material is in very thin films. In this case for a given section of material the magnetic field resulting from a given current density is less than in the case of a straight wire, and the threshold-current density would consequently appear larger.

The theories thus far proposed to account for superconductivity by Onnes, Lindemann,

and Thomson do not specifically indicate the existence of a critical magnetic field, and only the latter accounts for a threshold-current density (by assuming a saturation effect). If it is true, as indicated in this paper, that the magnetic effect is the more fundamental, it would seem that this fact might afford a valuable clue leading toward a more satisfactory theory of the superconducting state and perhaps of metallic conduction in general.

EXPERIMENTAL PHYSICS.

(*Continued from page* 680)

EXPERIMENT 58—

The making of enlargements is practically as simple as the taking of the photograph, but altho this phase of the art is very interesting, it is not indulged in much by amateur photographers because of the mistaken notion of its difficulty. All that is necessary is an ordinary camera (better the camera that took the negative to be enlarged) a window admitting sunlight, a few pieces of wood and cloth and some tools. The back of the camera should be taken out and the camera attached to the window (with the back at the window) the negative inserted between the window and the back of the camera and the rest of the window boarded up. By the use of some cloth the room may be made light tight so that the only light entering the room will come thru the negative, thence thru the lens and into the room. The sun's rays will now illuminate the negative (this illumination can be intensified by placing a piece of white cardboard outside, meeting the window at an angle of about 45 degrees, thus reflecting the rays against the negative). Now the negative has become the object to be photographed and its image can be caught on the wall of the room, or better, on an upright piece of white cardboard or easel. If the lens is in position A (Fig. 51), the image of the negative will be formed at I, and by slight movement may be focused sharply. The size of the enlargements is EF. If the lense is moved to position B, the image is at II, and its size is denoted by CD. Thus we see that the further from the back we move the lens the smaller the picture. If bromid paper is placed in the position where the enlarged image was sharply focused and an exposure of the right length (determined by trial or from handbooks) is made and the paper developed, the enlargement will be finished. If one wishes to enlarge by artificial light a light-proof box may be constructed with the artificial light in it, and the camera fitted to it in the same manner as if it was attached to the window. The rest of the operations will be identical. The process of reduction (the inverse of enlarging) is exactly the same except that the lens is moved out from the back of the camera very far, the image becoming smaller than the negative. (See Fig. 51.) The essential details in regard to the formation of the image having been given we shall now close the article by considering a few of the principles of color.

White is a combination of several colors, and can be broken up into its constituents, while black is simply the absence of color. As in the case of sound we shall fix our attention not on the physiological sensation of light and color but on the physical considerations.

EXPERIMENT 59—

If ordinary sunlight is allowed to pass thru a prism (see Fig. 52) the sunlight (white light) will be broken up or "dis-



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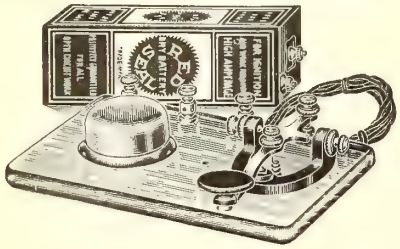
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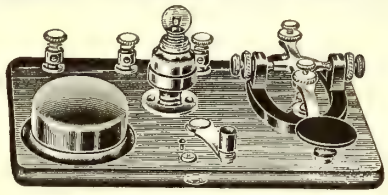


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persed" and a sort of rainbow will result. Note that the violet is bent (refracted) most and the red least but *all are bent* to some extent. Since light is a wave motion and the violet waves are the shortest and the red the longest, just as in the case of water waves, the short ones on meeting an obstruction are retarded more and, therefore, bent more. The rainbow is the same phenomenon caused by the sun's rays meeting the drops of water.

EXPERIMENT 60—

If white light is allowed to pass thru two prisms (see Fig. 53-A) the result is white light since the light bent up by the first prism is bent down by the second one, etc. This is equivalent to a piece of glass with parallel sides (see Fig. 53-B). The placing of the two prisms together is analogous to the placing of crown and flint together to secure a lens free from chromatic abberation.

The color of opaque bodies under white light is determined by their relative powers of absorbing and reflecting the different colors. For example, a body that absorbs all colors except red, reflects the red and we say its color is red. If it reflects more than one color the resulting color of the body is the combination of those reflected.

The color of transparent bodies viewed by the light passing thru them depends upon the light they permit to pass thru. If a body transmits all colors equally its color is white. If it transmits only one color, say red, its color is red, but if it transmits several colors its color will be that which results from combining the transmitted colors in the relative amounts in which they are transmitted.

Complementary colors are two colors which when added together give white, as, for example, yellow and ultramarine blue are purple, and green or violet and yellowish green.

(*To be continued.*)

HOW NEW YORK POLICE USE RADIO.

(*Continued from page* 682)

Marine Division of the Department—the Division which gives the same protection to New York's six hundred miles of waterways, that the rest of the force gives the land part of the city. With the outbreak of the war, altho practically all the other privately owned wireless plants were closed, these three stations were continued in operation, under supervision of the Navy Department, and new work in conjunction with the several Government wireless stations covering the Metropolitan District. Nearly nine hundred important radiograms connected with the work of the police force have been exchanged between the "Patrol" and the headquarters stations, which could not have been handled in any other manner. The promptness with which orders and reports can be exchanged with the "Patrol" is, therefore, of valuable assistance to both the Federal and the Municipal Government.

The "Patrol" is stationed at Pier A, at the lower end of Manhattan Island, and cases where police aid is needed on the surrounding waters are reported immediately to Headquarters or the Pier A precinct by telephone. When the boat is at the dock it is sent to investigate, and when circumstances require it, the commander of the boat sends a wireless report of the matter investigated to the headquarters wireless operator for delivery by telephone. When the "Patrol" is cruising around the bay, such messages are sent by the headquarters wireless operator direct to the boat. Previous to the installation of wireless, when the boat was cruising, it was necessary to tie up at some dock, and for an officer to find a telephone, in order to communicate with headquarters or the Precinct. This took considerable time, particularly at night. Now communication is instantaneous, which increases the efficiency of the Harbor Police considerably.

A few of the many cases where the wireless has enabled prompt police service to be rendered are mentioned below. In each instance altho the "Patrol" was away from the pier, communication with it was establisht instantly, whereas valuable time would have been lost in notifying the crew of these occurrences, under the old system.

May 18th, 4:00 A. M.—Two barges broke away from the pier at the foot of East 54th street, and, driven by a strong wind and tide, swept up the East River and carried three more away from the pier of East 70th street. The five then drifted out thru Hell Gate, in the path of the fleet of steamers that come in thru Long Island Sound early every morning. The "Patrol" was off Staten Island when this information reached headquarters, and was notified by wireless about four o'clock. At 5:35 A. M. it reported by wireless that four of the barges had been caught and docked by the police boat, and that the fifth was taken in charge by a tug.

May 21st, 1:00 A. M.—A small fire occurred in the Metropolitan Hospital on Blackwell's Island. The "Patrol," cruising around the lower bay was notified by wireless, and to stop at the East 51st Street pier for a Battalion Fire Chief on the way. When the fire was out, wireless orders were given the boat to continue cruising.

May 26th, 3:00 P. M.—Richmond Telegraph Bureau notified Harbor A of a fire on board a Municipal ferry boat bound from New York to Staten Island. The information was wirelessed to the "Patrol" which was in the East River, and promptly investigated. At 3:39 P. M. it reported by wireless that the fire was extinguished with slight damage.

June 5th, 4:35 P. M.—Brooklyn Telegraph Bureau was notified by a citizen that people in a motor boat off Manhattan Beach were waving distress signals. The Brooklyn wireless operator sent the message to the "Patrol' which was cruising up the East River, but immediately started to the rescue. At 5:16 P. M., the commander of the boat inquired by wireless if any further information had been received and the Brooklyn operator, after communicating with the citizen who reported the matter sent the following message to the boat at 5:28 P. M.—"Party in motor boat off Manhattan Beach still waving white flag. Coney Island Life Corps tried to reach them and failed." The "Patrol" reached the location at 6:15 P. M., just as the disabled launch was taken in tow by a fishing steamer.

July 13th, 1:50 P. M.—Trouble on a steamship anchored in the harbor was reported by telephone to Harbor A. The "Patrol" was sent to investigate and it was found that a member of the crew of the steamship had been dangerously stabbed by another sailor during a brawl. A wireless hurry call for an ambulance to meet the "Patrol" at the pier was sent to Manhattan headquarters at 2:10 P. M., and the injured man was brought ashore, and placed in the waiting ambulance at 2:10 P. M., and taken to the hospital, where he subsequently recovered. His assailant was arrested and held.

August 26th, 6:50 P. M.—It was reported to headquarters by telephone that three barges of coal had broken away from the pier at the foot of East Tenth street and were drifting up the East River. The "Patrol" was sent after them, and reported

by wireless at 9:50 P. M., that all three had been returned to the pier they broke away from, without damage.

The "Patrol" has also met at Jersey City and brought to New York, each of the seven Foreign Commissions that have visited this country on official war business, during the summer, and the wireless equipment of the department on these occasions has been a valuable means of keeping the city officials in close touch with the movements of the parties. If the special train bringing the Commission reached Jersey City at a time other than expected, headquarters was immediately notified by a wireless message from the boat, which was waiting at the Jersey City railroad pier, and the information telephoned to the officials who were interested. When the party boarded the boat a wireless message to Headquarters was telephoned to the Inspector in charge of the line of parade, so that the route could be cleared in time, but with least interruption to regular traffic. Headquarters was also notified by wireless when the party disembarked and the parade started.

In several inspection trips made around New York harbor on the "Patrol" by the different Commissions, accompanied by one or more of the city officials, the wireless was in almost constant use in handling urgent official communications between the officials and their offices, via Police Headquarters and the telephone system.

An extension of the wireless system to some ten or twelve of the seventeen Inspection Districts of the Department is now planned.

EXPERIMENTAL MECHANICS.

(*Continued from page* 689)

motor is mounted in order to secure strong foundation. Fig. 3 shows the manner in which a piece is being fastened to the lathe between two centers clamped to the face plate of the lathe by means of a *dog*. It also shows the position of the operator. Precaution is always necessary around the moving parts of the lathe. More details as to turning objects in a lathe will be described in a forthcoming chapter.

Fig. 4 shows how the lathe is utilized as a drill press. The lathe is a most useful tool for drilling long or short cylindrical articles. The article to be drilled is secured firmly to the revolving chuck, and the drill is secured to a stationary chuck, the arbor of which is tapered to correspond to the hole in the tail stock spindle. The drill is permitted to advance into the metal by revolving the dead spindle handle, as the photograph shows.

In Fig. 5 is seen a circular saw as used in connection with the lathe. This close-up view shows more clearly some of the important parts of the lathe. A small steel or wrought iron table is provided for supporting the metal to be cut. In a later article the writer will discuss more fully the arrangement with drawings as to the construction of this table in conjunction with the saw arbor, and also various attachments in connection with this saw table, so that the experimenter can obtain the full benefit of this valuable attachment.

In the next lesson the author will give a full description of how to use the lathe in actual work, with full details of the various lathe tools employed.

WHY NOT AERIAL "STEPPING STONES" FROM U. S. TO EUROPE.

(*Continued from page* 663)

something after the following fashion: A given airship having reached a "float," lands on the top deck, is lowered to a second and partially enclosed deck by means of an incline or elevator device, where it would be overhauled by the repair crew if necessary. It would leave this particular float for its continued flight thru an opening for that purpose, which opening could be closed during the night time when harboring a number of airships in the capacity of a "rookery."

At night the "floats" would be marked by a ring of powerful vertical shafts of light as the illustration shows. Moving belts driven by electric motors would stop the alighting aeroplanes quickly and also speed them off when leaving. The former belts would travel in an opposite direction to the alighting planes.

Probably an aeroplane could be so accommodated every eight or ten minutes during eight hours of each day, so that within about one year at least 20,000 aeroplanes would be delivered to the shores of Europe.

These gigantic "floats" would also have to be arranged so as to provide an overnight "rookery" between decks, between intervals of daylight flights.

The shortest feasible route would, of course, have to be figured out by those in a position to know, so that a minimum of these floats would be required.

Probably twenty or even more of these floats might be required to successfully span the Atlantic Ocean, all depending, however, upon the length of the span; and the safe flying distance between floats at 200 miles per float, there being twenty floats, would cover 4,000 miles.

Each of these floats could themselves have a coterie of half a dozen or more aircraft soaring and circling above and about their own float, like eagles on the watch for prey—ever and always safeguarding its own particular float from danger. At night this coterie would also find shelter between decks and resume their duty with the approach of day. Torpedo boat destroyers could also be used.

I have not stopt to figure out what size such floats would be required to be to afford shelter over night for both transient and home craft, but it would necessarily be very large. However, the aircraft could be packed closely together and securely lashed to the deck during such enforced idleness. Possibly a length of 1,000 feet would suffice.

The mobility of the floats being practically nil, the defensive features could be carried on to a very large extent, such as practically draping the hull completely with suitable steel nets.

Such a scheme in successful operation and with each other's co-operation would provide an invulnerable pathway across the Atlantic Ocean, and would be in effect the same as if Uncle Sam thrusted a huge fist to the very borders of Germany and still remained immune from attack.

Secret communication would be facilitated as the wireless messages could be relayed between floats, with a minimum of energy, and a corresponding lack of danger of their being received by the enemy.

The suggestion entails big things, but the need is just as great.

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No craving for tobacco in any form when you begin taking Tobacco Redeemer.

Don't try to quit the tobacco habit unaided. It's a losing fight against heavy odds and means a serious shock to the nervous system. **Let the tobacco habit quit YOU.** It will quit you, if you will just take **Tobacco Redeemer,** according to directions for two or three days. It is a most marvelously quick and thoroughly reliable remedy for the tobacco habit.

Not a Substitute

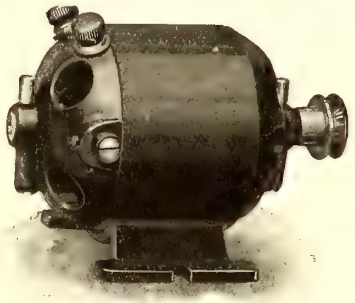
Tobacco Redeemer contains no habit-forming drugs of any kind. It is in no sense a substitute for tobacco. After finishing the treatment you have absolutely no desire to use tobacco again or to continue the use of the remedy. It makes not a particle of difference how long you have been using tobacco, how much you use or in what form you use it—whether you smoke cigars, cigarettes, pipe, chew plug or fine cut or use snuff, **Tobacco Redeemer** will positively banish every trace of desire in from 48 to 72 hours. This we absolutely guarantee in every case or money refunded.

Write today for our free booklet showing the deadly effect of tobacco upon the human system and **positive proof** that **Tobacco Redeemer** will quickly free you of the habit.

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A Regular lathe, not a toy



EXPERIMENTERS: This is the first practical lathe especially designed for all kinds of experimental work. With this lathe you can make almost anything described in this magazine, whether it is in the "Constructor" Department or "How-to-Make-It" Department. Particular attention is called to the fact that cardboard tubes can be wound nicely with wire by means of this lathe, and it can easily be driven by means of a sewing machine or by a small electric motor.

Excellent for small wood turning, fibre turning, etc. Lathe is made from finest materials. Size seventeen inches over all—swing 4 inches. 11 inches center to center. Bed is machined and centers accurately; shipping weight is 13 lbs.; price $4.00 cash with order.

Sypher Manufacturing Co., Department C, Toledo, Ohio

THE HOME TREATMENT OF TUBERCULOSIS BY HIGH FREQUENCY CURRENTS.

(*Continued from page* 681)

body—for example, in acute bronchitis or "cold in the chest"—we have as prominent symptoms—fever, congestion, cough and expectoration. Most people think that by taking medicine to suppress these symptoms they can cure the disease; hence the use of cough-syrups, sedatives, etc. When the patient recovers under such treatment it is in *spite of the medicine rather than because of it,* for these symptoms are the very means nature is using to throw off the infection. Extra vital force is being wisely directed to the endangered area—hence the fever, heat, congestion and expectoration. Medical science has been working at the problem of "cure" from the wrong end. Instead of suppressing symptoms we must aid nature to throw off the disease-producing germs and neutralize their poisons. In other words we must assist and promote the process of inflammation. It is because the inflammation is not sufficiently vigorous that many cases of tuberculosis do not recover. The infected areas are usually anaemic to start with and after the infection becomes well establisht the general blood pressure drops and it is still more difficult to establish the healing inflammatory phenomena. Other germs come in and cause secondary infections which greatly hasten the progress of the disease.

Now the D'Arsonval High-frequency current, when applied to certain tissues of the body, produces all the effects of a natural inflammation—they cause "hyperaemia" or increase of blood to the parts, liberate heat and probably promote the circulation of the vital currents. This method is known as "diathermy" or "thermo-penetration" and has been successfully employed in many hospitals and clinics in treating pulmonary tuberculosis. Dr. Albert Geyser, of New York City, reports over *sixty per cent of recoveries* in cases so treated at his Clinic at Fordham University; others have reported equally good results, yet it is a fact that the State Boards of Health, the Public Sanitoriums and thousands of lung specialists ignore this important method of combatting the "Great White Plague."

For those who can make or procure a High-frequency apparatus, such as the writer described in the December, 1917, issue of the ELECTRICAL EXPERIMENTER, or any other standard therapeutic high-frequency apparatus giving both Tesla and D'Arsonval currents, the successful home treatment of tuberculosis is easily possible. The technique is exceedingly simple—once daily for twenty-five minutes, the patient is given a D'Arsonval treatment—a block-tin electrode attached to a cord connected with each terminal of the solenoid being held or strapt in close contact with the skin of the patient's chest and the corresponding portion of the back (Fig. 1), so that the infected area of the lung lies in the path between the electrodes. The spark is opened until the patient feels a deep penetrating heat in the tissues between the tin electrodes. If the heat becomes uncomfortable the spark gap should be made shorter. All physicians' machines are provided with hot-wire milliamperemeters in the patient's circuit. When the meter is available the current strength can be adjusted so as to begin with 1,000 ma.,—gradually increasing this to 2,000 ma., by the second or third week of treatment. A home-made machine operated from a one-quarter K. W. wireless transformer will not give more than 1,200 ma., in Diathermy, but this can be made sufficient by increasing the length of the treatment to forty minutes. Continued daily for months this treatment will bring about recovery in a majority of consumptive patients. It is scarcely necessary to add that proper dietary and hygienic measures should also be employed. Bulletins giving all needed information on these points can be had gratis from any State Board of Health. A physician should be consulted occasionally so that the progress of the case can be intelligently followed.

The use of the "Ozone Nebula" by *inhalation* is of great value in treating tubercular cases and when it is given in connection with Diathermy the chances of the patient's recovery are materially increased. A simple home-made apparatus for this treatment is made from a Welsbach lamp chimney mounted in a wooden upright as shown in the drawing (Fig. 2); one end of the chimney is open, from which the patient inhales the nebula; the other end is closed with a disc of wood thru which is past a short glass tube three-eights inch in diameter; a brass rod ¼" by 8" slides thru a hole in the center of the disc. The inner end of the rod carries a small brass disc 1/16" by 1½"; a small insulating rubber handle being attached to the outer end of the rod. A rubber tube connects the small glass tube with a *DeVilbis Oil Nebulizer* (procurable for a small sum at any large drug store) containing a small amount of "Pinoleum"—a preparation containing oils of pine and eucalyptus.

In treating, the patient sits on the fiber condenser pad which is connected with one terminal of the Tesla coil; the other Tesla terminal is connected to the brass rod in the chimney which is brought up close to the patient's face until a fine purple effluve passes between him and the brass disc. An assistant now alternately compresses and releases the nebulizer bulb, thereby forcing the vaporized oil across the effluve so that it emerges from the open end of the chimney close to the nose and mouth of the patient. The patient, breathing naturally, inhales the chemical combination which is said to form between the oils and the ozone and nitrous vapors formed in the effluve: these are later released in the lung tissues. The action is antiseptic and also carries oxygen into the infected areas. Clinical tests seem to prove that there is a complicated vitalizing effect obtained by the simultaneous use of the ozone nebula and the Tesla currents.

This method was devised some years ago by the writer and differs from all the Ozone and "Oxylene" systems on the market in the above respect; in other words it is a combination treatment of two well recognized healing agents.

It should be given for only a few minutes at a time, and twice daily. If the vapor is too irritating, reduce the effluve by means of the spark gap or by withdrawing the sliding rod in the chimney.

No possible dangerous effects can follow the intelligent use of the electrotherapeutic methods above described, in the home treatment of tuberculosis, and the beneficial results are very marked.

Those interested in using high-frequency currents for the above purpose should obtain the back numbers of the ELECTRICAL EXPERIMENTER containing the articles "Electricity and Life," and "Treatment of Disease by High-frequency Currents" by the writer.

It is hoped that this article may be the means of enabling many sufferers from tuberculosis to regain their health.

After the disease is once cured its recurrence may be prevented by observing the following rules, which are equally appropriate for anyone who wishes to have more abundant health and life.

1. Breathe deeply plenty of fresh air, night and day.

2. Spend a part of each day walking or working out-of-doors.
3. Make at least one meal each day of nothing but fruit.
4. Make the rest of the diet largely or wholly vegetarian.
5. Never "get sorry for yourself"; get busy and help the other fellow who is worse off than you are.

SHOCK-PROOF SCREW-DRIVER FOR ELECTRICIANS.



The insulated shock-proof screw-driver here illustrated is indispensable to employees of Power Plants, Electric Light, Telephone, Railway and Traction Systems, and all others having to do with live circuits.

The long fibre handle serves a two-fold purpose: first, by being made of a firm, insulating material which will not be damaged if dropt from a height to a hard surface; second, by providing ample room for the worker's hands so that they need not come in contact with the blade. This handle will not be impaired if brought in contact with or immersed in Ammonia, Turpentine or Petroleum, it is claimed.

The blade is hammer forged from crucible steel, and its construction inside the handle is such as to constitute firm holding surfaces.

WOMEN AS RAILWAY EMPLOYEES.

The Interborough Rapid Transit Company and the New York Railways, New York, recently announced that as a war measure the companies would receive applications from women for positions as station employees on the subway and elevated lines and as conductors on the surface lines. Preference will be given to dependent women relatives of employees now in the army and navy, and the pay will be the same as for men. It is not the intention of the company to replace men now employed by women, but only to fill vacancies as they occur. Applicants must be between 21 and 45 years of age. The women conductors will be placed on the pay-as-you-enter cars first.

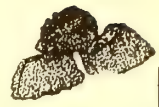
NEW TOY ELECTRIC MOTOR.

A new toy motor has recently been brought out by a Connecticut concern. This motor is wound particularly for battery use but will operate equally as well used with step-down A. C. transformer direct from house current. It has reverse attachment in the base with special features, and the frame is entirely die-cast. It is said to be the only die-cast motor on the market. The motor is exceptionally powerful for its size owing to the accurate fitting of the parts, particularly the air gap between armature and field. The motor is highly finished and should prove a winner with our young Edisons.



New Toy Electric Motor.

Radium and Radioactive Substances FOR EXPERIMENTERS



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Carnotite (Radium Mineral) The American Pitchblende found in Colorado, from which *Radium* is extracted.
A generous piece, enough to conduct experiments, such as affecting photographic plates thru opaque material (similar to X-Ray pictures), first made by Sir W. Crookes and Mme. Curie, is furnished in neat wooden box.
Price of one specimen of Carnotite as described above, sent prepaid $0.25
Sensitive, prepared Photographic film (X-Ray work film) to be used for above experiments furnished for **$0.10** each extra.

Radium—Radioactive Salts, containing one microgram pure Radium. Very powerful! Brilliant white luminescence in the dark!
10 Milligram of this most carefully prepared Radioactive Salts, sealed in glass tube (protected by a metal container), with which every Radium experiment can be conducted, are furnished.
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There are lots of "Jims" in the world—in stores, factories, offices, everywhere. Are *you* one of them? Wake up! Every time you see an I. C. S. coupon your chance is staring you in the face. Don't turn it down.

Right now over one hundred thousand men are preparing themselves for bigger jobs and better pay through I. C. S. courses.

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☐ Electric Machine Designer	☐ ILLUSTRATOR
☐ Telegraph Expert	☐ DESIGNER
☐ Practical Telephony	☐ BOOKKEEPER
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☐ Machine Shop Practice	☐ Traffic Management
☐ Gas Engineer	☐ Commercial Law
☐ CIVIL ENGINEER	☐ GOOD ENGLISH
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☐ MINE FOREM'N OR ENG'R	☐ CIVIL SERVICE
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Mr. E. Hume Talbert

PATENTS

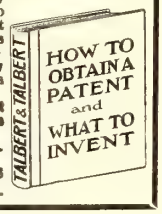
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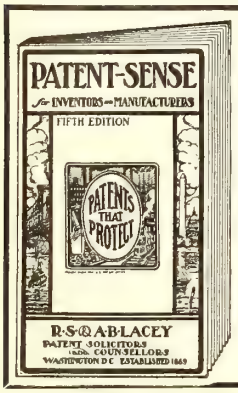
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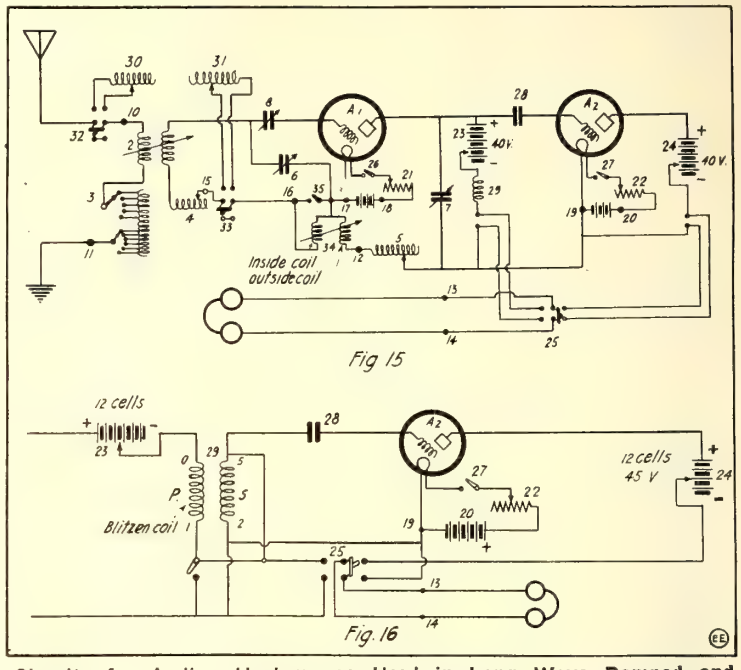
PATENT SPECIALTY COMPANY
462 Sanches Street San Francisco, Cal.

DETAIL CONSTRUCTION OF A DAMPED AND UNDAMPED WAVE RECEPTOR.

(*Continued from page 687*)

tween the two interacting frequencies. Deducting from this, it is easy to understand that by changing the frequency of the local oscillations by the adjustment of the capacity or inductance at some point in the circuit, the beat frequency or the *tone* of the received signal can easily be varied over a wide range. In this respect the above apparatus is very sensitive. A mere movement of the operator's hand in the vicinity of the circuits alters the capacity of the system sufficiently to cause quite large fluctuations in the tone. Always keep the beat pitch for long wave length stations quite low; otherwise the *compensating wave* radiated will interfere with perfect reception. In receiving long wave length stations with the heterodyne receiver the signals become rough, losing their musical tone qualities, but the intensity is considerably increased.

With the above apparatus the Joly type transmitter at Sayville and the Goldschmidt reflecting alternator at Tuckerton have been heard *over 65 feet from the receivers,* using 3,000 ohm Holtzer-Cabot telephones. The German stations have been heard several inches away from the receivers during unfavorable conditions.



Circuits for Audion Hook-up as Used in Long Wave Damped and Undamped Radio Receptor.

CORRECT TELEPHONE HABITS.

The following suggestions are publisht by the New York Telephone Co., at the request of a number of large business houses that are interested in developing pleasing telephone manners among their employees:

On all
OUTGOING *CALLS*

Always look in the telephone book to *make sure* you call the right number. If you do not find the number in the book, ask "Information."

Call *your number* with a slight pause between the hundreds and the tens. For example, in calling "Barclay 1263," say, "Barclay One Two (pause) Six Three."

Speak *clearly* and *distinctly, directly* into the transmitter.

Listen to the operator's repetition of the number and acknowledge it.

Hold *the line* until your party answers and then give your whole attention to the telephone conversation.

To recall the operator, move the receiver hook up and down *slowly.*

When you have finished talking, say "Good-bye" and replace the receiver on the hook.

Remember, courtesy over the telephone is always desirable. It wins friends for you and your company.

On all
INCOMING *CALLS*

Answer your telephone *promptly* and *pleasantly.*

Announce your name and the name of your department. Don't say "Hello."

Be ready with pad and pencil in order not to keep your caller waiting.

If you require help in handling the call properly, get it at once or politely transfer the call to the employee who can best handle it.

If you answer for another employee, offer to take the message, then call it to the other's attention at the first opportunity.

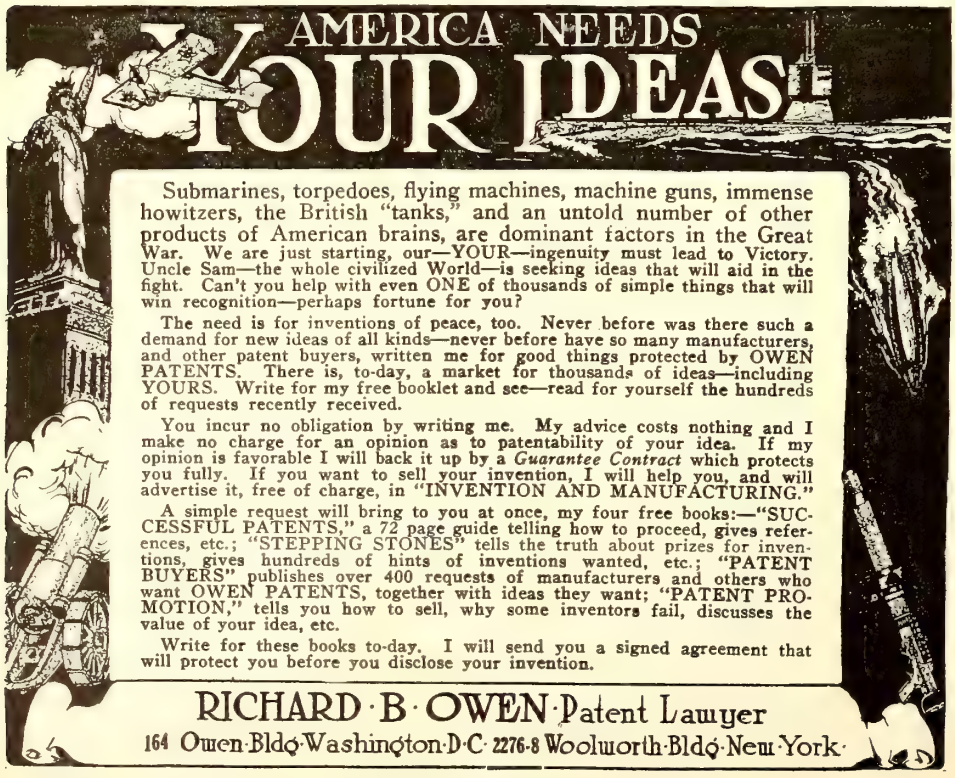
Listen attentively, so that you will not have to annoy the caller by asking him to repeat.

Remember, abruptness or indifference *drives away trade.* Close attention to telephone orders helps win it.

Maintain the same courtesy and consideration in a telephone conversation that you would with your customer face to face.

ENGINE SOOT TIES UP TELEGRAPH LINE.

Trouble that has beset a new line of the Western Union Telegraph Company between Eugene and Marshfield, Ore., since it was constructed and which had been a puzzle to electricians, is believed to have been solved. It has been found that where the wires run thru a 4,300-foot railroad tunnel the insulators have been made conductive by soot from locomotives. Now employes of the telegraph company go over the line within the tunnel and wipe away the soot collections at regular intervals and telegraphic communication is uninterrupted.



Submarines, torpedoes, flying machines, machine guns, immense howitzers, the British "tanks," and an untold number of other products of American brains, are dominant factors in the Great War. We are just starting, our—YOUR—ingenuity must lead to Victory. Uncle Sam—the whole civilized World—is seeking ideas that will aid in the fight. Can't you help with even ONE of thousands of simple things that will win recognition—perhaps fortune for you?

The need is for inventions of peace, too. Never before was there such a demand for new ideas of all kinds—never before have so many manufacturers, and other patent buyers, written me for good things protected by OWEN PATENTS. There is, to-day, a market for thousands of ideas—including YOURS. Write for my free booklet and see—read for yourself the hundreds of requests recently received.

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RICHARD·B·OWEN·Patent Lawyer
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PATENT ADVICE

Edited by H. GERNSBACK

In this Department we publish such matter as is of interest to inventors and particularly those who are in doubt as to certain Patent Phases. Regular inquiries addrest to "Patent Advice" cannot be answered by mail free of charge. Such inquiries are publisht here for the benefit of all readers. If the idea is thought to be of importance, we make it a rule not to divulge details, in order to protect the inventor as far as it is possible to do so.

Should advice be desired by mail a nominal charge of $1.00 is made for each question. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on.

TELESCOPING TELEPHONE SUPPORT.

(197) E. T. Jones, New Orleans, La., has submitted to us a novel idea showing a telephone bracket with a telescoping support, taking up very little room in its normal position. Our advice is asked on the idea.

A. This is a very good stunt and seems to have quite a good many points of superiority over the ordinary telephone brackets, which as a rule take up quite a good deal of room, and do not work easily nor very readily. By making a few minor changes, we think our correspondent may secure a very good patent upon this idea. It certainly looks very simple and very efficient, and there are no manufacturing difficulties connected with the device.

ELECTRIC TRAFFIC REGULATOR.

(198) S. B. Blair, Marquez, Texas, has an idea whereby he will throw all the traffic cops out of work, his idea being that instead of using a human being, he uses an electro-mechanical machine, and the drawings which he submits as well as the idea of the arrangement are certainly quite plausible, and have a good many points of interest. He proposes to have the regulator entirely automatic; thus he has designed a machine so as to operate signals at intervals of one minute between "stop!" and "go!" reasoning that traffic can thus be regulated by the public itself.

A. While this idea is very good, and while the details have been worked out to perfection, still we do not think that it will be practical, as nearly all machines are wont to leave out the human equation. If the traffic were dense enough and if one driver wanted to get ahead of the other, he certainly would not much mind the indicator, as an indicator has no authority and would not be likely to arrest the offender, and this of course the offender knows; hence, the traffic regulator would probably not regulate at all, and for that reason we are afraid it is of no commercial use.

SELENIUM DEVICE.

(199) W. J. Pinckard, Wray, Colo., has an idea to utilize a paper record on which an impression is made in black and white by human voice, this record to be run like a phonograph record, then when a beam of light is thrown on the record, it is supposted to influence a selenium cell thereby operating the telephone, thus reproducing the human voice. Our advice is asked on the scheme.

A. The device is good as far as it goes, but there is just one hitch. How is the record to be obtained, in the first place, and by what means? Also it would be very difficult to have the record influence the selenium cell in the way described by our correspondent.

AUTOMATIC SOLDERING IRON.

(200) Geo. H. Parkman, Washington, D. C., has submitted to us a soldering iron which carries its own supply of solder. In other words it makes it unnecessary to pick up solder from the bar, and the work therefore could be performed continuously. Our advice is asked.

A. This is really a very excellent idea and as novel as it is good. We think that a good patent could be obtained, as this is certainly an article for which there is a good demand. We would, however, caution our correspondent to first make a model and see how it operates in practise. Would also caution that a soldering iron must be cleaned by means of a file very frequently, and this might be a feature that would tend to clog the flow of the solder more or less. This is worth while looking into.

U.S. PATENTS



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FLAT IRON ATTACHMENT.

(201) Mrs. Leslie P. McNeill, Corpus Christi, Texas, submits a novel idea, being a sprinkler arrangement attached to the front of a flat iron. Also suitable container carrying water and the means whereby the flow of the water can be regulated.

A. This is a capital idea and looks to us very practical, but the device has one objection, namely the handle will not hold enough water, and we would suggest using a flexible tube or otherwise mount a reservoir in front of the iron, which would do away with this objection. Otherwise, it looks to us like a very good propostion, and a patent certainly ought to be procured.

FLYING TORPEDO.

(202) Joseph Sear, Philadelphia, Pa., submits an idea of what he calls a flying torpedo, not designed for submarine destroying, but to be used for land batteries traveling thru space under its own power, and to cover a greater distance than the biggest shell. Our advice is asked as to the novelty and feasibility of this scheme.

A. This idea is entirely impracticable, and the scheme as shown by the correspondent cannot possibly work. The power to propel the device would require a power plant so large and so expensive as to preclude the use of the device for practical uses. Also there would not be any way to steer the torpedo, and the chances are that it would not make a hit once in ten thousand. We caution our readers not to spend too much time in developing machines that are entirely controlled by wireless or electricity as hardly any devices of this kind have as yet proved their value.

FREAK TROUBLES—TIPS TO "BUG" HUNTERS.

(*Continued from page* 696)

statements made are facts; secondly and thirdly, let me add to that assurance.

A house-lighting system was in trouble. It seems that the "madam" would receive a shock every time she touched a switch. The trouble shooter looked the system over and reported it O. K. All his tests could locate no "leak" or "short". Still a shock was awaiting the aforementioned lady at each switch.

Again the system was gone over, carefully and with the utmost care. And it was clear, he swore there was no ground, "short", "open" or "leak", or any of the ills to which electrical apparatus are frequently subject. Even so, it did not alter the fact that the lady in question would still receive her shocks.

The electrician was sent again to kill the "bug". Instead of working on the wiring itself, he decided the trouble was elsewhere and sat down to think it over. As he sat there the "madam" past him and as he glanced after her a great light dawned on him. Approaching her, he asked: "Does anyone else in the house experience the trouble you have with the electric light?"

Her reply in the negative clinched his idea. So he made the strange request that she allow one of her maids to wear one of her gowns. He instructed the maid to turn on one of the light switches. As her hand touched the switch a crackle was heard and she stepped back in alarm.

Well, fellow "bug-hunters", have you determined what the trouble was?

Turn to any text-book on electricity and in the chapter on "Static Electricity" you will find the statement *that silk becomes electrified when subjected to friction.* The lady wore silk gowns almost without exception.

As the gown swept along the floor it rubbed against the high pile of the carpet. The electrical charge thus generated would leap to ground when the hand of the wearer was in the vicinity of a grounded conductor. The metal switch plates were all grounded in accordance with the underwriter's ruling on that point. And thus the mystery was solved. The only cure was to wear shorter dresses or to insulate the switch covers.

Electricity may be the servant of Man, as the poets like to have it, but it is chuck full of more tricks than a box of monkeys.

STORAGE BATTERIES FOR ELECTRON RELAYS.

(*Continued from page* 683)

replenishment of the solution with distilled water from time to time. In very small cells, the total liquid content is not sufficient to fill the smallest hydrometer; therefore the specific gravity of such a cell cannot well be ascertained. To remove all the electrolyte from any storage battery cell, when the cell is in a charged condition, will positively injure it; so that hydrometer readings of the electrolyte which are so necessary to keep some types of storage battery in condition are a practical impossibility in miniature cell operation. It is therefore requisite that a type of battery which requires no hydrometer readings should be used, and that such a battery should also incorporate the virtue of not being injured by oft-repeated overcharging, or by standing idle for protracted periods in a charged, semi-charged or, in some cases, totally discharged condition.

It should also be of as light weight as is consistent with rugged constructions.

All these and many more characteristics, so necessary for absolute dependability, are possessed by the new storage battery here illustrated.

This cell consists of a plurality of interconnected positive tubes and a plurality of inter-connected negative pockets, immersed in a solution of caustic potash. The positive tubes are of perforated, nickel-plated sheet steel. These are loaded with alternate layers of nickel hydrat and pure nickel flake. The negative pockets are likewise made up of perforated nickel-plated sheet steel, and are loaded with iron oxid.

The number of tubes and pockets that make up the elements of a cell depends on the capacity required. In the wing circuit of ordinary electron relays the current rarely exceeds a few milli-amperes, and a single positive tube with four negative pockets provide ample capacity. All steel parts, it should be noted, are nickel plated, the plating being welded on.

Two of these cells are combined to form a "twin" cell by connecting their containers together, and grounding the inner positive of one cell and the inner negative of the other to their respective cans.

At the low discharge rates used in electron relay work, the average voltage during discharge of a twin cell is 2.56, and the final voltage, when re-charging becomes necessary, is 2.4. Hence, 16 twin cells are employed for a 40-volt battery and 42 for a 110-volt battery.

The ampere-hour capacity of one of these cells is 1.25, and the normal charging rate 0.25 amperes. Hence, under normal conditions, the time of charge is five hours; but in an emergency, the normal charging rate can be greatly exceeded, without injuring the cell. The low discharge rate in the wing circuit enables a battery to run from several hundred to several thousand hours continuously, on one charge, depending upon the characteristics of the relay bulb.

Obituary

WILLIAM DUDDELL.

It is with very great regret that we record the death of William Duddell at the early age of 45. He past away on November 4, and his death will come as a shock to those who have not been aware of his failing health during the past year.

William Duddell was born in London in 1872, and after education at private schools and at the Collège Stanislas, Cannes, he served his apprenticeship with Messrs. Davey, Paxman & Co., of Colchester, England, from 1890 to 1893. He then went to the City and Guilds Central Technical College at South Kensington, where he studied from 1893 to 1900 under the late Prof. Ayrton, obtaining a Whitworth Exhibition in 1896 and a Whitworth Scholarship in 1897. In 1913 the Fellowship of the City and Guilds of London Institute was conferred upon him. He remained at the college considerably longer than usual, engaged in original experimental work, and it soon became apparent that he possest unusual talent as an experimentalist.

In 1898 he read, in conjunction with Mr. (now Prof.) E. W. Marchant, a paper before the Institution of Electrical Engineers, entitled "Experiments on Alternating-current Arcs by Aid of Oscillographs." It was on this occasion that he showed the *oscillograph* which has become so markedly identified with his name, and which he developed into one of the most useful instruments for investigating transient electrical phenomena that has been placed in the hands of the physicist and engineer for many years.

Two years later Duddell read a paper, also before the Institution of Electrical Engineers, on "Rapid Variations of Current Thru the Direct-current Arc." In this classical paper he described the *musical arc*, which he found to act as a generator of high-frequency currents. This paper was of fundamental importance, showing how undamped oscillations could be produced; but its full significance was not immediately recognized, partly, no doubt, because the frequency of these waves was not very high.

In connection with wireless telegraphy may also be mentioned his discourse to the British Association on "Arc and Spark in Radio Telegraphy," his discourse on "High Frequency Currents" before the Royal Institution, and his Christmas juvenile lectures before the same Institution on "Signaling." He also described a variable condenser with a square law in a paper publisht in the "Journal" of the Institution of Electrical Engineers.

Duddell was an active member of many societies. After having past thru all the then grades of Membership, Student, Associate, Associate Member and Member, Member of Council and Vice-President, he was elected President of the Institution of Electrical Engineers at the early age of 40, holding office for two years in succession. His first presidential address was of the orthodox kind, but the second gave his audience a rare opportunity of witnessing instructive experiments on "Pressure Rises" most skilfully performed.

Among the apparatus then shown was an electro-mechanical model of the arc, which was a most ingenious device for reproducing mechanical analogies of the various well-known and somewhat puzzling characteristics exhibited by the electric arc. The up-to-date nature of the Institution library, which was by no means its character some few years ago, was largely due to the efforts of Duddell as chairman of the Library Committee. In 1907 he was president of the Röntgen Society. For a time he was a vice-president of the Physical Society, and was hon. treasurer of the So-



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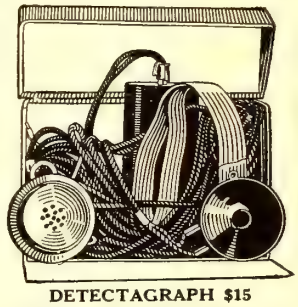


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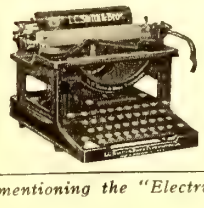
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ciety from 1910 up to the time of his death. He was hon. secretary to the delegates to the International Electrical Congress at St. Louis in 1901, and one of the hon. secretaries to the International Conference on Electrical Units and Standards which met in London in 1908. He was also president of the Commission Internationale de Télégraphie sans Fils, and in 1914 he publisht an outline of the investigations contemplated by that body, but which were, unfortunately, interrupted by the calamity of war.

Among his honors may be mentioned gold medals for his oscillographs at the Paris Exhibition of 1900 and at St. Louis in 1904; and the Hughes medal of the Royal Society in 1912. He was elected a Fellow of the Royal Society in 1907. He was a member of the Advisory Council for promoting Industrial and Scientific Research, and of the Board of Inventions and Research of the Admiralty. Recently the honor of Commander of the Order of the British Empire was bestowed upon him, but it will generally be felt that his name should have appeared in some more distinguished class.

Altho the value of his work was quickly recognized, he always remained unassuming, and his lightness of manner made him readily approachable by all and sundry. Being unmarried, he gave himself unreservedly to his work; and it may indeed be said that this was his only hobby, which made it all the more difficult for his friends to induce him to put work aside when it became evident that his health was failing. The end came suddenly, and those who knew him will feel some relief that it should have been so. He will long be remembered as a brilliant experimentalist, to whom the electrical industry owes a debt of gratitude, and whom the electrical profession can ill afford to lose.

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"GARABED" TO CONGRESSIONAL NOTICE THIS SESSION.

Not discouraged by the fact that President Wilson killed the "Garabed" Free Energy bill by a pocket veto last session, Garabed T. K. Giragossian, the Naturalized Armenian from Boston, has appeared early in Washington, and will bring his Free Energy bill to the surface again.

Congress will be asked again to provide for a demonstration of his invention with the intent of turning over the patent to the Government for use during the war. Mr. Giragossian said that he had the assurance of a number of leading congressional members that provision would be made for the necessary demonstration at this session.

35 POUNDS OF SUGAR KEEPS ELECTRIC PLANT FROM CLOSING.

Officials of the Westinghouse Lamp Company of Bloomfield, N. J., which employs 3,500 workers, appealed recently to Federal food authorities for thirty-five pounds of brown sugar, saying it would be necessary to suspend operations unless the request was granted. It was explained that brown sugar is used in infinitesimal quantities in making electric light globes. The Food Administrator gave assurances that the quantity desired would be made available each week.

ELECTRO-CHEMISTRY.

(*Continued from page* 700)

An ion is not a simple atom, or radical, as one might at first suppose. It is more; *it is the atom or radical plus a certain charge of electricity;* it has properties different from the atom; sodium and chlorin atoms are represented as Na and Cl; their ions as, Na^+ and Cl^-.

When sodium chlorid is dissolved in water and it is thereby, to a certain extent

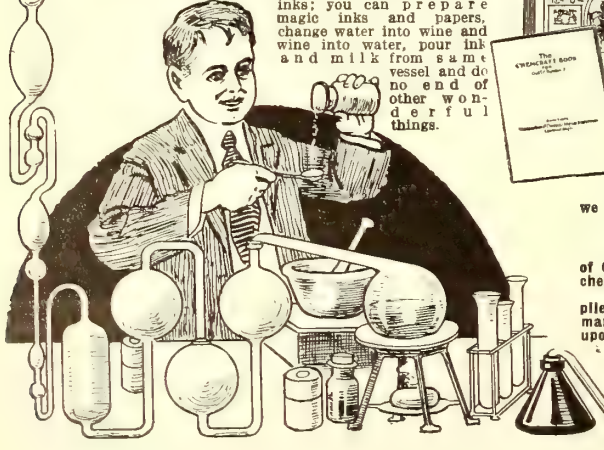
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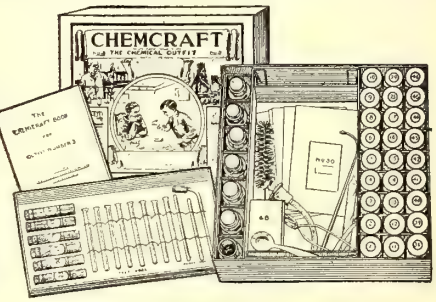
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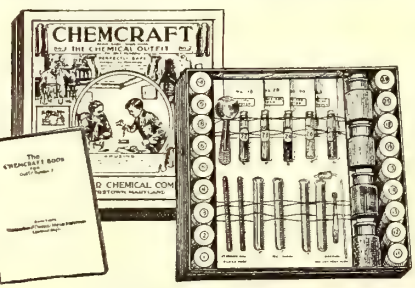


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ionized, if the solution contained simple atoms or molecules of sodium, the latter would at once react with the water and form sodium hydroxid; the charge of electricity which the Na ion carries, prevents this action. It is a sodium *ion,* not a sodium *atom.* The same explanation applies to the chlorin ion. When the current is passing and sodium ions are deposited on the electrode, they lose their electric load and act as atoms of sodium. For this reason Davy found in 1807, when he electrolyzed sodium hydroxid (NaOH) in solution, that he got no sodium. When he fused sodium hydroxid and used no water he obtained metallic sodium. The same thing is true in the electrolysis of other substances; ions become atoms or radicals and no longer act as ions, but behave as such atoms or radicals ordinarily do in the given solution. If there is nothing which reacts with them, they are deposited if solids, or set free if gases.

We have said that *anions* were charged with negative electricity and *cations* with positive; not only this, but during the passage of a current they are carriers of electricity to their respective electrodes. The non-ionized molecules of a solute do not act as carriers; only the ions so act. This explains why non-electrolytes like sugar or water are non-conductors, for they have no ions.

IONIZATION INCREASES WITH DILUTION:

The conductivity of a solution is dependent upon the degree of ionization; for example, if only 90% of a solution is ionized, the solution is less of a conductor than if 100% is ionized. Conversely, *the conductivity of a solution becomes a measure of the degree of ionization.* This is, in fact, the test of the relative degrees of ionization. The more dilute the solution, up to a certain point, the greater the conductivity. Acids dissociate into hydrogen ions and the residual minus ions, bases into metallic ions and OH ions, salts into metallic and non-metallic ions.

A small amount of a substance in a given volume of a solution is ionized to a greater degree than is a large amount of the substance in the same volume; by way of illustration: In a dilute solution of sodium chlorid there is a greater proportion of dissociated molecules of the solute than in a more concentrated solution. At a definite limit of dilution the ionization attains its maximum value, as shown by its electric conductivity. Beyond this point the conductivity does not increase with further dilution. (This maximum point varies with different electrolytes, but it indicates that at this particular point of dilution all the solute has became ionized, that there are no free molecules of the solute, and this is an important thing.

There are certain laws and conditions which govern electrolytic action, and it is obvious that a thoro knowledge of these must be had in order to successfully perform such operations.

The amount of chemical action is equal at all parts of the circuit. If two or more electrolytic cells should be placed at different points of a simple circuit, the amount of chemical action would be the same in all, for the same quantity of current would flow past every point of the circuit in the same time. If these cells should contain acidulated water, and others contain copper sulfate, the weights of hydrogen and of copper will not be equal, but will be in chemically equivalent quantities.

The amount of substance liberated at an electrode in a given time is proportional to the strength of the current. Thus a current of two amperes will cause just twice the quantity of chemical decomposition to take place as a current of one ampere would do in the same period of time.

FARADAY'S LAW AND ELECTRO-CHEMICAL EQUIVALENTS.

In studying the quantitative results of electrolytic action Faraday arrived at the conclusions which are now summarized and known as *Faraday's law,* and are fundamental for all calculations in connection with electro-chemical. work. *The same quantity of electricity passing thru an electrolyte either sets free or transfers to other combinations always the same number of valencies.* Illustration:—A given current (that is, a given number of coulombs of electricity) past thru a given solution of silver nitrat would set free twice as many silver atoms as the same quantity of electricity would of copper atoms in a similar solution of copper nitrat. The silver ions may be said to have one charge of electricity (having valence 1) whereas the copper ions have two charges (valence 2). These are written Ag^{+} and Cu^{++}. The corresponding minus ions would be written NO_3^{-} and NO_3^{-} NO_3^{-}. Thus the quantity of electricity that would deposit one atomic weight of copper will in the same time cause to deposit two atomic weights of silver. It acts the same as the chemical reaction: $2AgNO_3 + Cu = Cu(NO_3)_2 + 2Ag$. Two atoms of silver are deposited, one atom of copper taking their place.

The amount of substance liberated at an electrode in one second is equal to the strength of the current multiplied by the "electrochemical equivalent" of that substance.

The passage of one coulomb (the quantity of electricity conveyed by a current of one ampere in one second; amperes × seconds = coulombs) of electricity thru a solution of silver nitrat liberates 0.0011183 gram of silver. Hence a current of i amperes will liberate i × 0.0011183 gram of silver per second. The number 0.0011183 is the *electrochemical equivalent* of silver. The electrochemical equivalents of other elements may be easily calculated if their *chemical equivalent* is known:

$$\frac{\text{Atomic weight}}{\text{Valency}} = \text{Chemical Equivalent}$$

Thus the chemical equivalent of hydrogen is 1.008 while that of silver is 107.88. Hence the electrochemical equivalent of hydrogen will be 0.0011183 × 1.008 ÷ 107.88 = 0.00001044.

The *chemical equivalent* must not be confused with the *atomic weight.* The atomic weight of copper is 63.57; that is its atoms are 63.57 times as heavy as atoms of hydrogen. But in chemical combinations one atom of copper replaces, or is equivalent to, two atoms of hydrogen; hence the weight of copper equivalent to 1 of hydrogen is 63.57 ÷ 2 = 31.78, the chemical equivalent of copper.

All atoms that are univalent carry exactly the same minute quantity of electricity; all atoms that are divalent carry exactly twice that amount; all trivalent atoms carry three times that amount. Every atom conveys a quantity of electricity proportional to its valence, *not to its weight.*

Every electrolyte is decomposed into two parts, as stated before, an *anion,* and a *cation,* which may be themselves either simple or compound. In the case of simple binary compounds, the ions are simple elements. In other cases the products are often complicated by secondary actions.

In binary compounds and most metallic solutions, the metal is deposited by the current where it leaves the cell, at the cathode.

Aqueous solutions of salts of the metals of the alkalies and alkaline earths deposit no metal, but owing to the secondary action of the metal upon the water, evolves hydrogen.

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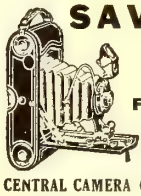
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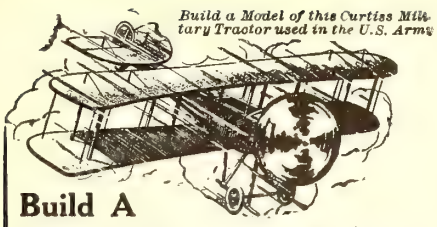
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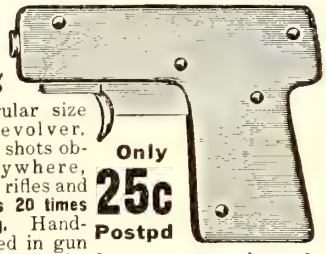
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Electrochemical Character of Elements.

Negative end

Oxygen	Tin	Zirconium
Sulfur	Hydrogen	Aluminum
Nitrogen	Gold	Scandium
Fluorine	Osmium	Erbium
Chlorine	Iridium	Yttrium
Bromine	Copper	Ytterbium
Iodine	Uranium	Beryllium
Selenium	Bismuth	Magnesium
Phosphorus	Gallium	Calcium
Arsenic	Indium	Strontium
Chromium	Germanium	Barium
Vanadium	Lead	Platinum
Molybdenum	Cadmium	Rhodium
Tungsten	Thallium	Ruthenium
Boron	Cobalt	Palladium
Carbon	Nickel	Mercury
Antimony	Iron	Silver
Tellurium	Zinc	Lithium
Tantalum	Manganese	Sodium
Columbium	Lanthanum	Potassium
Titanium	Cerium	Rubidium
Silicon	Thorium	Caesium

Positive end

In the above table, the principal elements are arranged according to their electrochemical character, each atom being *positive* to any atom placed above it and *negative* to any atom placed below it.

From a solution of mixt metallic salts the least electro-positive metal is not deposited first, if the current is so strong relatively to the size of the cathode as to impoverish the solution in its neighborhood. To deposit alloys, a solution must be found in which both metals tend to dissolve with equal electromotive-forces.

The liberated ions appear only at the electrodes.

For each electrolyte *a minimum electromotive force* is required, without which complete electrolysis cannot be effected.

If the current be of less electromotive-force than the required minimum, electrolysis may begin, and a feeble current may flow at first, but no ions will be liberated; the current being completely stopt as soon as the opposing e.m.f., of polarization has risen to equality with that of the electrolyzing current.

There is no opposing electromotive-force of polarization when electrolysis is effected from a dissolving anode of the same metal that is being deposited at the cathode. The feeblest cell will suffice to deposit copper from copper sulphate *if the anode is a copper plate.*

Where the ions are gases, pressure effects the conditions but slightly. Under 300 atmospheres acidulated water is still electrolysed; but in certain cases a layer of acid so dense as not to conduct collects at the anode and stops the current.

The chemical work done by a current in an electrolytic cell is proportional to the *minimum* electromotive-force of polarization.

Altho the electromotive-force of polarization may exceed the minimum, the work done by the current in overcoming this surplus electromotive-force will not appear as chemical work, for no more of the ion will be liberated; but it will appear as an additional quantity of heat (or *local heat*) developed in the electrolytic cell.

Experiments show that the resistance of a given column of a specific electrolyte is a constant, no matter whether larger or smaller currents are used in testing the resistance.

Amongst the secondary reactions which may occur the following are the chief:

[1] The ions themselves may decompose; as SO_4 into $SO_3 + 0$. [2] The ions may react on the electrodes; as when acidulated water is electrolysed between zinc electrodes, no oxygen being liberated owing to the affinity of zinc for oxygen. [3]

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The ions may be liberated in an abnormal state. Thus oxygen is frequently liberated in its allotropic form as *ozone,* particularly when the permanganates are electrolysed. The *nascent* hydrogen liberated by the electrolysis of dilute acid has peculiarly active chemical properties. So also the metals are sometimes deposited abnormally; copper in a black pulverulent film; antimony (from the terchlorid solution) in round grayish masses which are possessive of a curious explosive property.

When a solution of lead is electrolysed a film of lead peroxid forms upon the anode. If this be a plate of polished metal placed horizontally in the liquid beneath a platinum point as a cathode, the deposit takes place in symmetrical rings of varying thickness, the deposit being thickest at the center. These rings, known as Novili's rings, exhibit all the tints of the rainbow, owing to interference of the waves of light occurring in the film. The colors form, in fact, in reversed order, the "colors of thin plates" of Newton's rings.

[4] In certain cases the deposit may be of a non-conducting nature, as, for example, when aluminum is the anode in an alkalin solution, and an oxid of aluminum is formed as a film which entirely stops the current. Hence if a cell is arranged with a small plate of aluminum and a large plate of lead, which are immersed in a solution of sodium carbonat or ammonium phosfate, a current can flow thru it from lead to aluminum, but not from aluminum to lead. Such a cell, known as Nodon's valve, conducts in one direction only, and can be used to rectify an alternating current.

Equilibrium and Balance.

In order to have *equilibrium* it is quite evident that there must be the same number of *negative* as of *positive* ions in a solution. This serves to explain why a salt readily soluble in water, is not so soluble in water containing other compounds having some of the same ions in solution. For example, upon the the addition of hydrochloric acid to a strong solution of barium chlorid, a precipitat of barium chlorid is formed. This is usually explained by saying that barium chlorid is less soluble in hydrochloric acid than in water; the ionic explanation is that there is an excess of chlorin ions when hydrochloric acid is added to barium chlorid, equilibrium is upset, and hence a precipitat continues to fall until equilibrium is again establisht. The same effect is produced upon the addition of sodium chlorid solution to one of barium chlorid, and in general when there is an excess of one or another ion. The more concentrated either or both of these solutions are, the more rapid and complete the precipitation. This leads on to the *Mass-Action Law.*

Mass-Action Law.

The rate of chemical change between two reacting substances is directly proportional to the concentrations of the two substances reacting.

By way of illustration: let us see from the modern theory of solution what is supposed to take place when a solution of sodium chlorid is added to one of lead nitrat. Theoretically, no less than eight substances are present, as follows: Pb $^{++}$ $(NO_3)_2$, NaCl, $PbCl_2$, $NaNO_3$, Na, Cl, Pb, and $(NO_3)_2$. $PbCl_2$, by reason of its comparatively insolubility, is mostly precipitated. Not being wholly insoluble a portion remains in solution. According to the concentrations of the two factors, so will be the rapidity of precipitation of $PbCl_2$, and consequently more or less rapid establishment of equilibrium of the solution. If in a solution, all the substances are in equilibrium, no chemical action takes place. Disturbance of that chemical equilibrium produces a reaction. Adding more of either factor disturbs the poise. Taking away either of the products produces the same thing, each giving a *molecular concentration,* which causes increased action. This is the gist of the *mass-action law.*

Migration of Ions.

Prepare the apparatus shown in the photograph Fig. 102 from the constructional details given in Fig. 101. Pass one wire containing the copper disc thru a cork which fits tightly into the test tube (to prevent dripping of solution) and then fasten a binding post to the end. This serves as one electrode. Fill the tube three quarters full with a strong solution of copper sulfate slightly acidulated, which solution serves as the electrolyte. Place the upper cork, which has been previously fitted with an electrode, in the same manner as the first one. The upper electrode, which will be considered as the cathode, should be immersed about an inch beneath the solution. The other, the anode, should come within a couple of inches below the cathode as shown. The current from a few battery cells is then sent *UPWARDS* thru the electrolyte, the current being so regulated that it is not too strong, otherwise bubbles of gas will be given off and throw out the experiment. Of course, copper will be deposited *on* the cathode plate, an equal amount of copper being dissolved *off* the anode. After half an hour or more it will be seen that, immediately beneath the cathode, the blue liquid will become quite colorless, and if the experiment is continued, the surface of separation between the colorless liquid at the top and the blue liquid beneath it will be found to have steadily moved downward. If the current is sent *downward* thru the cathode, instead of upward thru the anode, no such phenomena can be seen, due to the descent by gravity of the heavier blue liquid. The colorless liquid is simply acidulated water.

There are two ways of explaining the action which has taken place. The first is that, in some way, in addition to the ordinary electrolysis in which the Cu and SO_4 ions have transferred in opposite directions, there has been a bodily transfer toward the anode of the copper sulfate which was in solution. The other way of explaining this is that the Cu and SO_4 ions have traveled with different velocities, the Cu traveling upward more slowly than the SO_4 downward. In the sketch Fig. 103, on both sides are some rows of dots, the black dots showing the *cations* (Cu) and the white ones the *anions* (SO_4), for the purpose of illustrating the relative number of the ions in the upper and lower portions of the liquid. Before electrolysis began the solution was uniform, as shown on the left, there being 9 anions and 9 cations (that is, 9 of $CuSO_4$) in each part, upper and lower. Suppose that electrolysis has gone on for so long a time that 6 of the cations have been dissociated and plated on the cathode, and that 6 of the anions have been likewise liberated and carried down to the anode, there to combine with the copper. Now, if the observed state of things is represented by the diagram on the right, it will be seen that while in the upper layer there are 5 $CuSO_4$ molecules, in the lower there are 7 $CuSO_4$ molecules, together with the 6 SO_4 which have gone to dissolve fresh copper. If the migrations of anions and cations had been equal, there would have been 6 $CuSO_4$ in each layer. If the anions alone had migrated, downwards, there would have been 15 $CuSO_4$ below and 3 $CuSO_4$ above. If the cations alone had moved, upwards, there would have been 9 $CuSO_4$ in the upper layer, leaving 3 of the original $CuSO_4$ in the lower, together

(*Continued on page 729*)

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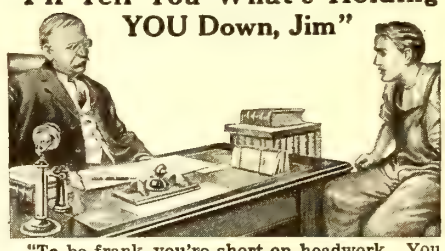
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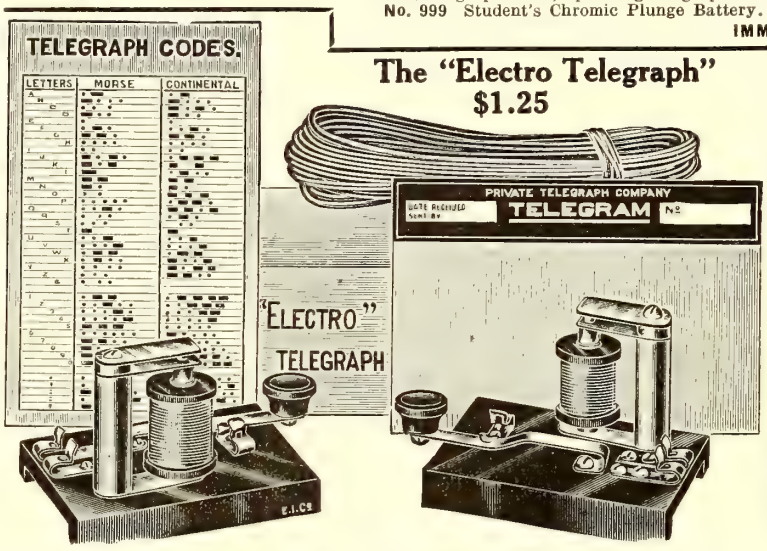
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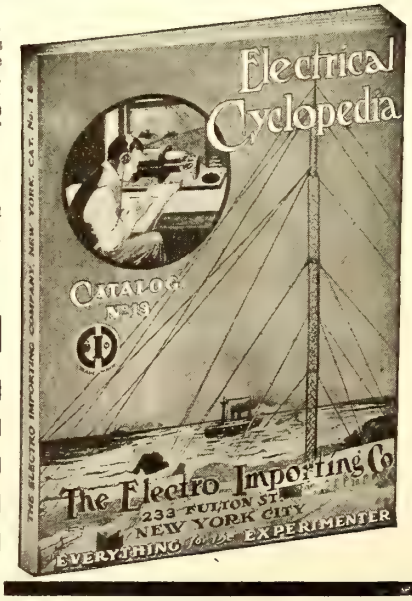
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ELECTRO-CHEMISTRY.

(*Continued from page 727*)

with the newly formed 6 $CuSO_4$. If, however, the diagram on the right represents the facts, either 2 $CuSO_4$ must have been bodily transferred into the lower layer from the upper, or else the transfer of ions must have been unequal; 4 anions going downwards into the lower layer, while 2 cations have gone upwards into the upper layer.

Theory of the Current in Electrolysis.

To get a picturesque illustration of what takes place when a current is past thru a solution of sodium chlorid (common salt), let 1, 3, 5, 7, 9 (Fig. 104) be five sodium ions, and 2, 4, 6, 8, 10, five chlorin ions, each ion having its charge of electricity neutralized by the ion above or below before the current is past, 1 being balanced by 2, 3 by 4, etc., and the solution being in equilibrium is disturbed by the passage of a current from a source of electricity. The plus ion 1 is then attracted to the cathode, where its plus charge neutralizes a part of the minus electricity of the cathode and ion 1 becomes an atom of sodium (see Fig. 105). The cathode then repels minus ion 2, and the latter attracts 3 and leaves 4 unbalanced, which in its turn attracts 5, leaving 6 to attract 7, which leaves 8 to attract 9; 10, being then unbalanced, is attracted to the anode, and losing its charge to the anode, becomes an atom of chlorin. The operation is repeated with almost infinite rapidity, atoms of sodium being set free at the cathode and of chlorin at the anode. Each unites with atoms of its fellows to form molecules of sodium and molecules of chlorin. The chlorin having nothing to combine with, escapes as a gas and may be collected. The sodium, of course, reacts with the solvent water to form sodium hydroxid and liberates hydrogen. Advantage is taken of this reaction in the manufacture of NaOH. This series of reactions takes place instantaneously and continuously.

(*To be continued*)

THE HOW AND WHY OF RADIO APPARATUS.

(*Continued from page* 685)

neutralize the other and minimum inductance will be had in the instrument. Theoretically considered, if coil "A" produced a magnetic flux density of 1,000 gausses per square centimeter of core section, then if this was opposed by 1,000 gausses of flux per square centimeter, of *opposite* polarity, the resultant magnetic flux, reacting on the coils will be zero. If the flux of 1,000 gausses per square centimeter of coil "A" is aided by the *like* flux due to coil "B," then the resultant flux acting on the coils will be 2,000 gausses per square centimeter. [For calculating the inductance of both long and short single layer as well as multilayer radio coils, reference should be made to the March, April and September, 1917 issues of the ELECTRICAL EXPERIMENTER, containing Parts I, II and III of a complete series on the *"Calculation and Measurement of Inductance."* See also "Wireless Telegraphy and Telephony Hand-book," by Dr. W. H. Eccles; "The Calculation and Measurement of Inductance and Capacity," by W. H. Nottage, B. Sc.; Bulletin of the Bureau of Standards, Vol. VIII, No. 1, page 64, for formulae covering the calculation of self as well as mutual inductance.]

Fig. 5 shows how the so-called *loose coupler* transfers the antenna circuit oscillations to the detector circuit by electromagnetic induction. The farther the secondary coil is separated from the primary the smaller the number of flux lines linking the secondary turns, and the less the mutual induction between the coils. With the secondary coil all the way within the primary, the strongest signals will be heard usually, but owing to interference from other stations, static, etc., it is often found in practise that the signals are heard best with a relatively loose coupling, or with the secondary considerably removed from the primary. At the Sayville, L. I., station, signals from Germany have been received with 2 to 4 foot of coupling separating the primary and secondary. The coupler coils were quite large of course, or about 20 inches long. The September, 1917 issue of the ELECTRICAL EXPERIMENTER contained the rules and formulae for designing both large and small loose couplers.

Loose couplers, as well as tuning coils, variometers, etc., should preferably always be designed to handle the wave lengths to be tuned in. If the range of frequency is quite large then two loose couplers forms the best solution of the problem; a small one for short and medium wave lengths and a large one for higher wave lengths. Loading coils, generally speaking, are a source of loss and are to be avoided. They offer considerable resistance to the weak antenna currents and cannot transfer energy to the detector circuit, except indirectly, such as by bringing the aerial or open oscillating circuit into resonance with the incoming wave. This, of course, causes a maximum flow of energy thru the antenna circuit, which, under many conditions, will effect a sufficient transfer of energy to the detector circuit to operate the responsive devices therein. This explains why the erstwhile Radio Amateur was forever building gigantic *loading coils.* He had found that his fellow "Radio-bug" could hear "Nauen" or "Honolulu" on his receiving set consisting of an 800 meter loose coupler coupled up with a *loader* made of a cardboard tube 9 feet long, wound with a mile or so of No. 36 silk covered magnet wire. He heard these far distant stations not because of good tuning conditions but rather in spite of poor tuning; this was often due also to the superior sensitivity of the Audion or other amplifier used, over which he exercised no control.

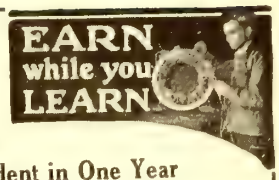
This argument is the same as that for charging 6 volt storage batteries with a bank of lamps (or a rheostat) from a 110 *volt* circuit. If you are going to charge the 6 volt battery in that way, well and good; but don't forget that the energy expended in lighting up the bank of lamps is forever wasted and it does the battery no good whatever. The moral is—use a low-voltage charging dynamo, driven by a water wheel or small engine, or a well designed rectifier if alternating current is available. Likewise, if long waves are to be tuned in, use a large enough loose coupler and put all of the energy to work. For short or medium ranges, a loading coil is often satisfactory because of the superior strength of signal received.

Diagrams Figs. 6, 7, 8 and 9 illustrate four of the principal tuning schemes in use to-day for receiving radio signals, Figs. 6 and 7 for the reception of damped waves and Figs. 8 and 9 for interpreting undamped wave signals, such as sent out by stations employing the Poulsen arc or a Goldschmidt (or Alexanderson) radio frequency alternator.

Fig. 6 outlines the connection of the Marconi *magnetic detector.* It is tuned in either by a tuning coil in series with the aerial or it may be connected in the secondary circuit of a loose coupler. It is connected in the tertiary circuit of the Marconi multiple tuner, the fixt or blocking condenser being variable and the tertiary winding of low

(*Continued on page* 731)

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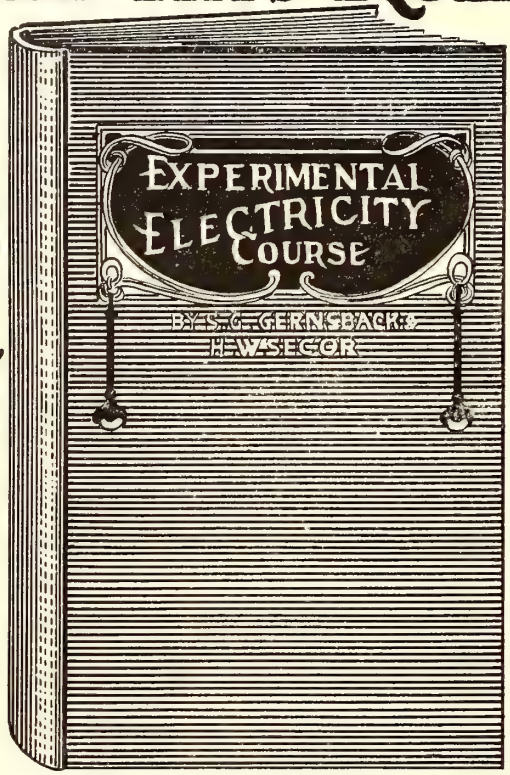
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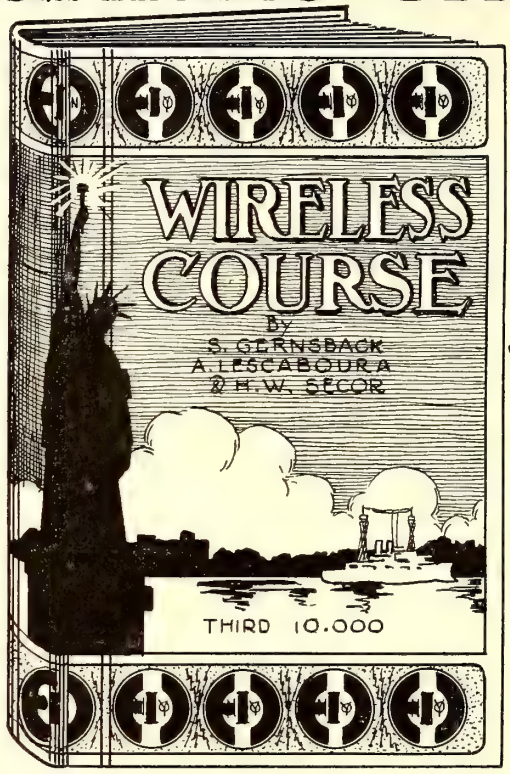
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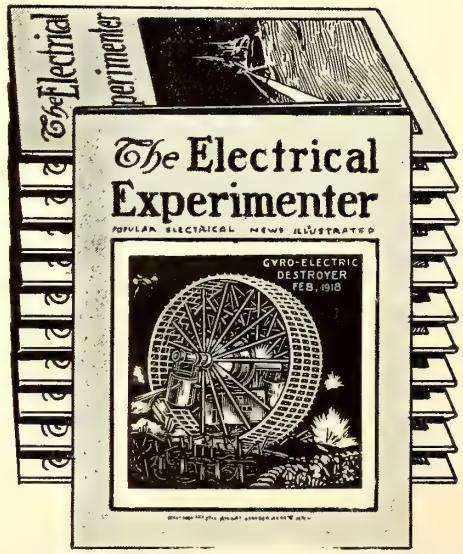
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THE HOW AND WHY OF RADIO APPARATUS.

(*Continued from page 729*)

resistance; i. e., wound with relatively coarse wire. Low resistance 'phones (75-80 ohms each) are used with this detector.

Fig. 7 is the hook-up for a standard *damped* wave Audion receptor. The loose coupler secondary should have high resistance; i. e., many turns of fine wire, so as to give a relatively high potential, as this detector is a potentially operated type. It is remarkably sensitive and many times more efficient than any form of crystal detector. High resistance 'phones are used with this layout of apparatus, and the battery polarities should be watched carefully.

Diagram Fig. 8 shows how the Poulsen *tikker* should be hooked up for receiving *undamped* wave signals. In one instance, cited by deForest, the tikker (interrupter) made from 150 to 200 breaks per second (the tone is regulated by the tikker speed); the 'phones comprising two ordinary 75 ohm receivers in series were shunted by a paper and tinfoil condenser of .02 microfarad. The same authority also found that a crystal detector could be used, as shown in diagram, if desired, but that while it raised the pitch of the incoming signals, it also reduced the strength of the signals on long ranges. A buzzer or gold wire tikker is indicated here, but the Poulsen stations now use a rotary wheel tikker, driven by a motor. A light spring wire brush rests in a groove filed in the perifery of the revolving disc. The action of the tikker is to allow the radio frequency energy to pile up in the large capacity connected across the secondary of the loose coupler; this periodically discharges into the condenser connected across the 'phones and which capacity in turn discharges thru the 'phones.

Diagram Fig. 9 shows a regenerative hook-up for a single Audion, whereby damped as well as undamped signals can be received. The November, 1915, issue of this journal contained full details of this interesting circuit and the work accomplisht with it.

The layout in Fig. 9 consists virtually of a loose coupler, primary and secondary loading coils and three variable condensers connected to an Armstrong circuit. The dimensions of the inductance coils are as follows: Primary of coupler is 10 x 5 inches and is wound with No. 22 S. S.; the secondary is 10 x 4¼ inches, wound with No. 28 S. S.; the secondary loading coil SL is 22 x 3½ inches and wound with No. 30 S. S., while the wing inductance WI has No. 30 S. S. for its winding. The capacity of each condenser is given in the diagram.

An aerial successfully used with this set measured 600 feet long, the wires starting 10 feet apart and ending 18 inches apart (fan shaped), the average height being about 50 feet. With this set it was possible to tune to 4,000 meters without any aerial inductance coils, and if loading coils are connected in the circuit it became possible to receive stations of over 9,000 meters wave length.

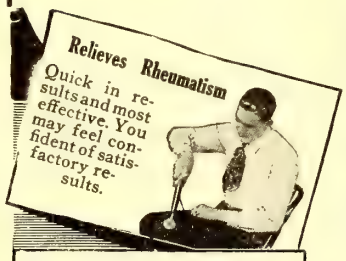
A simple Audion regenerative circuit, especially suitable for amplifying spark signals of wave lengths above 200 meters is shown in Fig. 10. The additional or *tickler* coil is a small auxiliary inductive coupler and connected as shown. It is used to interlink magnetically the wing and grid circuits. Remarkable amplification is obtainable with this scheme. It is being more widely adopted every day in commercial practise and many of the Army and Navy receiving sets are fitted with the tickler coil arrangement. The U. S. Navy specifications call for it. The superiority of the variable coupling tickler coil is that the device will always respond in a regenerative manner, while the circuit shown at Fig. 9 is more or less dependent upon certain critical conditions in the circuit for its successful operation. The hook-up shown at Fig. 10 is adapted to the reception of undamped as well as damped (spark) stations.

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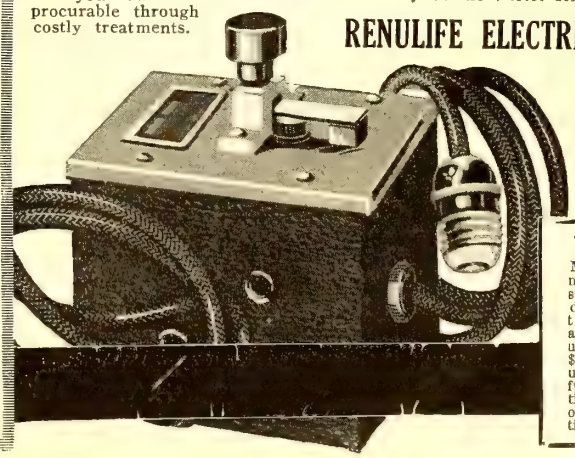
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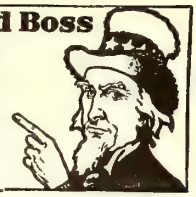
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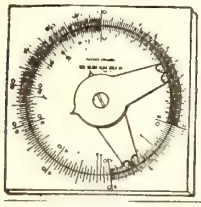
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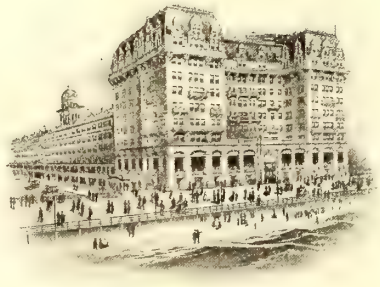
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NEW ORCHESTRA PHONOGRAPH PLAYS 48 RECORDS AT ONCE.

(*Continued from page* 662)

ers and thence over a sprocket wheel onto the take-up drum at the other lower end of the instrument as shown, which resembles an organ as far as its outside appearance is concerned. The sprocket wheel which engages perforations of the film similar to a motion picture machine and the take-up drum are driven by belts from an electric motor mounted directly upon the floor, with layers of felt placed between to subdue the hum.

Each needle of the various diaframs engages another sound record line and from each diafram leads a tube or sound-arm into a corresponding resonance compartment or horn, these being arranged partly above and partly below the channel rail. Between the two lower compartments which house the pay-out and take-up drums a space is provided for additional reels of film. A film of 1,500 feet length will play continuously for more than one hour, as the film moves only with a speed of 5" per second.

All diaframs can be lifted simultaneously with one lever so as to facilitate the insertion of a new film, the first few feet of which has to be pulled thru the perfectly smooth channel guide plate and attached by one end to the take-up drum. Otherwise the position of the various diaframs is absolutely a fixt one and cannot change relatively to each other, resting freely upon the film with the needle in a certain sound line. Saffire or diamond needles are used which do not require changing. As the film is not elastic and all sound records are at a certain fixt position to each other, corresponding to the position of the diafram engaging a particular record line, it is obvious that thus a perfect synchronism is attained, which never can be disturbed and the instrument can thus produce all the various sounds in perfect harmony with each other.

The action of this device will be understood from the foregoing description. If for instance the first diafram engages the first one of the parallel-running sound-record lines and the same contains all the sounds of the first violin of an orchestra exclusively and no others, we would hear only a violin solo if all the other sound-boxes (diaframs) were lifted from the film; while we would hear the complete orchestra playing in perfect harmony if all the different diaframs are engaging with their respective needles the various sound-record lines on the film. It would not be exactly necessary to use as many independent diaframs as there are instruments actually represented in a particular orchestra, as for instance all similar instruments producing sound waves of equal or similar length could be recorded with one sound record. Only where the variation in vibrations of a diafram to reproduce particular sounds is relatively great, would special sound lines and corresponding diaframs be required. Thus an orchestra of say about fifty musicians could be perfectly reproduced with an instrument of this kind, having, perhaps, only twenty-four sound-record lines on the film and twenty-four independent diaframs.

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HOW JIMMY SAVED THE TROOP TRAIN.

(*Continued from page* 679)

This done, there remained nothing else but to wait. At this point, feverish doubts began to fill Jimmy's mind. "Would it work as he thought, or suppose the track circuit were not in order?" he questioned himself again and again, as he laid there fascinated by the distant headlight of the oncoming locomotive which loomed larger and larger.

Then like the shrill scream of an enraged eagle, the whistle of the locomotive suspended the silence of the night. A cry came to Jimmy thru the chill night air, for it meant that the engineer had seen the signal, brought his train to a standstill and was now trying to ascertain the cause of the delay.

The realization that his effort to save the train had been successful brought on not only a mental but physical re-action on Jimmy, who in spite of his brave efforts to fight against the weakness, promptly fainted.

The sound of voices and the pattering of many feet were his first recollections on coming to. Opening his eyes finally, he saw that he was the center of a khaki-clad group, one of whom, on seeing his return to consciousness, stept forward and inquired if it were he who had stopt the train and why. Whereupon Jimmy explained as briefly as possible how he had overheard the plot to wreck the train and the plan by which he had succeeded in setting the signal against the engineer. On hearing the narrative, those about him were astounded not only at the narrowness of their escape from death, but at the quick wit displayed by Jimmy in thinking of such a novel plan as the short-circuit idea.

"Young man," spoke up one of them, whose eagle insigna showed him to be the colonel in command of the regiment, "what you have done I consider to be the cleverest bit of ingenuity that I have come across in a long while. Uncle Sam could find a good deal of use for one of your type in the engineer or signal corps. Let me have your name. Such work as you have performed to-night must not go unrewarded."

In the meantime an investigation had been made and resulted in the discovery of a huge quantity of dynamite and nitroglycerine contained in a metallic shaped receptacle so designed that by means of a protruding lever the whole would be detonated when the same was struck by the front wheel of a locomotive. No delay was lost in removing this menace from its dangerous position after which it was placed temporarily at a safe distance in a field nearby.

Also in order to apprehend the three conspirators, a detachment of soldiers was sent forward and soon afterwards they returned with the culprits in their midst, who were subsequently handcuffed and placed in the baggage car with a heavy guard over them.

One morning, as he came limping into the office to relieve his friend Jack Godfrey, who it will be remembered had joined the Signal Corps but had not as yet been called for active service, the latter excitedly handed him two business-like letters which he stated were left by the mail train that morning.

"Why," exclaimed Jimmy, as he looked at the printed matter in the left-hand corner, "what can this mean? Here's one from the Railroad Company and another from the War Department. Must be some mistake."

"Well," replied Jack, "there's only one way to find out and that is to open them."

Jimmy obediently proceeded to do so, in the order named and, imagine his delight and astonishment to read as follows:

My Dear Sir:

In recognition of the great service which you rendered the Company and the nation as well, in frustrating an enemy plot to wreck a troop train which recently past over our lines, the Board of Directors in meeting assembled have unanimously past a resolution in which they express the sincere gratitude of the Company for your brave act. Furthermore, as a more material expression of appreciation they have awarded to you the sum of one thousand dollars, as per enclosed check.

Hoping that you will see fit to accept this slight testimonial of thanks, I am

Yours very sincerely,

ALMER P. THOMPSON,
President, C. W. R. R. Co.

War Department
Washington, D. C.

Sir:

My attention has been called to an act of yours, by virtue of which a whole regiment of troops was saved from possible annihilation from train wreck plotted by enemy aliens. I am furthermore informed by the colonel in command of said regiment that in so doing you displayed a quick-wittedness and ingenuity, the like of which he had never seen before. The details are before me and after a careful perusal of them, I am led to the same opinion.

Now it is the purpose of this department to show in some way its appreciation of the great service which you have done the nation at large by saving the lives of those upon whom it depends to make the world free for democracy. I have information that you are at present employed as telegraph operator, which post ought to make you eligible for enlistment in either the Engineers or preferably the Signal Corps. Now, if you can see your way clear to joining either branch, this department will confer upon you the rank of First Sergeant and later that of Second Lieutenant should you prove your capability in the capacity first mentioned. You may use this letter as authority for such rating when presenting yourself for examination.

Again thanking you in the name of the department for your services and trusting that it may have further use of them in the Signal Corps, I remain

Yours very truly,

N. D. BAKER,
Secretary of War.

James Hanlon, Esq.,
Winslow, Pa.

* * * * *

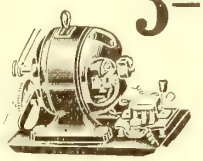
Did Jimmy join?
Well, would a duck swim?

[THE END]

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The Big Power Motor for Boys $3.00

A compact, highly efficient reversible motor, perfect in every detail. The reducing gear, easily adjusted, transforms the high speed to more power at slower speed. This motor is guaranteed by us to be exactly as represented.



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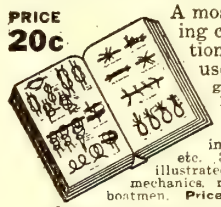
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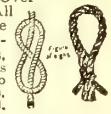
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Learn to throw your voice into a trunk, under the bed, out in the hall or anywhere. Lots of FUN fooling the Teacher, the Janitor, Policeman or Friends.

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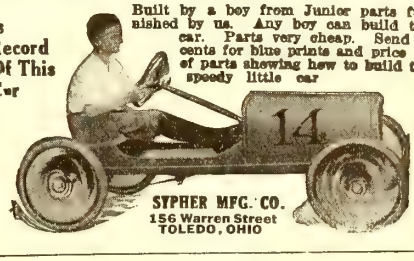
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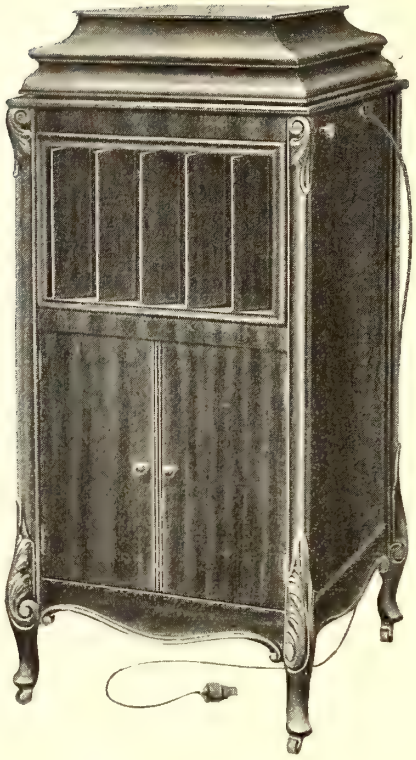
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Built by a boy from Junior parts furnished by us. Any boy can build this car. Parts very cheap. Send 2¢ cents for blue prints and price list of parts showing how to build this speedy little car



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Some such remark as this will pass your lips when you hear for the first time an electrically equipped Columbia. And you will not rest easy until you own one.

No winding necessary. The electric motor of the Columbia is a marvel of silence and smoothness. It is actually a part of the instrument and all the electric equipment is contained within the instrument.

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Advertisements in this section six cents a word for each insertion. Count 7 words per line.

Name and address must be included at the above rate. Cash should accompany all classified advertisements unless placed by an accredited advertising agency.

Ten per cent. discount for 6 issues, 20 per cent. discount for 12 issues from above rate. Objectionable or misleading advertisements not accepted.

Advertisements for the March issue should reach us not later than January 23.

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10,000 Scientific Formulas, the secrets of all modern industries, alphabetically arranged in 800 page volume. Price $3. Large descriptive circular on request. Alfred Claus Company, 1864 Harman St., Brooklyn, N. Y.

A BINDER for THE ELECTRICAL EXPERIMENTER will preserve your copies for all time. Price, 50c. Postage on 3 lbs. is extra. Send for one today. Experimenter Publishing Co., 233 Fulton St., New York City.

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Jan.	price each	$.35	
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April	"	"	"
May	"	"	"
June	"	"	"
July	"	"	"
August	"	"	"
Sept.	"	"	"
Oct.	"	"	"
Nov.	"	"	"
Dec.	"	"	"
1916.			
Jan.	"	"	$.35
Feb.	"	"	"
March	"	"	"
May	"	"	"
June	"	"	"
July	"	"	"
August	"	"	"
Sept.	price each		$.35
Oct.	"	"	"
Nov.	"	"	"
Dec.	"	"	"
1917.			
Jan.	"	"	$.20
Feb.	"	"	"
March	"	"	"
April	"	"	"
May	"	"	"
June	"	"	"
July	"	"	"
Aug.	"	"	"
Sept.	"	"	"
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We can fill orders at once upon receipt of your remittance and if you have not these numbers already now is your chance to get them as they probably will be snapped up very quickly. Experimenter Publishing Co., 233 Fulton St., New York City.

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PREPAID 80 DIFFERENT CHEMICALS, $4.00—Mercury, Sodium, Iodine, Magnesium, Aluminum, Uranyl-Chloride, Silver Nitrate, Mercuric-Oxide, Zinc Dust, Iodoform, Manganese Dioxide, Calcium Sulphide, Hydrochloric, Oxalic and Acetic Acids together with 65 others. All are contained in glass bottles. Generous quantities of each. We do this to advertise the purest chemicals manufactured. Full list sent free upon request. Sent prepaid to any address in the world, $4 complete. C. O. D. terms accepted. The Swimmer Chemical Co., 1904 Park Place, Brooklyn, N. Y.

MINERAL SAMPLE with instruction sheet for testing, five cents. Clarence Appel, Mathews Ave., Knoxville, Pittsburgh, Pa.

LABORATORY APPARATUS AND ANALIZED CHEMICALS—For February: Funnels, 19c; Test Tubes 6 x ¾, 3c. Flasks 8 oz., 24c. Complete list, 5c. $3 orders postpaid. Klaus, Eureka, Ill.

1520 *St. Marks Ave.,*
Brooklyn, N. Y.

The Experimenter Publishing Co.,
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Gentlemen:

The advertising columns in the "E. E." certainly bring excellent results. I have sold 250 spark coils and orders are coming in at the rate of 10 a day, all resulting from one insertion in the classified columns of the E. E.

I would highly recommend this paper as an advertising medium to those who desire to trade or sell.

Respectfully yours,

J. EISGRAN.

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THOUSANDS GOVERNMENT WAR POSITIONS OPEN to men and women, 18 or over, $100 month. Rapid increase. Short hours. Pleasant work. Vacation with pay. Pull unnecessary. Examinations everywhere. Common education sufficient. List positions free. Write immediately. Franklin Institute, Dept. L-27, Rochester, N. Y.

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No. 2375—Extra best Tennis Racket, $5 grade, air dried ash, popular long oval form, concave walnut wedge, superior quality of gut; each, $2.75.
No. 2377—First grade Tennis Racket, second growth ash, walnut and maple throat, very good grade of gut; handle of cedar with leather cap; a $3.25 grade; each $1.85.
No. 2376—Medium grade Tennis Racket made of the same stock as No. 2377 except the gut. A perfect $2.25 grade. Ideal for beginners. Each $1.35.
Shipping weight of each size two pounds. Send for one today. Our stock is limited and policy is: "First Come, First Served." Don't forget to include money for postage, or we ship express collect. The Electro Importing Co., 233 Fulton St., New York City.

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YOUR IDEA WANTED. PATENT YOUR INVENTION. I'll help you market it. Send for 4 free books, list of patent buyers, hundreds of ideas wanted, etc. Advice free. Patents advertised free. RICHARD B. OWEN, Patent Lawyer, 130 Owen Bldg., Washington, D. C., or 2278 T Woolworth Bldg., New York.

INVENTIONS WANTED! Manufacturers constantly writing us for patents. List of inventions actually requested and book "How to Obtain a Patent" sent free. Send rough sketch for free report regarding patentability. Special assistance given our clients in selling patents. Write for details of interest to every inventor. Chandlee & Chandlee, Patent Attorneys, Est. 21 years. 551 7th St., Washington, D. C.

PATENTS—Without advance attorney's fees. Not due until patent allowed. Send sketch for free report. Books free. Frank Fuller, Washington, D. C.

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BEFORE BUILDING that receiving set get our circular on perfectly designed switches and switch points. Hard rubber knobs used exclusively. Eureka Secondary Co., 6939 S. May St., Chicago, Ill.

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High Frequency Transformers "Oudin Style," complete, prepaid, $4.50. J. C. Swimmer, 1904 Park Pl., Brooklyn, N. Y.

HAMS! Have 87 Navy Transformers (5a) $10 each, 100 Sayville $12 Gaps, at $7. Other like bargains. Send for list. J. S. Brown, Main St., Menominee, Mich.

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UNDOUBTEDLY you have at the present time some things for which you have no further use. **Do you wish to exchange them for something for which you have immediate use?** There is no surer and quicker way to do this than by advertising your articles in these columns. The *Very* people, the *Only* people, who could possibly have a use for your things read this journal. More than 75,000 interested people will see your ad. It is furthermore the cheapest advertising medium for you in the country. Dealers' advertising accepted in Opportunity Exchange columns only.

The rates are: *Five cents per word* (name and address to be counted). minimum space 3 lines. Count about 7 words to the line. *Remittance must accompany all orders.* No advertisement for less than 50c. accepted.

We reserve to ourselves the right to refuse any advertisement which we consider misleading or objectionable. Advertisements for the March issue should reach us not later than January 23d.

The Classified Columns of "The Electrical Experimenter" Bring Positive Results.

Subscribers experiencing trouble in dealing with any advertiser should notify the publisher very promptly.

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HYDROMETER—Tycos make, corrected, with certificate. 80 to 120 degrees. Cost $3. Never been used. $1.75 postpaid. J. W. Weldon, 5724 Montgall, Kansas City, Mo.

NEW COLBY TUNER, with switches, $5; will trade for 3000 Holtzer-Cabot receivers. Merrill Rose, Oneida, N. Y.

PHOTOGRAPHY GOODS WANTED—Have high-class magical goods to exchange, no toys, all professional goods. Studio goods preferred. C. O. Lorenze, 2502 Proctor St., Port Arthur, Texas.

EXCHANGE—An excellent bunch of electrical engineering books for modern type firearms. Frank Utley, Macomb, Ill.

SELL OR EXCHANGE—Large variety of switches, etc. Write enclosing stamp. Perry Crawford, 13 Len Broech Street, Albany, N. Y.

FOR SALE—An astronomical telescope that actually shows things—no toy—75 diameters. A sure enough find for $18, or have you a flexible transformer. Ask M. E. Everson about it. Neligh, Neb.

SELL—Two new Electron Relays, each $2.75; new Tigerman Detecto-Amplifier, cost $7, sell $3.50; "O" Crystaloi, $2; two new Lenzites, each $3. Everything unused. Brainerd Stratton, Oneida, N. Y

FOR SALE—Four Meccano sets worth $12. First $8 takes them. Geo. Milne, 142 Totowa Rd., Paterson, N. J.

WANTED—Electrical and chemical apparatus. All answered. Box 255, North Bennington, Vt.

EVEREADY AUTO-PED; A-1; swap for 1916 Light Excelsior 2-speed or $40. Frank Weil, New Canaan, Conn.

BARGAIN—Motorcycle engine, $15. J. Liese, 234 Seeley, Chicago, Ill.

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Do you realize that these "Scientific Exchange Columns" are the World's most renowned "Swap" market? "THE ELECTRICAL EXPERIMENTER" prints 90,000 copies of this issue; that means that at least 180,000 readers see this page and probably a great many more. Our readers who advertise here seldom advertise the same thing twice—usually within five days after the issue is out the advertised article has been sold, or swapped. The many testimonials which we print here from time to time are ample proof of the almost miraculous pulling power of these columns.

Look around in your attic or workshop and you will find dozens of long forgotten articles, useless to you now, but very useful to someone else. At a ridiculously low cost you can either sell or swap such articles.

And remember this fact: The U. S. Postal Laws protect you. No one can "do" or cheat you. Of 3,495 "ads" published in these columns during the past five years, only twelve complaints were reported to us, and each and every one was adjusted to the full satisfaction of the complainant.

It matters not if you have old books or magazines, a kodak, electrical or chemical apparatus, scientific instruments, bicycles, typewriters, moving picture machines, air rifles, watches, structural toys, etc., etc. All these and countless others can be speedily disposed of here. Try it and be convinced.

The ad I had in your magazine some time ago brought me 122 *different* answers; they came from all over the United States and even from Canada. The advertising columns in your magazine are the BEST I ever used. I obtained splendid results for such a small ad.

Yours very truly,

LOUIS E. KRIEG,

134 North School Street, Gloversville, N. Y.

BARGAIN—Superior Phones, Detector, Tuning Coil. Write Jno. B. Craven, Lexington, N. C.

BOOKS—I.C.S. Elements of Electrical and Mechanical Engineering. Vols. 1, 2, 4, 7. Like new. Set $6. Ralph Leffler, Tiffin, Ohio.

EXCHANGE for motorcycle, 1, 3 H.P. Ferro outboard engine ran 100 miles. 1, 25-20 Winchester repeater. 1, 30 calibre standard automatic high-grade rifle gun, never used. I. B. Terry, General Electric Co., Cincinnati, Ohio.

HAVE four large Spark Coils, two ¼ K.W. transformer coils and other instruments. Cash or exchange. Chas. Reidinger, 4317 Howlett Ave., Cleveland, Ohio.

I'LL exchange up-to-date radio apparatus for high-grade military wrist watch; ANSCO vest-pocket camera. PRAY, 102 Heath, Somerville, Mass.

Two 6x10 hand printing presses $12 and $18; also type, rules, etc. Have a lot of mail-order literature $5. Write your wants. Alderman, 174 Plymouth St., New Haven, Conn.

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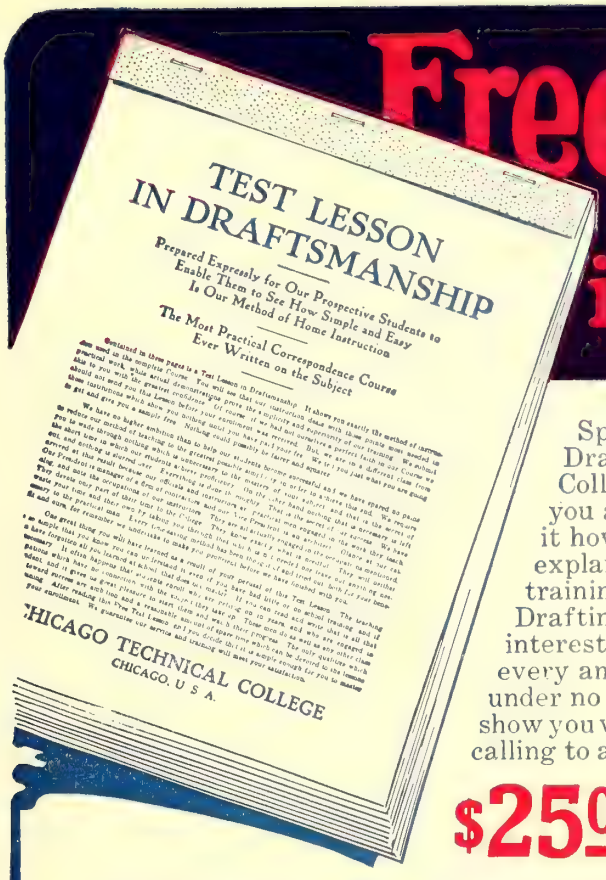
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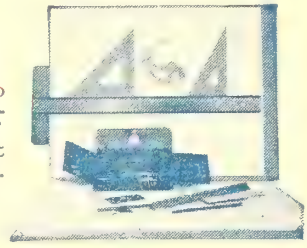
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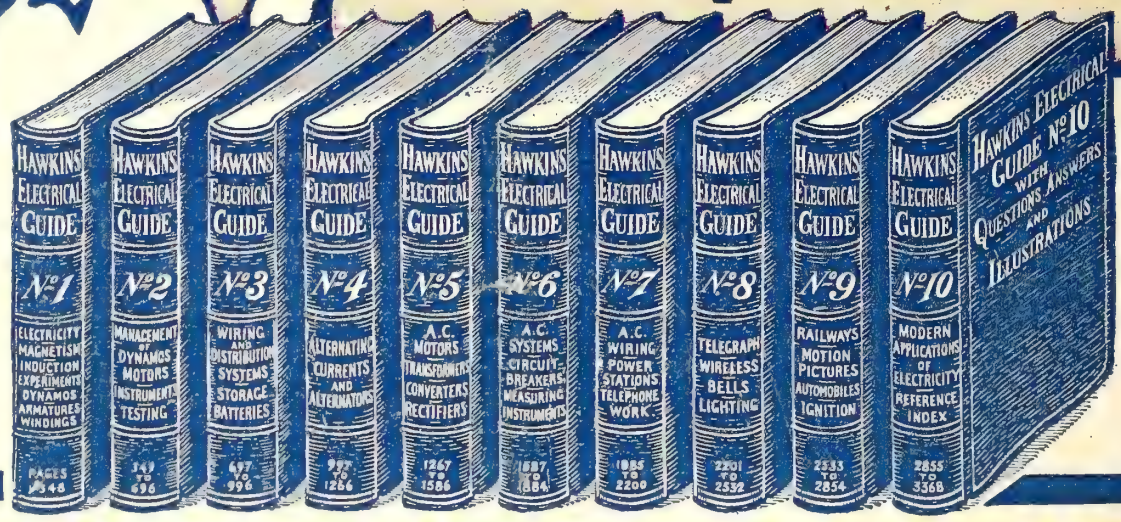
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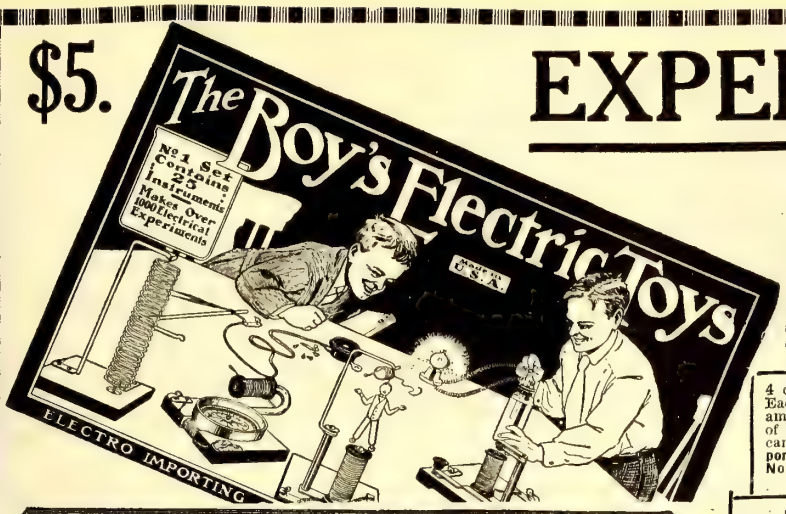
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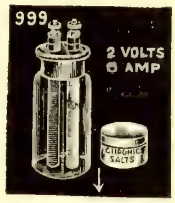
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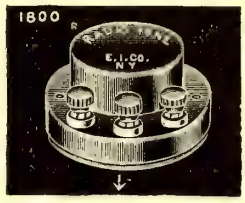
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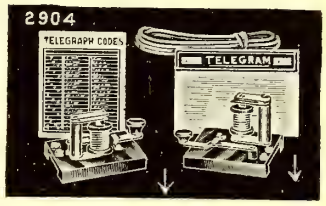
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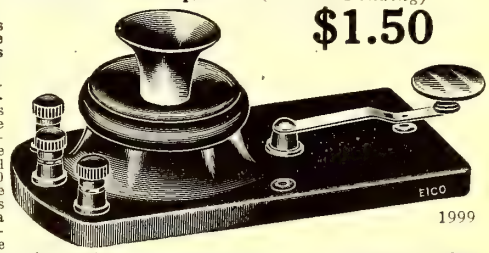
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Dormant Forces

DURING the past few months we have read a good deal in the daily press about a wonderful new force purported as having been discovered by an Armenian gentleman by the name of Garabed Giragossian. "Garabed," as the new "force" is now popularly known, is supposed to drive ships across the oceans at a fraction of the cost it is possible of doing the same thing now. Aeroplanes with a "handful" of Garabed will cross the Atlantic in a few hours, so we are told; in short, all our known notions of present-day energy-producers will be thrown on the ash-heap,—always providing that Mr. Giragossian will be able to make good his promise!

That the scientific press has kept itself aloof—never even mentioning the supposed invention—matters little. Scientific men quite properly like to deal with facts, not suppositious inventions. But Mr. Giragossian has been able to interest our Government, and at the present time five scientists of repute are looking into the merits of the "discovery." Whether Mr. Giragossian has actually made a great invention or not is beside the scope of this article. The point we wish to make is that the world, as far as cheap energy is concerned, still sleeps the sleep of the ages. We cannot even claim that the world in that respect is still in its infancy. It is much further back than that—it has not even been born. What are we to think of ourselves and our much-vaunted science when we contemplate the fact that, for instance, when burning coal to produce electric light we get **6/10 of 1%** of useful light from the energy stored in our coal when we burn it, the other 99 4/10% being totally lost in useless heat which we don't want. Just think of the tremendous energy we expend in first mining coal, then hauling it over a thousand miles of rail, then transshipping it a dozen times, re-loading and unloading it before we finally drive an engine with the little heat we can actually extract from the coal. Is it not tantalizing to realize that the latent energy stored up in ¼ ounce of coal—theoretically—can haul a long train over one thousand miles! Atomic forces are so gigantic that we cannot begin to even comprehend them. All about us—in every stone, in all metals, in every piece of wood, every material in fact—billions of horsepowers are laying, locked up, dead and inert. The atomic energy locked up in a one-cent piece is sufficient to lift up the Woolworth building several thousand feet into the air. The only trouble is we do not as yet know how to unlock this tremendous energy. We are still blind towards atomic forces, just as blind as the savage is towards a cubic foot of Trinitrotoluol. It means nothing to him, for he can kick it around to his heart's content, without danger, and nothing will happen. Even if we did supply him with the necessary percussion cap it would not help him to unlock the 10,000 cubic feet of gas lying dormant in that one cubic foot of explosive. He would not know how to apply the cap, which perhaps is a good thing—for he would never have to try it again—at least not after his relatives had discovered his remains, miles away from the scene!

Some of the newspaper editors have ridiculed Mr. Giragossian, as they thought he meant perpetual motion by his perhaps rash term of "free energy." These worthy gentlemen evidently forget that their fathers some forty years ago talked in like terms when the Niagara Falls were first spoken of to run the street cars in Rochester and Syracuse—over 100 miles distant!

All this of course is ancient history now, but it is simply a conversion of a natural power, and "free" energy in a sense. For it costs man actually nothing; the power is there, all we need to do is tap it, and we do not have to expend additional energy in so tapping it either, as for instance we must do in mining and hauling and handling coal.

Of course, this tapping of our waterpower to-day is a barbarous procedure, one our grandchildren will laugh at; but for us it is as wonderful as it was for our forest ancestors when they tried laboriously to make a fire by rubbing dry wood sticks together.

But the new energy is coming as surely as the sun will rise to-morrow, and just as surely this force will make man free from most of his present physical drudgery.

H. GERNSBACK.

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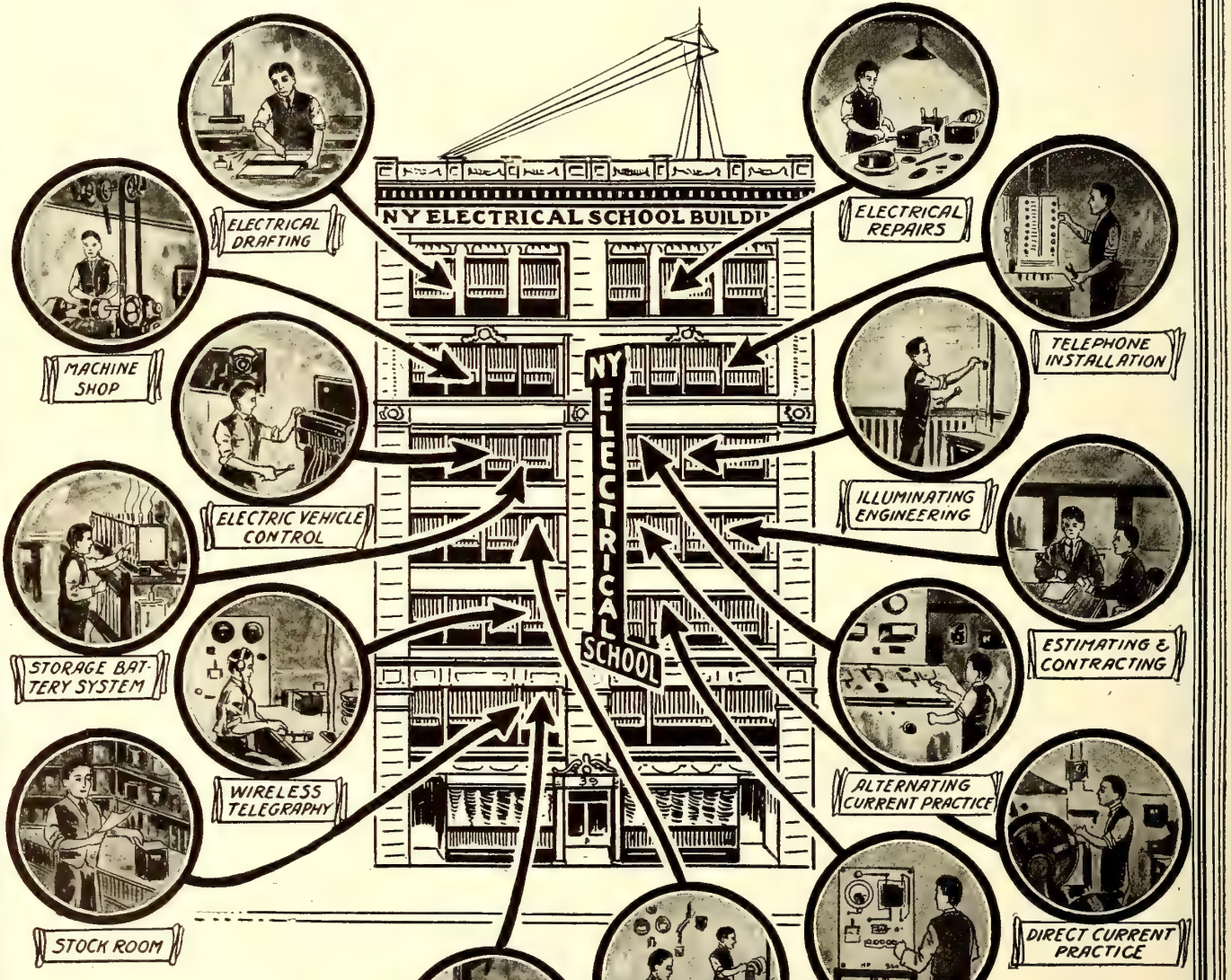
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ELECTRICAL EXPERIMENTER

H. GERNSBACK EDITOR
H. W. SECOR ASSOCIATE EDITOR

Vol. V. Whole No. 59 March, 1918 Number 11

President's Speech to World Via Cable and Radio

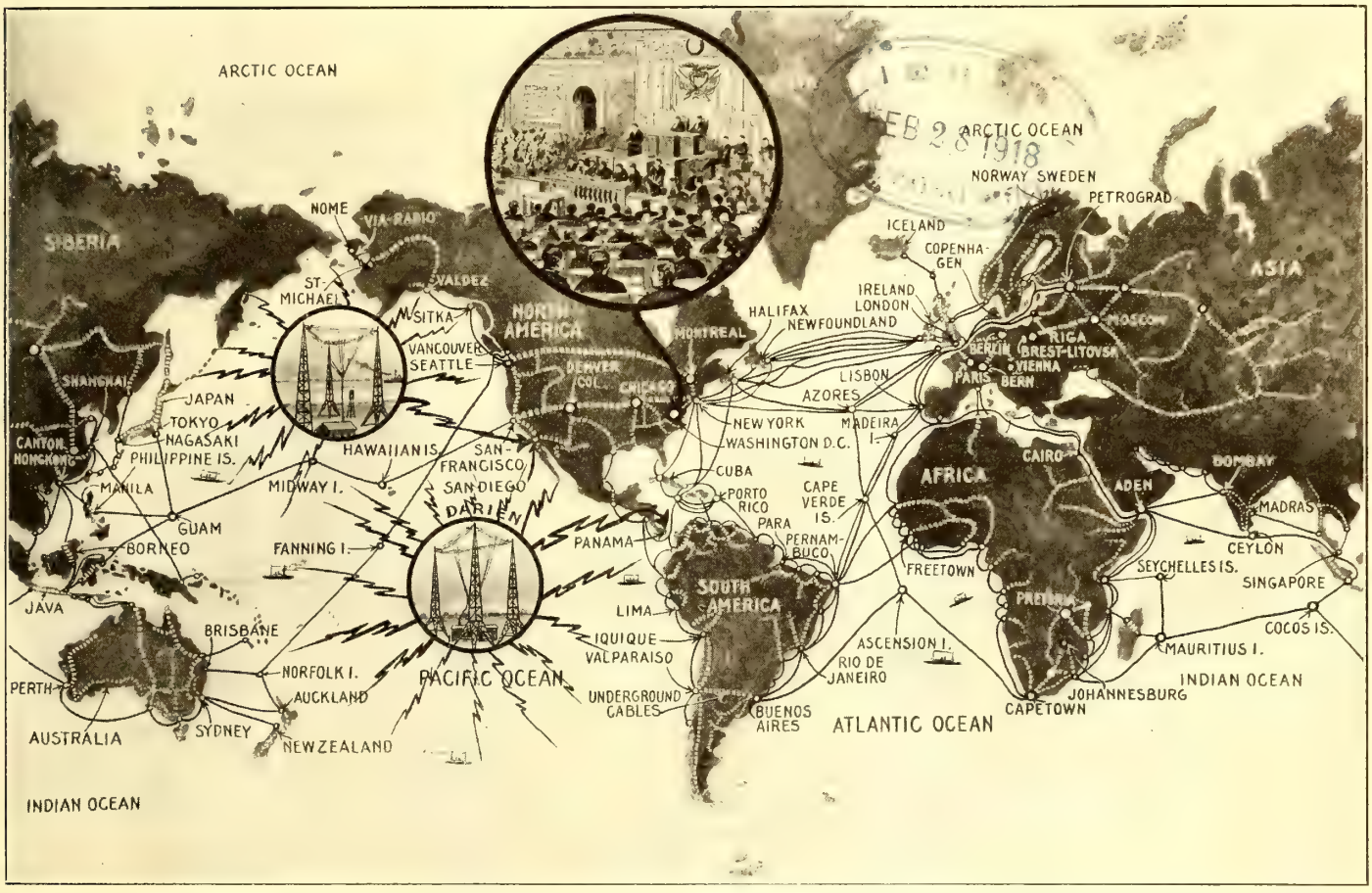
LITERALLY to the ends of the earth President Wilson's recent "Peace-terms" address was sped by cable, telegraph and radio as soon as he began it, and thru the newspapers of every civilized country the whole world's reading population has become acquainted with America's war aims in detail.

used for the transmission, and the operators at both ends were locked in their rooms lest by any chance there might be a leak as to the nature of the speech before Mr. Wilson delivered it.

Then, in order to insure absolute accuracy, the address was "read back" to Washington over a private long-distance

kept under lock and key or under naval guard. Advance information would have been almost priceless to Wall Street speculators.

At thirty minutes past noon the word came "Release President's speech," and the cable and telegraph operators started clicking it off to the four quarters of the globe.



Map of the World, Showing Principal Cables (Full Lines) and Land Lines (Dotted Lines) By Which President Wilson's Recent "Peace-terms" Address Was Broadcasted to Every Civilized Country as Soon as He Started Speaking at Washington. The Powerful U. S. Government Radio Stations at Darien and San Diego Flashed the Message to Ships at Sea and the Smaller Islands in the Caribbean.

This was one of the biggest and swiftest bits of news distribution on record, and it was done in this way:

The speech was telegraphed in advance the day before the President spoke, to the Division of Foreign Press of the Committee of Public Information at New York City. The Government's private wire was

telephone. When it had been verified, it was cut into "cable takes" of approximately 100 words each, and the operators who were to handle it opened their keys and got ready for the "flash" which would tell them to start sending. The speech contained about 2,700 words. Every one who had anything to do with the handling of the speech was

To London it went by Western Union cable. There it was given to the Reuter, Exchange Telegraph and Central News agencies, which flashed it at once to all the newspapers they serve. Via Western Union cable the message flashed to London and was actually delivered in that city in 2 hours and 35 minutes. Reuter's agency in

AUSTRIANS USE RADIO IN ALPS.

The Radio operator in active military service does not always have a hut or dug-out in which to set up his instruments. The photo herewith illustrates a temporary Austrian radio station near the top of a mountain peak in the Alps. The small antenna mast is guyed in position as shown and the operator at the foot of the pole is busy receiving a message. At the extreme right an officer is making observations which he reports to the wireless man for transmission to headquarters. Note the two industrious radio squad men kneeling down in the center of the photo. They are the "dynamo men" and their duty is to turn the crank and spin the dynamo until the voltmeter registers 110 volts. The operator can then press his key and send out his message. No current is necessary for receiving the messages. Photo © by Underwood and Underwood



Far Up in the Cold Mountain-tops, Thousands of Feet Above Sea Level, the Wireless Proves Itself Invaluable. This Portable Radio Set Is Being Used by an Austrian Signal Corps Squad in the Alps Region.

PERISCOPE FOR READING TRANSFORMER TEMPERATURES.

In order to read the temperature of the oil as indicated by the thermometers on transformers, the Pacific Power & Light Co. in one of its sub-stations has attached periscopes to each transformer to enable the operator to observe the temperature from the floor. This makes it unnecessary to use step-ladders. The periscope consists of a square metal tube 4 ft. 8 in. (1.4 metre) long and 2 in. (5 cm.) square. At the ends are placed two mirrors facing each other at an angle of 45 deg. with the sides of the tube. The lower mirror is 1⅞ in. (4.8 cm.) wide and 3 in. (7.6 cm.) long, while the upper one is 1⅞ in. (4.8 cm.) by 3⅜ in. (8.6 cm.) long. The upper mirror is made longer to give a longer view of the thermometer scale.

ELECTRIC SHIP HAS FUTURE.

The electric ship is no longer a dream but a reality, and it is quite possible that within a few years of the close of the war every new vessel of any size will be driven, steered, stopt, reversed or turned, merely by the pressing of a series of buttons on the bridge. The application of this principle will enable ships to be run with the highest efficiency at an even speed, permit marine engineers more liberty of design and yield proportionately greater cargo space than the present cumbrous form of machinery allows. The newer American merchant ships are electrically controlled.

London also recabled it immediately to the American Ministers in The Hague, Stockholm, Copenhagen and Christiania, thus covering Holland, Sweden, Denmark and Norway. The Ministers gave out the speech as soon as they received it to all the news agencies in their respective countries.

From London the speech was sent also to Petrograd and distributed to the news agencies by a branch of the American Committee on Public Information in the Russian capital. From Petrograd it was telegraphed over land lines to Moscow and thence to Brest Litovsk, the scene of the recent Russian-German peace parley.

To Paris the President's address was sent by way of the Commercial Cable in the space of 1 hour and 38 minutes. There it was given out to the Havas News Agency, the Agencie Radio and the Maison de la Presse, the French official institution for distributing news. These organizations forwarded it to Berne, to Rome, to Athens and to Madrid and Lisbon; thus covering Switzerland, Italy, Greece, Spain and Portugal.

News wires are working between Berlin and the Holland border, as well as to the Swiss border, so the speech got into Germany certainly from one or another of these border stations, (the message received in Holland and Switzerland being transmitted to the German border by courier, from which point it was telegraphed to Berlin) and doubtless was sent down thru the Central Empires from Berlin.

South Africa and India receive their news thru the Reuter Agency in England, and the speech was cabled to them by that organization.

It was sent to Australia by the British cable which runs from Vancouver, B. C., to Sydney. It was telegraphed to San Francisco in the short time of 1 hour and 38 minutes, and then cabled to Hawaii, to Shanghai (there distributed by Reuter's) and to Tokio, where the Japanese agencies —Kokusai and Nippon Dempo—sent it out.

By cable the speech went by direct cable to Havana, Port au Prince, Hayti and Carraccas, Venezuela. It also went via direct cable to Colon, across the isthmus to Panama, and from there down the west coast of South America to Santiago, Chili, whence it was telegraphed across the Andes (over the longest *under-ground* cable in the world) to all the lower capitals of South American republics, reaching Buenos Ayres first.

From the naval radio station at Darien, on the Isthmus of Panama, the address was flashed out to all the little islands and ships in the Caribbean. The naval radio station at San Diego, Calif., also flashed the message to ships in the Pacific.

The United States and Canada, of course, received it thru the ordinary news agencies which supply both.

An idea of the speed with which the speech was sent out may be had from the fact that Buenos Ayres reported back that it had been received in full one hour and forty-five minutes after the operators here had stopt sending. Meanwhile it had been retelegraphed across the mountains down in South America.

Many extremely interesting points were revealed by this gigantic news propaganda which the average person, who never uses the cables, knows but little about. In the first place the modern atlas and geography "map of the world" does not show anywhere near all of the cables now laid and in successful operation in various parts of the world.

Several interesting long-distance cable routes used in broad-casting the President's speech of 2,700 words to the world are the following, and which were not mentioned in the newspaper accounts. In the preparation of this article the editors have had the assistance of Mr. Donald McNicol, Assistant Electrical Engineer of the Postal Telegraph Co., and Mr. Walter S. Rogers, Director of Foreign Press Division at New York.

The speech reached the "Far East"—India, Sumatra, Java, Ceylon (of Lipton tea fame) and the Malay Peninsula by cable. The message sped over the ocean cables from Lisbon, Portugal, down along the west coast of Africa, via Cape Verde Island, to Cape Town, South Africa. From here it was telegraphed across country to Durban, on the east coast, and flashed on via Mozambique north to Aden, at the south end of the Red Sea, thence by cable to Bombay, India. It continued from here by overland telegraph to Madras, on the east coast and, once more speeding under water, reached Penang on the Malay Peninsula. From Penang the message spread to the several islands in the East Indies. An alternative cable route, but liable to interruption due to present naval activities in the Mediterranean Sea, lies along the coast of Portugal from Lisbon, via Gibraltar, thru the Mediterranean, thence along the Suez Canal route, thru the Red Sea cables, to Aden

(*Continued on page* 802)

BACK NUMBERS!—Many readers desire to obtain back numbers of this journal. We have a limited quantity of these back issues on hand and can supply them at the following rates:—Back numbers of The Electrical Experimenter not over three months old, 15 cents each; over three months old, 20 cents each over one year old, 35 cents each.

Can Electricity Destroy Gravitation?

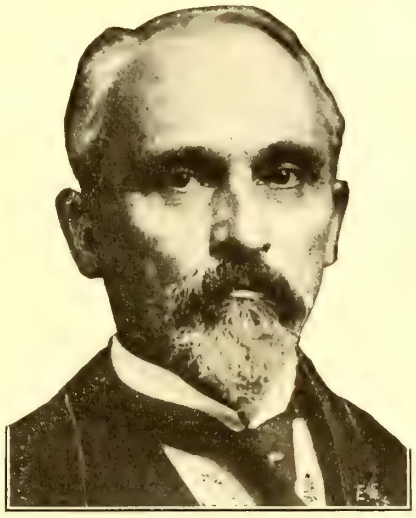
IS it possible to nullify, and further to even reverse, the effect of gravity by electricity? This scientific conundrum seems about to be solved, at least to a certain extent. To begin with, everybody is familiar with that law of physics which states "that all particles of matter attract each other with a force which is greater the nearer the particles are together," and to be still more definite, Newton's law says that bodies behave as if every particle of matter attracted every other particle with a force that is proportional to the product of their masses and inversely proportional to the square of the distance between them. It is the gravitational attraction between the earth and the bodies upon it which causes the latter to have *weight*.

This fact is often lost sight of and should be well understood by every student. To make the matter more clear let us imagine that a man's body is (as by flying, jumping, diving from a high point, etc.,) for the moment separated from the surface of the earth. As soon as the mass of the body is separated from the earth, gravitational attraction is set up between the two masses. The earth pulls the man's body, and also his body pulls the earth, but as the mass of the earth is infinitely greater, its movement cannot be detected.

The scientists of to-day believe that in some mysterious way the minute electrical charges existing on the particles making up molecules and atoms are definitely linked up and concerned with such basic phenomena as *gravitation*. Since all bodies are made up of atoms it would seem to logically follow that the forces of gravity must depend in some way upon attractions which atoms exert upon each other, and due to the fact that the atoms are separated, at least in solids and liquids, by extremely small distances, we might expect these inter-atomic forces to be relatively more powerful than are those of ordinary gravitation. Until recently, however, the mystery linking this inter-atomic activity with the force of gravitation baffled all attempts at solution, altho many scientists had tackled it.

But at last experimental proof has been forthcoming thru the untiring labors of Professor Francis E. Nipher, of the St. Louis Academy of Science. In a pamphlet issued November 8th, 1917, Professor Nipher supplies experimental evidence that gravitational attraction can not only be suspended or nullified by the electrical current, but it actually can be transformed into "gravitational repulsion!"

All during the summer of 1917, Professor Nipher had his apparatus in almost



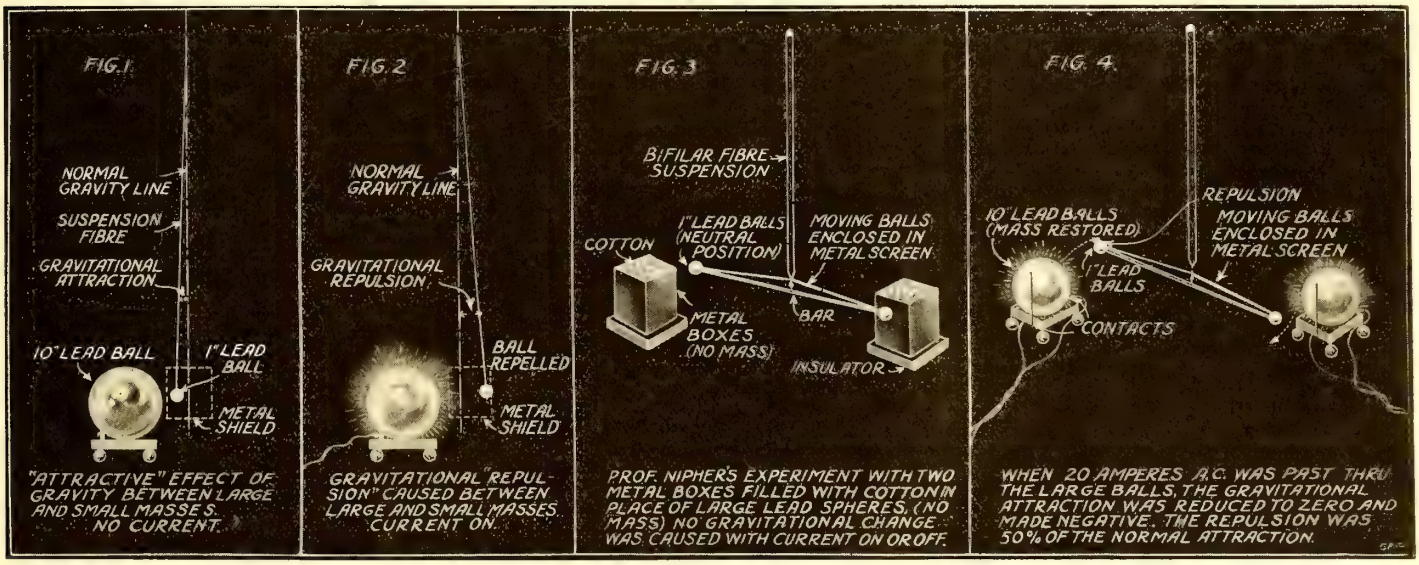
Prof. Francis E. Nipher, of the St. Louis Academy of Science, Who Has Proved By Laboratory Experiments That Gravitation Can Be Nullified and Even Converted Into Repulsion, By Electric Currents Properly Applied.

continuous operation and the experiments have been repeated time and again, always with the same result.

Prof. Nipher's mechanical apparatus resembled that used in the "Cavendish experiment," by which it was first experimentally proved that Newton's law of universal gravitational attraction applied to small bodies in their action upon each other at short distances, just as well as it did to small terrestrial bodies under the influence of the earth. This apparatus consists of a delicate torsion suspension fiber (see Figs. 3 and 4) a light, rigid arm at the lower end of the fiber suspension, and at either end of this bar two small lead spheres of known mass. Two equal large balls of solid lead are placed close to the small suspended spheres in the manner shown. Now, remembering our law of physics stated above—that every body in space attracts every other body proportionally to their respective masses and inversely as the distance between them—then it is evident that when this apparatus is set up, that the small suspended spheres will be slightly attracted by the larger, stationary balls. This condition is represented in Fig. 1.

Before connecting any form of electric current to the modified Cavendish apparatus, Prof. Nipher took special precaution to carefully screen the moving element from any electro-static or electro-magnetic effects. His apparatus briefly consists of two large lead spheres ten inches in diameter, resting upon heavy sheets of hard rubber. Two small lead balls, each one inch in diameter were now suspended from two silk threads, stationed at the sides of the two large lead spheres, from which they were separated a little distance. Moreover, the suspended balls were insulated elaborately from the large spheres by enclosing them first airtight in a long wooden box, which was also covered with tinned iron sheets as well as cardboard sheets. There was, furtheremore, a metal shield between the box and the large metal spheres. The large metal lead spheres now exerted a certain gravitational pull upon the suspended small lead balls as indicated in Fig. 1, and the small lead balls were slightly pulled over towards the large spheres.

In his first experiments Prof. Nipher applied a high tension current from a static machine to the large lead balls, see Fig. 2. No difference was noted whether the positive or negative terminals were applied. In one of these experiments the masses were "repelled" (normal gravitational *attraction* had been nullified and changed to *repulsion*) by a force nearly *twice* as great as the initial gravitational repulsion. This effect is shown at Fig. 2.



Several Simple Diagrams Which Show, In a Manner Understandable to All, the Essence of the Epoch-making Experiments on the Effect of Electricity on Gravitation, as Conducted by Prof. Nipher at Washington University, St. Louis, Mo.

In further experiments Prof. Nipher decided to check his results. To do this he replaced the large solid lead spheres with two metal boxes, each filled with loose cotton batting. These hollow boxes

(*Continued on page* 803)

Electricity and War in the Films

THRILLS, thrills and still more thrills! seems to be the slogan behind the majority of motion pictures on the screens in these tempestuous times. Surprising it is indeed the extent to which producers will go to secure the "reel" hair raisers, and in nearly every instance Science plays the all important rôle.

In the wonderful advance made by the photoplay in the last few years, the small and intricate details have come to receive more and more attention. The critical public has learned much in recent years; therefore it would not do to make use of scientific apparatus nowadays without some regard for its correct appearance and application. Foremost amongst the new films may be mentioned Thos. H. Ince's latest production "The Zeppelin's Last Raid." Mr. Ince has had a phenomenal rise in the motion picture field and must be complimented on this splendid and timely picture. A word would not be amiss regarding the work he has done to advance the motion picture along the path of big things. Five years ago he was next to being down and out, but he had an idea and struggled along till the chance came to produce on a big scale, his foremost and initial photoplay sensation being "Civilization," which cost thousands of dollars and employed hundreds of people to produce. "The Zeppelin's Last Raid" shows vividly the danger that the United States is exposed to, and to save us if possible from the lesson that was so bitterly learned by Belgium, France and England.

The story is woven around Mr. Hickman, the commander of a Zeppelin, and Miss Markey, a young and pretty girl who, with hundreds of others, is secretly working in an effort to rouse the populace against Kaiserism. The commander, like many other officers in the army and navy, is also a member of the same organization. The attack of the Zeppelin upon the defenseless British hamlets is one of the most strikingly realistic scenes ever converted to the screen. The biggest thrill comes when the commander of the "Zep" dynamites it, at the moment the crew attacks him for refusing to hurl bombs upon the defenseless city below. And the nerve-stirring scene of the flaming dirigible rushing downward to destruction is one not easily forgotten. The "Zep" is complete in every detail and in one of the photos herewith may be seen the releasing of the powerful death-dealing bombs. The orders are given to the men from the main observation post by telephone. Another scene shows the up-to-date radio equipment on board the Zeppelin.

The mammoth Marconi wireless station located just outside Los Angeles, Cal., recently taken over by the U. S. Government, was made use of in filming some of the important scenes.

The third photo shown is taken from a later episode of the gripping film drama—"A Daughter of Uncle Sam," showing the inner workings of the German spy system in this country. The action abounds in many stirring scenes and the one illustrated shows two German plotters secretly operating a concealed Radio station in the woods.



Above—Two Teuton Plotters Operating a Spy Radio Set in the Woods in "A Daughter of Uncle Sam."

Left—Preparing Zeppelin Bombs for Action by Means of Magnet in "The Zeppelin's Last Raid."

Right—Another Scene on the "Zep," Showing the Radio Instruments and the Operator.

HUN RADIO AT NIGHT DARES U. S. TO STRIKE.

Commanders and crews of the American destroyers operating in European waters are talking about a grim piece of Hun humor. Nearly every night the commander of one of the destroyers receives by wireless a message reading:

"My position is (so many) degrees north and (so many) degrees west. Come and get me. I'm waiting for you." The message is always signed, "Hans Rose."

Rose is the German who took a submarine into Newport two years ago. According to the story past around by the men engaged in the thrilling and hazardous task of seeking submarines, the captain to whom is directed the nightly messages of the German sub-sea craft, sank two. The commanders of both were intimate friends of Rose. He has sworn vengeance.

It is disquieting for the American commander, but he has no fears. Twice, it is stated, he has swiftly guided his craft to the location described by his enemy, but has found nothing. Still the mysterious wireless dispatch comes every night, no matter where the destroyer may be. Others catch it, and thus the weird story is told whereever the hornets of the sea are seen.

THE TELEPHONE MOUTHPIECE—HOW TO USE IT.

Science and experience have combined to determine the shape and size and material to be used in the proper construction of the most efficient mouthpiece.

This part of the telephone is designed to gather the sound waves of the voice, and will do so more efficiently when the lips of the person speaking are about half an inch from, and directly in front of it.

It is designed exactly for the purpose of most efficiency by accommodating the sounds from close proximity and excluding the distant sounds which would interfere with the transmission. Did you ever stop to consider how you hear only the speaker and not the other sounds of the room in which the speaker is?

When speech is directed to the mouthpiece at an angle, or from a distance of from six inches to a foot away, the person at the other end of the line cannot hear your voice distinctly.

The best results will be obtained by speaking directly into, and close up to, the mouthpiece in a clear, not-too-loud tone of voice.

WIRELESS FOR ST. PETER'S IN ROME.

The establishment of a wireless station on the dome of St. Peter's in Rome has been suggested to the vatican so that it may secure independent transmission of foreign messages of diplomatic character in code and also receive confidential and reliable reports from the vatican's representatives abroad. The question of speed is involved since at present wire transmission from France and England consumes 24 hours while much longer is required to receive messages and news from the United States.

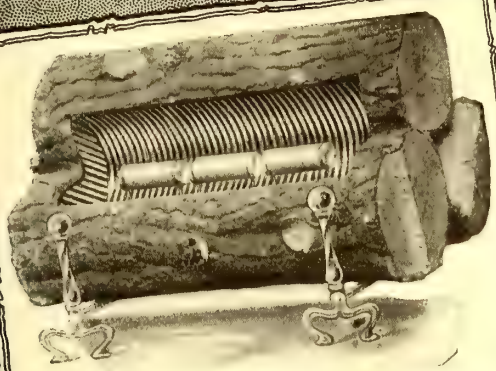
It is pointed out that the wireless would have the advantage of dealing with Switzerland, Austria, Germany and Russia. The vatican never has been able to rely upon newspaper reports for quick news.

The Italian Government is not likely to raise decided objections because the vatican never has paid tolls on its messages.

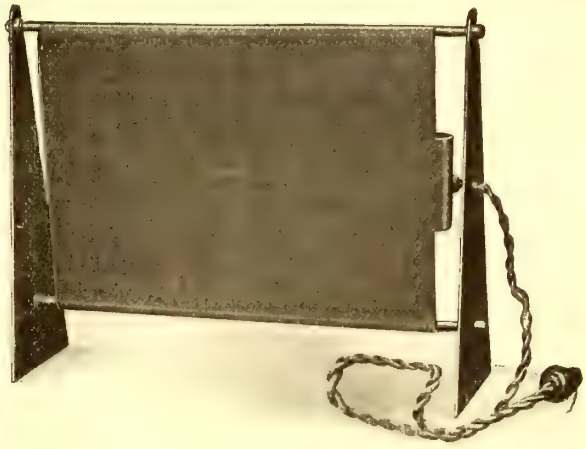
ELECTRIC LIGHT TO MARK AERIAL ROUTES.

Electrical companies and town councils in the United States are offering to provide the "lighthouses" necessary to mark the aerial routes between Dayton, Ohio, and Indianapolis, Ind., and other cities to be used by the aviation corps of the United States Army in training students for this service.

"ELECTRIC WINTER-TIME COMFORTS"



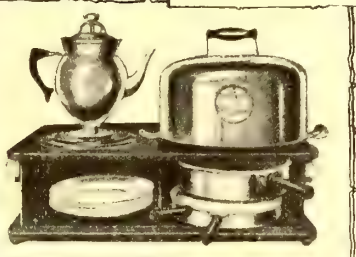
The "Electric Log" Will Keep You Warm, Besides Giving a Cheerful Fireside Glow, Just Like Grand-dad's Open Fire-place.



For Warming Bedrooms and Other Small Apartments, the Flat Sheet Heater Stove Here Shown Proves Extremely Handy and Efficient. Built in 600 to 4,000 Watt Sizes

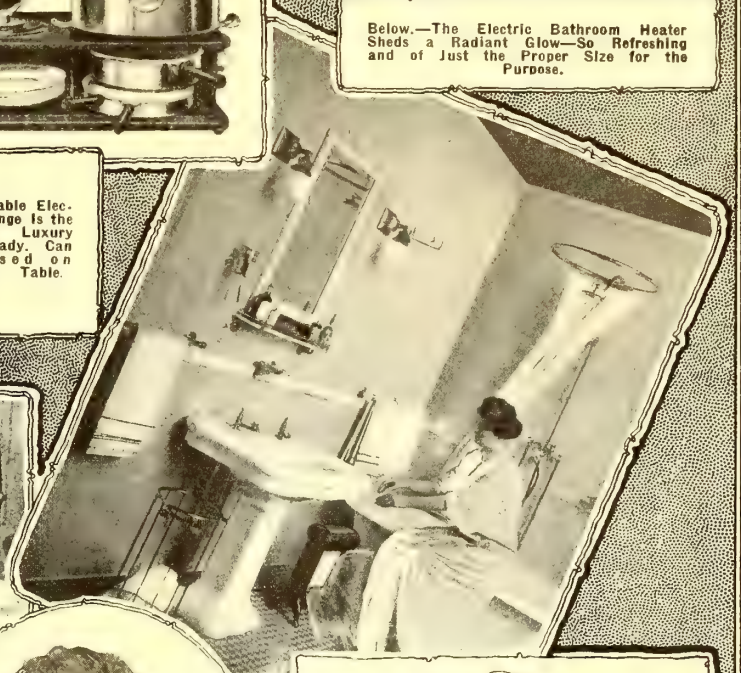


While "Pop" Lights His Cigar from an Electric Lighter, Sonny "pops" the Corn in His Electric Corn Popper.

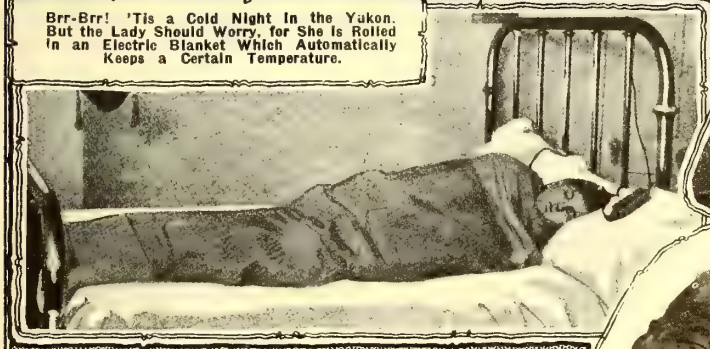


Below.—The Electric Bathroom Heater Sheds a Radiant Glow—So Refreshing and of Just the Proper Size for the Purpose.

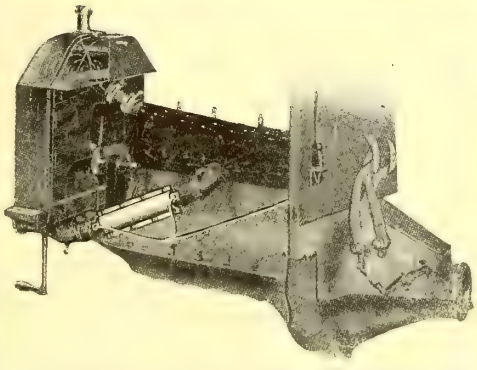
A Portable Electric Range Is the Latest Luxury for Milady. Can be Used on Dining Table.



Brr-Brr! 'Tis a Cold Night in the Yukon. But the Lady Should Worry, for She Is Rolled in an Electric Blanket Which Automatically Keeps a Certain Temperature.

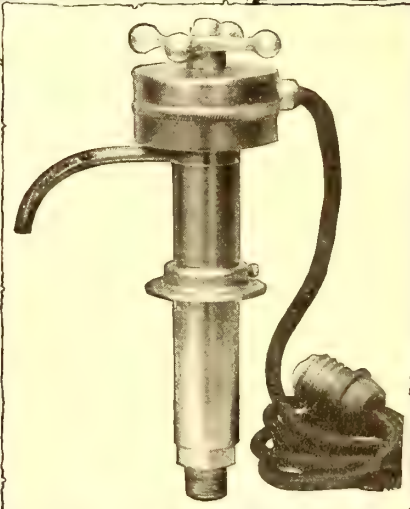






New Electric Heater for Use on Auto Engines. It Plugs into Any Lamp Socket and Makes Starting the Engine a Sure Thing in the Winter.

Oh! Clarice! We Didn't Know You Had a Faceache—But Rest Assured, This Electric Warming Pad Will Alleviate Your Suffering in a Short Time. Connects With Any Lamp Socket.



Something New in Hot Water Devices—the "Electric Spigot." Heats the Water Instantly and Attaches to Any Water Pipe.

How U-Boats Send Radio 1,000 Miles

By H. WINFIELD SECOR

THE Germans have developed submarine radio-communication to a fine art—they had to. This is so for obvious reasons—chief among which is that the success of the U-boat campaign depends to a large extent on keeping in wireless communication with the individual sub-sea boats and the possibility of certain of their number transmitting intelligence to the nearest land base. At first the submarines made use of folding or telescopic masts which did not elevate the radio antenna very far above the deck—not more than 20 to 30 feet in most cases. For ordinary inter-communication between submarines this collapsible antenna served its purpose admirably. Where long ranges were to be negotiated, either in receiving or transmitting, however, it became a real problem.

One of the latest Teutonic improvements in this arm of the naval service is the utilization of balloons for elevating the U-boats' antenna wire to a height of 1,000 feet and more. In this way vast distances can be covered and valuable intelligence sent by radio to a second relay submarine if necessary, so that it is not improbable that the news of ships' sailings from American ports could have been radioed to Germany by the aid of three or four U-boats.

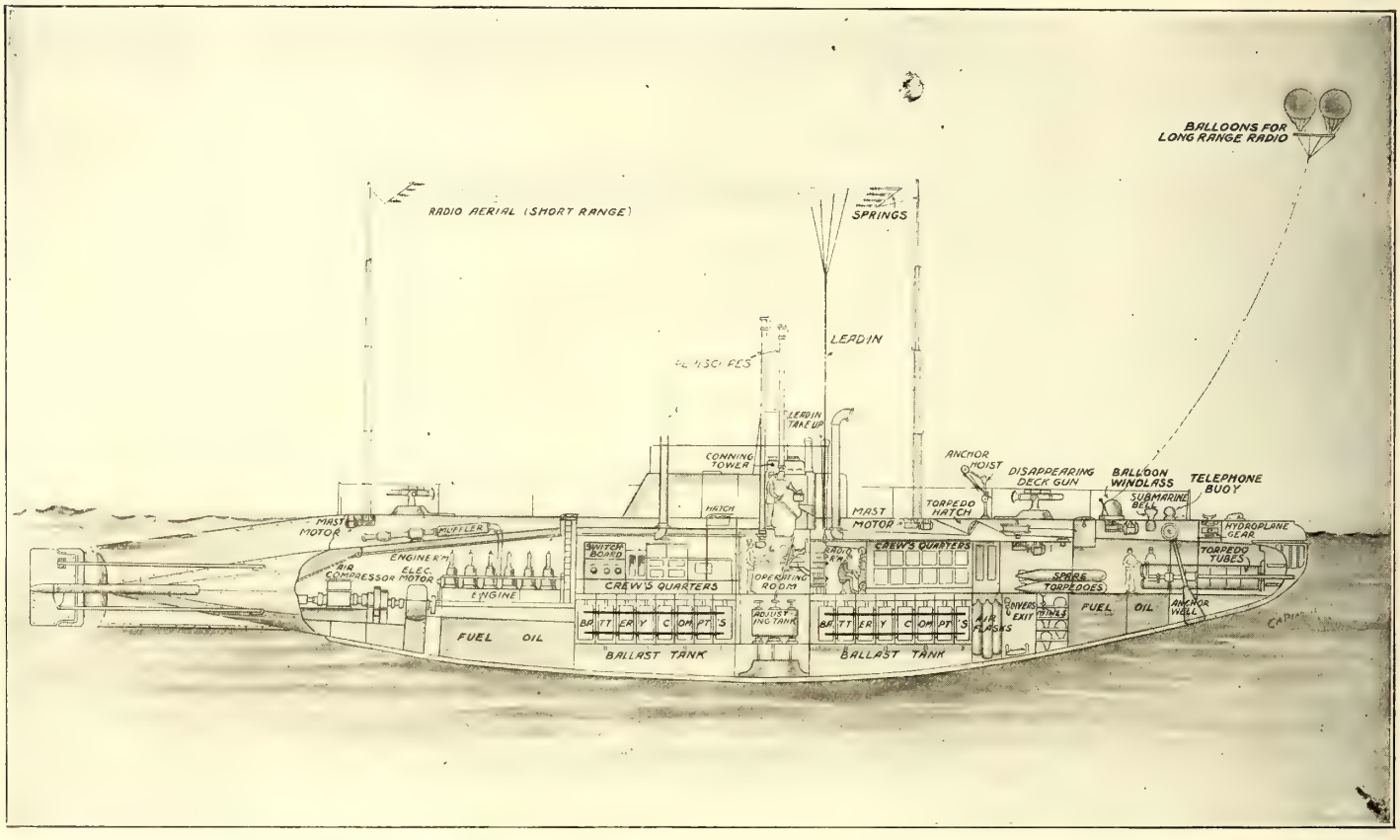
Our front cover illustration, as well as the ones herewith, show clearly just how the balloons, two in number and fastened to a rigid equilibrium member, carry up the antenna wire to a height of several thousand feet if necessary. The antenna, at its base, is wound on a special electric-motor driven drum. This drum is instantly controlled by the throw of a switch, so that if a ship comes into view, it can rapidly reel in the balloon antenna and the balloons are taken inside, hatches closed, and the craft submerged—all in almost less time than it takes to tell about it. It is difficult for an enemy ship to see the balloons as they are cleverly camouflaged, being painted partly white and partly blue, so that against the sky they are practically invisible. The antenna wire is, of course, quite fine and invisible at even a short distance away.

It has been a mooted question for some time as to just how far such a radio-equipt sub-sea fighter could send a message. The receiving range with such a balloon suspended aerial is easily several thousand miles, using modern amplifiers and other refinements in the radio art. The writer asked several well-known radio experts their opinion on the possible sending and receiving activity of a balloon-aerial equipt U-boat and they practically all agreed with the ideas exprest by Mr. F. H. Kroger, chief engineer of one of the leading American radio companies, that; with fair weather conditions, and with the proper radio transmitting apparatus tuned to a high wave length, it would be possible for the submarine to send a wireless message 2,000 miles, and possibly 3,000 to 4,000 miles under extremely favorable conditions. The transmitting set used might, of course, be a special one rated at 15 to 25 kilowatts. If the sub-sea boat wanted to transmit an important message, she would in all likelihood choose the night-time. She could then emerge and fly her balloon aerial with reasonable safety. And for a long range message requiring as much energy as mentioned above, it should be remembered that there is available all the engine power required. All that would have to be done would be to connect up the high capacity dynamo to these engines, and this in turn to the special high power radio transmitter. Such a set, including the dynamo, would not occupy such a large space as might be imagined off-hand. Also the newer U-boats are veritable submarine-cruisers, several hundred feet in length, which, of course, gives a much greater space for the radio equipment.

Many ingenious folding and other types of masts have been perfected for medium and short range radio work on the submarine. Several of these masts are illustrated in the drawing herewith. An interesting practical telescopic mast was patented by a Yankee inventor several years ago (U. S. patent No. 1,099,861) and is shown in detail at Figs. 1 and 2. The inventor, Mr. Joseph Raes, covered several modifications of the basic idea in his patent. In one type a continuous flexible metal cable is used, Figs. C and D. By following the path of the cable in the drawing it is seen how, when a pull, as produced by a motor, is applied to the lower end of the cable, it causes all of the sliding telescopic members to be elevated. The upper end of the cable is secured to the bottom of the top telescopic member. When pressure is removed on the cable the mast descends by gravity.

A similar type telescopic mast is shown at Fig. B, only in this case the individual sections are raised and lowered by a clever arrangement of gears and shafts. This elevating scheme would be considerably slower than the previous cable-operated type.

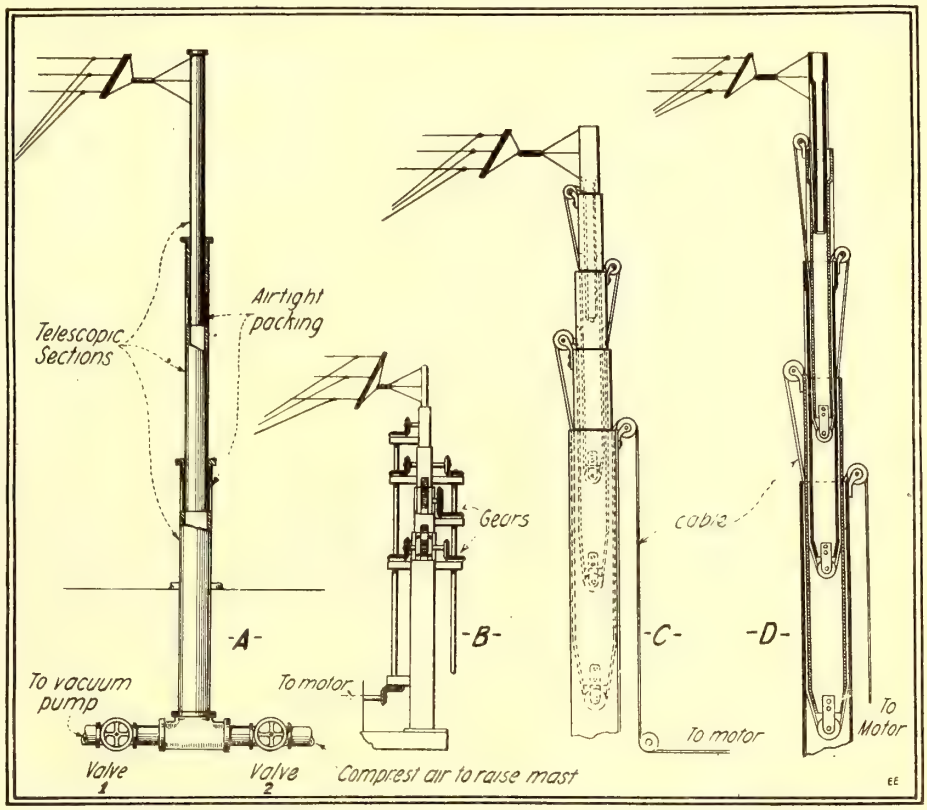
The author suggests herewith a pneumatic telescopic radio mast of the type illustrated at Fig. A. This is similar in principle to the pneumatic (comprest air) lifting



Sectional View of Modern Submarine Showing the New Telescopic Collapsible Masts Supporting the Radio Antenna, as Well as Motor Actuated Cable Windlass for Rapidly Reeling in Balloon Aerial Wire. The U-boats Are Said to Be Using the Balloon Aerial for Communicating by Radio Over Distances of Several Thousand Miles.

cranes used in manufacturing plants, foundries, etc. With the proper pressure of comprest air, it is only necessary to close the suction blower pipe valve, open the high pressure air valve attached to the pipe line from comprest air tank or flasks, and the mast rises up by expansion of the air within it. When it is desired to lower the mast quickly, the comprest air valve is closed and the suction blower line valve slowly opened; the air is thus removed and the mast collapsed. Ordinarily, no suction would be required to lower the mast; merely a valve opening to the atmosphere thru which the comprest air could rush to the outer air.

An ingenious collapsible radio mast was invented in Germany some years ago and several of them have been used in this country. It was perhaps the lightest ever designed thus far—possibly too light for submarine requirements — but it possest the element of speed. It employed four flexible strips of metal rolled on drums at the base. These strips were notched on both edges and when the handle was turned, the four notched strips of thin steel intermeshed with each other, making a lock-cornered square tubular mast about 8 inches square. It was found possible to raise a platform containing two men on it to a height of 80 feet for observation purposes when necessary. Two men could raise the mast in a short time by turning a geared crank handle.



Some Examples of Collapsible Radio Masts Adaptable For Use on Submarines. The Types Shown Include the Comprest Air, Steel Cable and Gear Actuated Telescopic Forms. A Motor Operates the Gear and Cable Types Directly.

The accompanying illustration of a modern submarine shows how the various compartments are arranged. It was prepared from official plans of such a craft. The location of the collapsible radio masts is given, as well as the position of the motor-driven winch for hauling in the antenna balloons. An interesting feature not generally known is that submarines are now fitted with submarine telegraph apparatus which operates by means of sound waves sent thru the water from powerful electric vibrators mounted on the hull of the submarine. Sensitive microphones suitably mounted on either side of the hull enable the commander to tell when a ship is approaching, even at a considerable distance, by the sound of her propellers which is transmitted thru the water.

Then there is the latest safety feature—the *telephone buoy*. If the submarine should sink and become unmanageable, the crew can pull a lever which releases the telephone buoy, which rises to the surface of the water. Any craft passing in the vicinity of the sunken sub-sea boat can open this buoy and, by means of the telephone inside it, speak to the imprisoned crew. Submarines send out sound signals of distress thru the water also, which may be intercepted by another submarine or by a warship or steamer.

A WAR-TIME SUGGESTION TO RADIO AMATEURS.

By Howard S. Pyle,
Electrician-Radio, U. S. N.

FELLOWS, in writing this, I want to address it to the Amateurs—the real, dyed-in-the-wool "hams," who have started in the right way—a spark coil of uncertain antecedent, a few discarded dry cells from the family Ford, a lump of silicon—you know the type. Fellows that started with gigantic problems to face, no one to help and who have "stuck to it."

We have today, altho at present closed by our Government, such an efficient chain of amateur stations in this great country of ours, that, were it forecasted ten years ago, would have brought derision down upon one who would be so bold as to suggest it. And if you will look up the "star" stations, you will find that they are practically all in the hands of fellows that ten—yes, even five years ago—were struggling thru many failures, working out their own problems, 'nary a beacon to guide them in the right way. Look where they stand today—foremost among the country's youthful scientists and possest of an enviable knowledge of that most fascinating of mysteries—WIRELESS!

I have watched and grown up with them for the past eight years myself so am basing this on facts. While my stations never hung up any extraordinary records for transmission, due to several handicaps from outside sources which it was impossible for me to overcome, yet my interest has been just as keen thru all the years and I hailed each new record with as much delight as if it were my own. I did have sensitive receiving apparatus, however, which I kept strictly up-to-date and have spent many, many pleasant evenings (and wee hours) with the "cans" on and am proud to consider myself one of the "self-mades."

To come to the subject of this article, tho, we amateurs have built up our present organization upon our own lines. As our problems were presented we worked and finally overcame them. They were our problems—we fought them as such. Meanwhile the commercial companies met their barriers also and overcame them. Now doesn't it seem reasonable that the commercial companies, having to build their organization to the highest stage of development, as theirs is a cold, commercial proposition, many people being dependent for their living upon the success of wireless as a commercial enterprise — doesn't it seem reasonable to you fellows to grant that these companies have a higher, more efficient service than the amateurs? Of course they have, as they must have to remain in business.

Supposing a commercial telegraph company accepted a message from Portland, Oregon, to Los Angeles, Calif., would they deliver it at its destination, a week or so after the filing? Would a company send a message from Seattle to Portland, Oregon, and effect the transmission in a few minutes but hang the message up at its destination and deliver it four days later? How long would they remain in business if they did? Yet these are both actual amateur examples of occurences on this coast in one week! In the former case: no excuse as a line of communication is available (or was at that time) between those two points at all times, with numerous relays if necessary. In the latter case: also inexcusable as direct 'phone connection between the receiving operator and the addressee was to be had. The latter finally heard of the message in a roundabout way and after some trouble and inconvenience, finally got it.

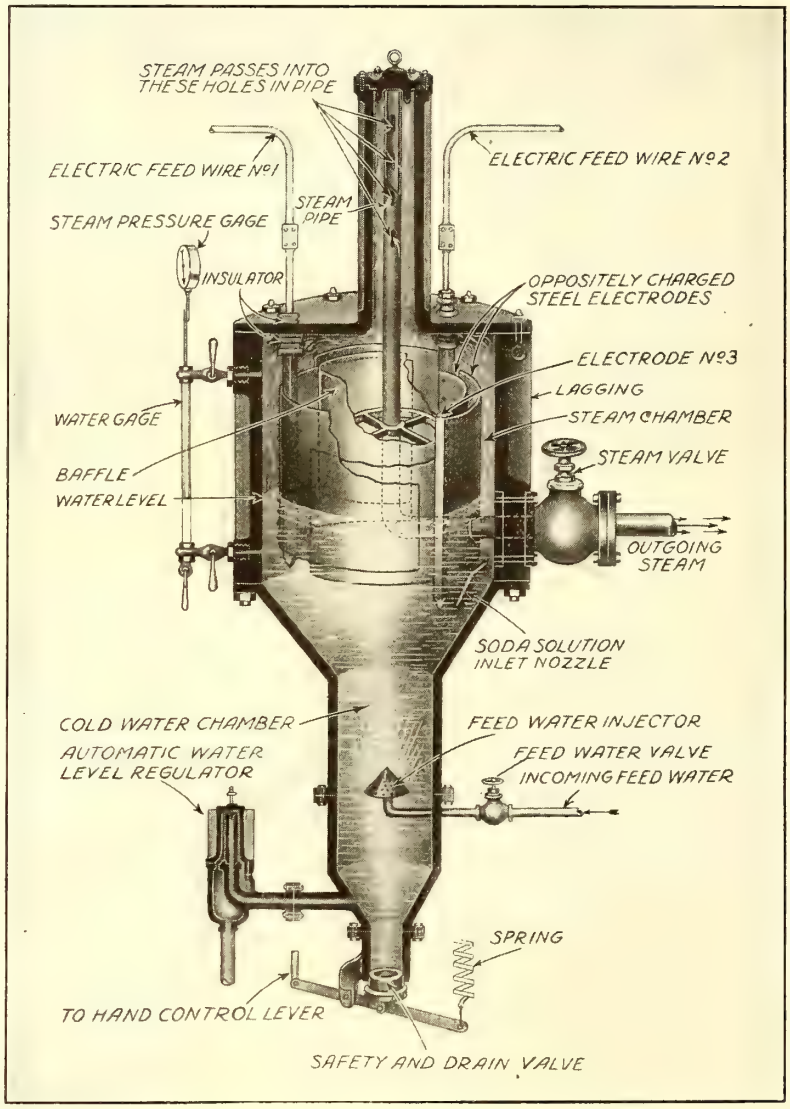
Altho I'm in the commercial game now, yet I'm a "ham" at heart always, and want to see them make a name. I keep in close touch with the fellows, altho I'm "all over the ocean" at times, so to speak. It's only since breaking into the commercial game that I saw the faults of our organization and I would suggest that our best "hams" spend a little time in commercial service—even only a few trips on some vessel. Operators are scarce and jobs plentiful and I'll warrant you'll have your eyes opened and it will result in better service in the future among our own stations. Think it over, fellows. If you don't feel like joining the U. S. Navy, why not try the U. S. Naval Reserve Force. They are looking for good radio operators every day. Come on, fellow "Radio-bugs"—put on your hat and take a walk to the nearest recruiting office—and don't forget the great chances looming up now for a berth as radio officer on the vast merchant marine fleet Uncle Sam is building. Look into this—it will pay you.

Electric Steam Boiler Most Efficient

JUST one year ago, in the March, 1917, issue of this journal, we had the pleasure of describing and illustrating a remarkable piece of engineering work carried out successfully by Italian engineers, viz., the application of volcanic heat to a steam boiler and thence to a dynamo, from which several thousand horsepower were distributed at high potential to a considerable area in northern Italy. Now, we are confronted by another ingenious and successful steam-electric stunt, due to an Italian engineer—Colonel Revel of the Italian army, whose extremely simple electric-steam generator is described in *Engineering* of London. As we do not know just yet how to produce electricity direct from coal or other combustive or explosive fuel, we shall not find, possibly, a very extensive field for Colonel Revel's new electric-Steam boiler, as it uses electric current to convert water into steam. But where there is superfluous hydro-electric power available, there we should find the Revel electric boiler of great economic value. Especially when it is considered that *steam is produced by the passage of the electric current thru water* at the almost unbelievable efficiency of 98 per cent. That is, 98 per cent of the energy in the electric current sent thru the water is actually converted into steam. The efficiency of the average coal-fired boiler is only about 50 to 60 per cent.

The principal characteristic feature of the generator is that for the transformation of electric energy into heat, and thereafter into steam, use is made of the ohmic resistance of the water which has to be evaporated. The Revel apparatus can be inserted in any alternating-current circuit of from 200 volts to 3,600 volts, and these are the form of current and pressures which are usually supplied for industrial purposes. In the Revel system, moreover, the production of steam is regulated automatically and continuously as required; the apparatus is entirely automatic in its action and demands no attention. Lack of feed water would only result in a decrease or a stoppage in the production of steam until the feed water difficulty was overcome. A 97 per cent to 98 per cent efficiency is claimed for this type of machine, since the whole of the heat generated by the electric energy is absorbed by the water, the only loss being that caused by radiation from the body of the apparatus.

The Revel generators are constructed to work at any pressure up to 14 atmospheres, and can be connected up at any time with the steam pipes from the ordinary steam boilers; owing to the rapidity of their action they take up any excess of *hydro-electric* (i.e., water-power electric energy) energy which may be available even for a short time. They may, in fact, be considered as serviceable appliances for turning to account any superfluous hydro-electric power available, and as such they were utilized in numerous installations in Italy before the war, when the price of coal did not exceed $8.00 per ton. At the present time they are also found to be practical and economical, even in cases where hydro-electrical power has to be paid for at the rates now ruling. The Revel electric boiler has been in successful use now for some time in many Italian works.



This Illustrates Graphically Just How the Revel "Electric Boiler" Generates Steam by the Passage of an Electric Current Thru the Water Between the Circular Metal Plates. The Resistance of the Water to the Passage of the Current Causes Steam to Form.

The semi-sectional view of the new Revel electric-steam generator here shown will aid in understanding just how this simple yet wonderful device operates. The working drawing shows one of these apparatus taking current at a pressure of 500 volts, in which we find the following arrangement: At the center, as shown, there is an electrode and steam space; at the bottom a cold water space. Thru the steam dome cover run three brass rods electrically insulated from the cover. In the steam and electrode chamber there are three sets of circular steel electrodes separated a short distance and rigidly fixt to the rods shown. Next we find a vertical steam pipe and steam pipe support and baffle; a feed-water injector, a steam valve, a water gage, a pressure gage, a receiver for soda solution, a water-level regulator, which automatically governs the working of the apparatus, a safety and drain valve, a handle for working this valve by hand and a feed-water valve.

The high-tension type has the same component parts as the low-tension type, and differs from the latter only in the shape of the electrodes and the dimensions of the steam dome, which in the high-tension type has the same diameter as the steam space.

One of these high tension installations in actual use in Italy consists of eight apparatus, taking three-phase current at 6,000 volts, each apparatus being capable of generating 900 kg. to 1,000 kg. of steam per hour.

In the Revel generator the transformation of electrical energy into heat takes place in the body of the water contained in the steam and electrode chamber, the water acting as an ohmic resistance inserted between the electrodes; the production of steam therefore varies with the immersed surface of the electrodes, and assumes all values between zero and the maximum, corresponding with the various levels of the water in the steam chamber.

For starting the generator the circuit-breaker is closed, the feed-water valve is opened, and a small quantity of soda solution is introduced from the small receiver to give a suitable conductivity to the water. When the water has reached the height of the lower edge of the electrode segments the current flows thru the water and commences to raise steam, the steam production increasing as the water-level rises, until it reaches the working pressure required. At this moment the automatic regulator enters into action, and the water-level, and hence the steam production, remain constant.

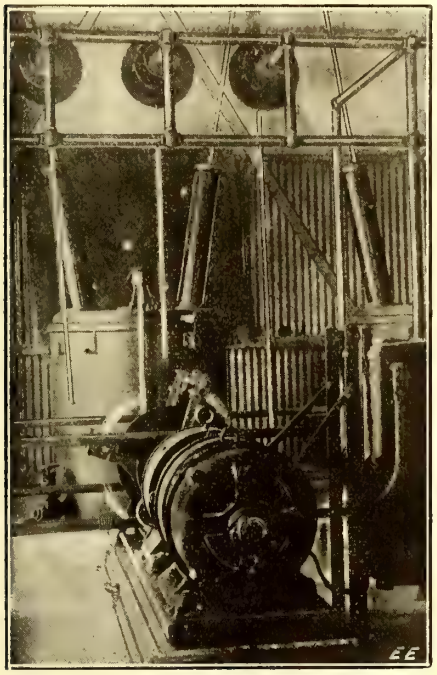
In order to stop the apparatus the feed-water valve is closed, the steam valve is closed slowly, and the bottom drain valve is opened by acting upon the hand lever until the ammeter has returned to zero.

When the feed water leaves a calcareous deposit it is advisable, every five or six hours, to free the boiler of the sediment deposited at the bottom of the truncated cone. This is obtained, without interrupting the working of the machine, by increasing the water feed and by acting at the same time on the drain valve handle, the excess water washing away the sediment; this operation, by a suitable action upon the feed water and drain valve and by following closely the ammeter and maintaining the current intensity constant, is carried out without changing the water-level and without impairing the working of the apparatus. The apparatus may find adoption in this country.

Eliminating the Smoke Nuisance by Electricity

By WILLIAM H. EASTON
Westinghouse Electric & Mfg. Co.

As every reader of THE ELECTRICAL EXPERIMENTER knows, if a rubber comb is rubbed against a woolen cloth, it becomes electrified and is able to attract particles of paper, threads, and other small objects. This peculiar phenomenon was known to man long before the dawn of history, for electricity gets its name from the Greek word "electron," meaning amber, which, of course, acts just like rubber. It is our nature to endeavor to put into practical use everything we know, and it is therefore very remarkable that for at least 3,000 years no commercial application, outside of a number of interesting laboratory experiments, was made of *electrostatic attraction.*



New Electric Smoke-eliminator Outfit, Showing Motor-generator Direct-connected to Rectifier. 100,000-Volt Transformer in the Background.

Today, however, this principle is being extensively used to solve one of our most perplexing industrial problems—the suppression of smoke and dust. The smoke from chimneys, the dust from cement mills, blast furnaces, etc., and the acid fumes from chemical plants are not only intolerable nuisances, but also the visible evidences of a great waste of valuable material. Many attempts have been made to check these emissions but the Cottrell electrostatic process, (so-called after its inventor) appears to be the most successful.

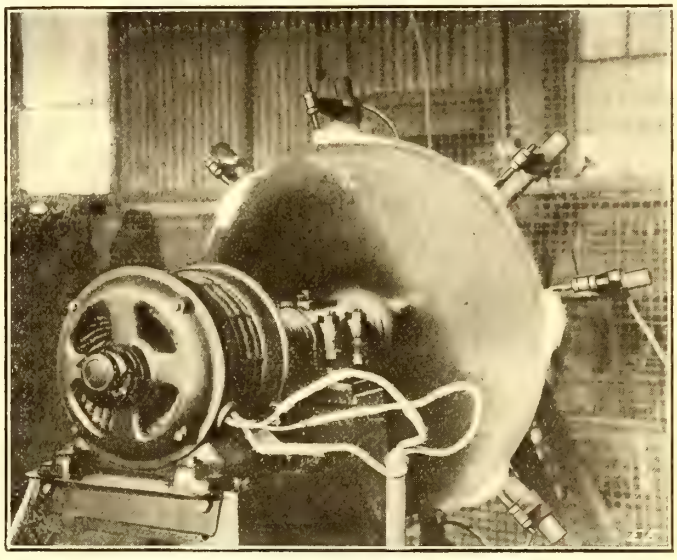
In this process the gases containing the solid particles of soot or dust, or the liquid particles of acid, are past thru vertical tubes or pipes in the centers of which fine wires or chains are suspended. The central conductors are connected with a source of *direct current* of from 40,000 to 100,000 volts potential and the pipes are grounded. The floating particles in the gases passing thru the tubes become electrified and are attracted to the walls of the tubes to which they adhere. At intervals the current is turned off, the tubes jarred or hammered by a motor-driven device, and the accumulated dust then falls into suitable hoppers below. When all conditions, such as the length and diameter of the tubes, the speed, temperature, and consistency of the gases, and the voltage of the current, are properly adjusted, an almost complete recovery of the suspended solid or liquid matter, can be secured. It is, however, impossible to remove gaseous particles in this manner.

It is, of course, impracticable to generate directly the necessary high voltage direct current. Alternating current is, therefore, stept up to the desired voltage by means of special transformers and this high voltage alternating current is then changed into direct current of equal voltage by means of a *rectifier,* which is simply a large revolving commutator.

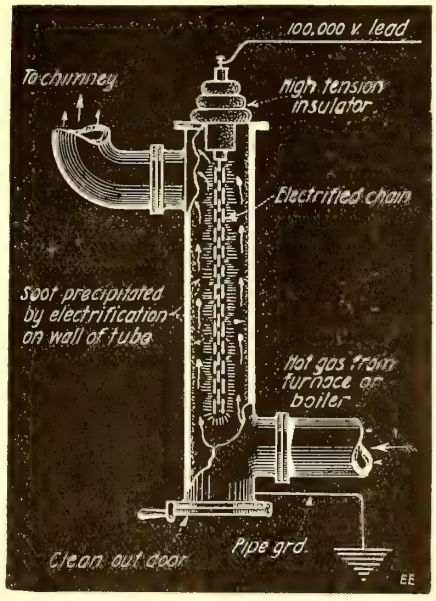
The alternating current can be taken from the regular power line, but it is generally best practise to have the entire Cottrell system independent. Separate generators, driven by motors operated from the main power line, are therefore usually employed. The system is also usually divided into a number of independent units, each with its own generator, transformer, rectifier, and set of pipes, so that one or more units can be shut down without interferring with the operation of the plant. It is essential that the rectifier revolve in synchronism with its alternating-current generator and so it is usually mounted on the shaft of its generator; but sometimes synchronous motors are used for operating the rectifiers.

Great care must be taken to guard the system from static surges. Powerful choke coils are mounted in the transformers for this purpose. Each transformer has a number of different, high voltage taps so that the voltage of the direct current can be adjusted to suit the conditions at the installation.

All switching and control arrangements are placed in the low voltage side of the system, the path of the high voltage current from transformer and rectifier to the precipitation pipes being kept as direct and simple as possible.



Close-up View of 100,000-Volt Mechanical Rectifier, Direct-connected to Synchronous Driving Motor. Note the Sparks at the Edge of the Revolving Disc.



Section Thru One of the Electric Smoke Precipitation Units. Several of These Are Used in the Chimney-path from the Boiler. The Soot Particles Are Electrified and Deposited Upon the Walls of the Chamber, the Latter Being Cleaned Out Periodically.

The power actually needed for precipitating the dust is insignificant in amount, and by far the greater part generated is absorbed as losses in the system. Hence the cost of operating the process is small.

Much has been said recently about the recovery of potash from cement dust. This valuable by-product is obtained by means of the Cottrell process.

IRON CRUCIBLES INSTEAD OF PLATINUM.

Platinum is more expensive now than at any time in its history and yet it is regarded as an indispensible medium as a crucible for use in analyzing certain compounds. It is, however, possible to dispense with it in analyzing ferro-silicon, an important alloy used in making steel. According to Dr. Herwig, in a German technical paper, iron crucibles can be used for this purpose if, instead of the usual carbonate of soda and potash method, sodium dioxide is used in the ignition mixture. Great care must be taken to reduce the ferro-silicon to as fine a powder as possible, to remove all coarse particles, and to mix the powdered silicon thoroly and very uniformly with the dioxide, as otherwise dangerous ebullition might take place, which would nearly empty the crucible and cause spattering.

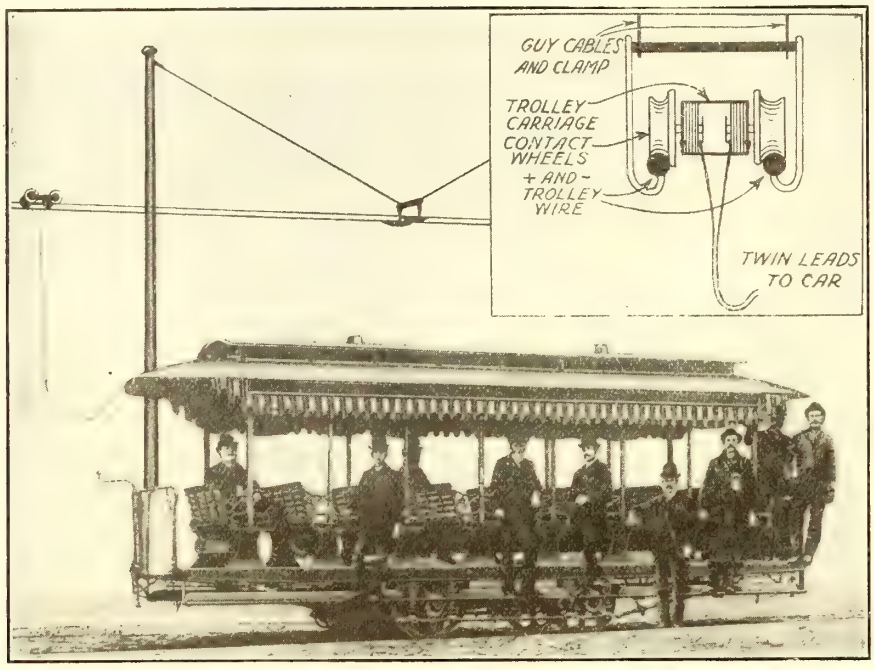
NEW WIRELESS STATION OPENED.

The newspapers of Willemstad, Curacao, S. A., recently began publishing wireless dispatches received by the new wireless station there. Dispatches are received from several European and American stations.

THE FIRST TROLLEY

By GEORGE HOLMES

A GREAT deal of historic interest is attached to the modern trolley car. Its evolution has been gradual and the present car is the result of many years of trials, experiments and failures, not to mention the many amusing incidents that went hand in hand with the early pioneers.



Yes, They're Old-timers—Heroes of the Initial Run of the "First Electric Street Car." The Now Familiar Trolley Pole Was Unknown Then. Instead, a Small Four-Wheeled Trolley Bogie Was Hauled Along, the Current Flowing In Thru One Set of Wheels and Out Thru the Other Two, Two Trolley Wires Being Necessary.

The first attempts in electrifying street cars met with great opposition from the then existing horse and cable car companies, and even the public was slow to grasp its full import. The few concerns which sprang up at that time used many and varied ways to induce the transportation companies to adopt the new means of propulsion.

It is amazing to note that the engineers in those days took on contracts for installations that even now would be considered "big chances." With hardly any factories for making such parts as were semi-standard, (for most of the installations varied pretty near as much as the weather) and the difficulty of securing funds and materials, they agreed to have cars running in such short periods of times as two or three months. Tracks, pole lines, power houses, cars and all the other paraphernalia!

The Bentley-Knight Co., had its shop on Tenth Avenue, New York City, where most of the equipment was made and many patents were granted them, among others being that on the underground "shoe" contact system. Frank Julian Sprague's early efforts also tend to show what difficulties were experienced by his company.

During a storm the overhead wires became covered with ice and the motorman had to get on top of the car and hack off the ice with an old broom.

The first trolley cars installed in Richmond, Va., were rather unique, seating but a few passengers.

The trial trip was to take place in the early evening with Mr. Sprague and his assistants; also most of the town was out to see the grand sight. The car ran fairly well until it struck the up-hill grade. On it's seven odd horse-power motor it labored up a little-ways, then pop went the motor. Mr. Sprague, who realized the car wouldn't make the hill, told the commission that some "testing" had to be done and sent one of his men to "bring the instruments." The crowd waited and waited as the hours past and finally left for their homes.

Mr. Sprague laid down upon the seats and went to sleep; about ten o'clock his assistant arrived bringing the instruments—two mules!!

Before the final car was made the engineers were pretty much on the go—every car was tested after a run (every half-hour) the road being about ten miles long. The brushes had to be replaced after each trip, as they were made of brass and occasionally the entire car was out of running order. Sometimes the brushes would arc and weld the particles of brass to the commutator segments, short-circuiting them—some fire works!! It used to cost some nine to ten dollars a day to buy brushes for a half dozen cars. Later on the present style carbon brushes were brought into use. Mr. Sprague stuck to his job, however, and among several hundred other inventions he is responsible for the multiple-unit control system now in use, whereby a train comprising any number of motor cars can be started and stopt from any individual car in the train.

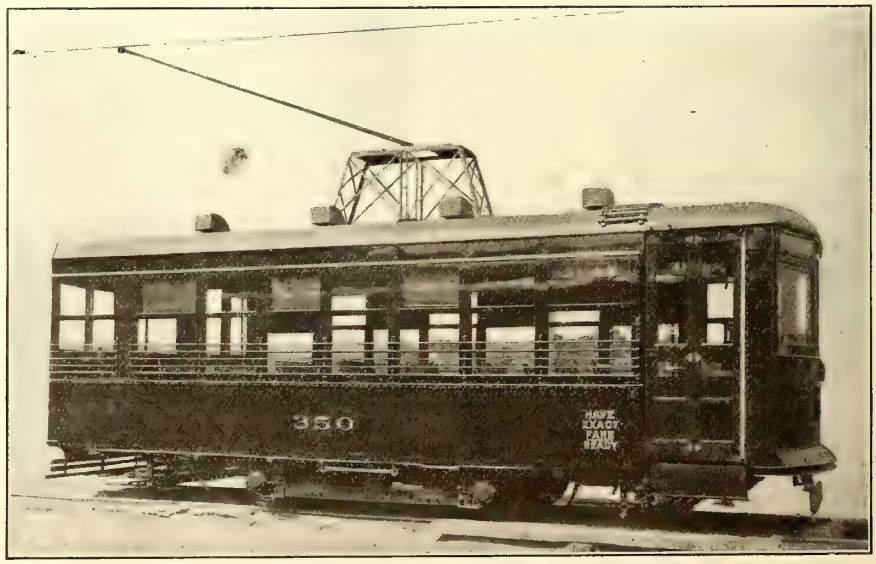
In marked contrast to the first commercial trolley of uncertain progress, we show herewith the very latest "one-man" automatic trolley. The problem of providing better and more frequent service as demanded by growing communities, and at the same time reducing operating costs to meet the competition created by the so-called "jitney" automobile in the electric railway field has led to the evolution of various forms of light weight "Safety" or One-Man Cars.

This type of car is now in operation in many parts of the country and enables substantial economies in the direction of reduced power consumption per passenger haul, reduced car and track maintenance and reduced platform and operating expense, not to mention a relatively low first cost. For branch lines and territory having an intermittent traffic, this type of car appears to be especially well adapted.

While safety is fundamental in any operation of railway cars or trains, this factor is, of course, particularly important in the operation of the new one-man Safety Car. Where a single operator is entirely responsible for the control of the car and the sole dependence in the event of danger, such service demands that every automatic safety feature possible be provided in the system by which the car is controlled. In addition, practical economy and convenience argue strongly for the performance of all possible functions automatically.

The safety control devices are air operated and act in such a manner that the motorman must be at his post and attentive to his duties before the car can proceed and must remain alive and alert in order to keep the car moving. Should the motorman be incapacitated by sudden death or should he remove his hand for any reason from the

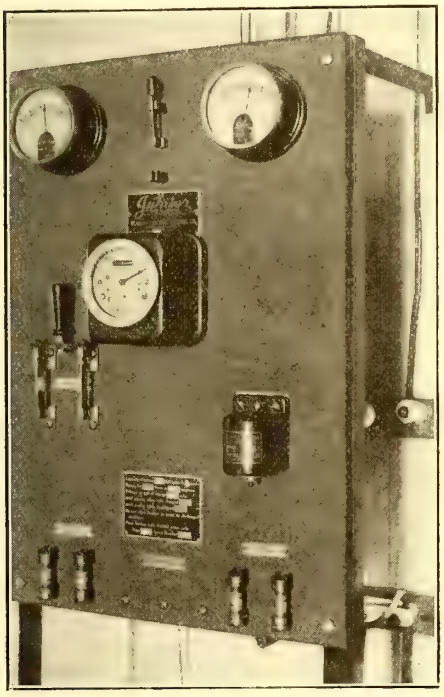
(*Continued on page* 805)



In Marked Contrast to the Early Trolley Car Shown Above, Is this "One-man Automatic Trolley." It Is Built Like a Machine Gun. The Motorman Controls the Power, Brakes, Track Sander, Door Openers, Collapsible Steps, Bell and Lights.

Electric Power from the Wind

THE Fuel Administrator has had a hard time of it, trying to "educate" the people in all parts of the country to burn less coal. Coal is expensive to-day—and hard to get. Think how much easier would be the Fuel Director's problems if the land was dotted with thousands of electric wind-power plants of the type here illustrated. It is not necessary that such plants be kept small



Appearance of Automatic Electric Switchboard Used in Wind-power Electric Plants. It Cuts in the Dynamo When the Wind-mill Has Attained the Proper Speed.

like those seen here and there on farms thruout the country—they can be built in large sizes so as to develop hundreds of horse-power—even thousands of horse-power. Such a large wind-power plant for town and municipal utility is illustrated here and was designed by E. H. Manning of Tomah, Wisconsin.

The small farm size plant illustrated possesses several unique features which lend themselves well to the driving of dynamos.

The working parts of the mill are enclosed in weatherproof casings and these are filled with oil to insure perfect lubrication at all times. The steel tower extending above the wheel securely anchors the wheel at the top; the bottom is carried on heavy duty ball bearings, thus making a construction which will stand the most severe wind storm. Every bearing of service is a ball bearing, giving greatest efficiency at all times.

In operation the power vanes are each rotated on their respective bearing in such a manner as to expose them to the wind at the angle of greatest efficiency at every degree of the circle, while traveling with, across, and against the wind, there being about 30 degrees only of the circle when the vane comes against the wind edgewise to a degree where it is not efficient.

It thus becomes evident that all wind pressure is delivered at a given distance from the center of the wheel and that the power then is delivered to the power shaft, instead of acting as a barrier to the wind. This is one of the features which give greater efficiency to this type of wind power wheels.

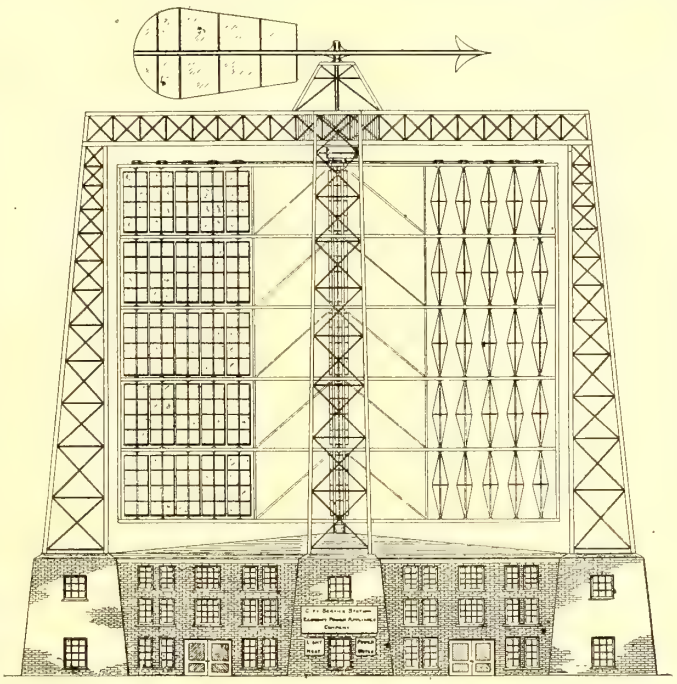
Another feature of this design of wind power wheel is the automatic controllability. By means of a centrifugal two-ball governor or by a resistance type electric governor, the vanes are varied in their angle to the wind in case of high wind velocity so that the motion of the wheel is kept from running above a given speed. This protects both the power plant and machinery from unnecessary wear and strain.

The automatic means for stopping the mill when the storage batteries are charged and throwing it in the wind when any given number of ampere-hours have been discharged, all simply means that when the plant is once properly installed you are assured of perpetual and abundant service, without further expense or attention except oil for the plant once a year, distilled or rain water for the batteries and reasonable attention to your generator.

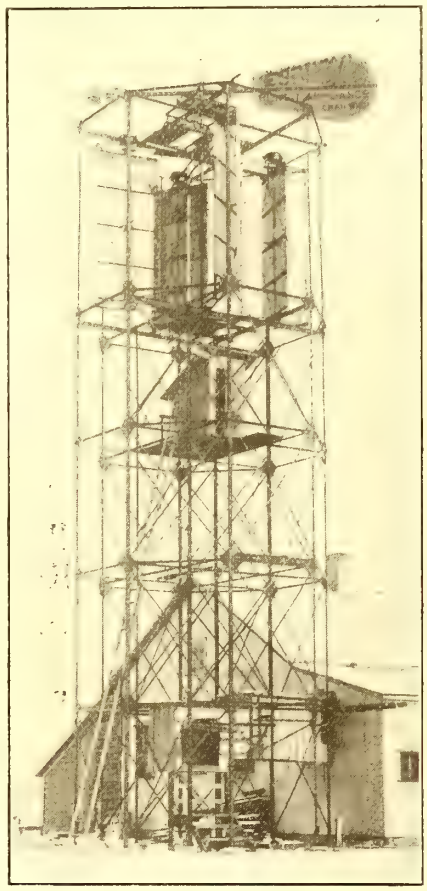
The small farm type plant here shown supplies electric power for a large group of buildings. It is automatic, starting and stopping according to the condition of the storage batteries. It charges the batteries about once a week on the average. One of the photos shows the electric control switchboard, including the volt and ammeters, automatic charging cut-out.

THE THIRD LIBERTY LOAN AND YOU!

This country had not been at war with Germany for many days before realizing the essential importance of the trained electrician in the Navy, in the trenches, behind the lines, at the various headquarters, and in Washington. To consider that city alone, and none of the others where war preparations are going on, the demand for electrical service is insistent. The War Department's system of communication with the outside world must be of the best. Here there must be no fraction of a second lost in the transmission of messages. The best of the technical minds of the country have been consulted on this problem and in the weeks just past there have been many adjustments in the interest of speed and efficiency.



Small Town Wind-electric Generating Plant Intended for Supplying Light and Power to a Whole Community.



American Wind-electric Generating Plant of New Design. It Charges a Storage Battery About Once a Week. The Plant Shown Supplies Electric Light and Power for a Large Group of Buildings.

The electrician in this war stands in the place of the ancient runner as a transmitter of intelligence. He may bear a message such as the first Marathon racer brought of the victory at Thermopylae. Indeed, the man who flashed the first word of the safe arrival of Pershing's force in France performed just such a service for the American people as did the messenger who gave up his life. The nation has been calling for the services not only of the electrical technician, but also of the man who dreams in terms of volts until he creates death-dealing and life-saving devices for use in this conflict. Never has the inventor taken so prominent a part in war. His ideas are being snatched up with the greatest eagerness in the hope that they may be applied to a weak spot on the Western front, to some condition of submarine warfare, or to the over-head warfare.

It has been impossible for most men to follow the development of the electrician in war times, fascinating as that subject may be. A more definite idea was presented at the recent exposition in New York City. Industrial lighting devices, for instance, have been

(*Continued on page* 796)

Women Now Study Wireless

A class in wireless telegraphy for women has been establisht at the East 86th Street branch of the Y. M. C. A. by Mrs. Herbert Sumner Owen, the founder and director of the Wireless Classes at Hunter College and the Marconi Radio School. The Y. M. C. A. offered the use of their apparatus and the services of their instructor Mr. Bohn to Mrs. Owen, so that women could learn wireless telegraphy and thus aid their country by teaching men and replacing them in many posts relieving them for active service in branches where they are more needed. The photo shows a class in radio engineering.

Eighteen women have already past the U. S. Government tests, hold licenses, and are thoroly capable of becoming code instructors, should the Government decide to use them.

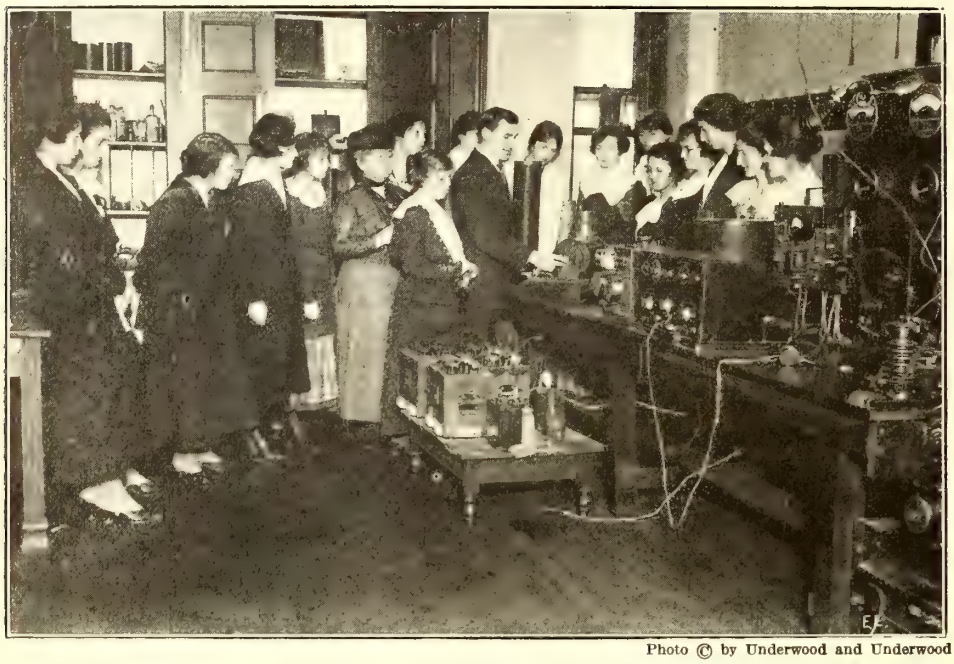


Photo © by Underwood and Underwood

An Interested Group of Young Women Studying the Mysteries of Wireless at a New York School, So as to Be Ready to Do Their Part When the Call Comes.

ANTILLES' RADIO OPERATOR DIED BRAVELY AT HIS POST.

Secretary Daniels has sent a letter to Robert Ausburne, who is employed at the Union Club, Fifth Avenue and Fifty-first Street, New York, commending the action of his brother, C. L. Ausburne, radio electrician first class, who went down with the U. S. Army transport *Antilles*, when it was sunk on October 17. Attention was called to the bravery of this radio operator in the findings of the court of inquiry, which stated that Ausburne went to his station to use the radio to give warning rather than attempt to save his own life.

Ausburne and Radio Electrician MacMahon were asleep in adjacent bunks, opposite the radio room, when the ship was struck. Ausburne, realizing the seriousness of the situation, told MacMahon to get his life preserver on. As he left to take his emergency station at the radio key he shouted to his companion, "Good-by, Mac." This was the last MacMahon saw of him. Going to the radio room, MacMahon found it locked, and, realizing that the ship was fast sinking, attempted to get Ausburne out, but without success.

Ausburne originally enlisted in the Navy at New Orleans, February 25, 1908. After eight years' service he reenlisted on March 1, 1916. He was one of the four men of the Navy who went down with the *Antilles*.

According to the report of the officer in charge of the armed guard on the *Antilles* the behavior of the Navy personnel thruout was highly commendatory. The two forward gun crews, in charge of Lieut. (Junior Grade) R. D. Tisdale, remained calmly at their gun stations while the ship was sinking and made no move to leave their posts until ordered to save themselves. An instance of remarkable coolness is cited in the case of one member of the gun crew who was rescued from the top of an ammunition box. When he saw a steamer coming near to pick him up he advised the ship by semaphore not to come too close as the box he was sitting on contained live ammunition.

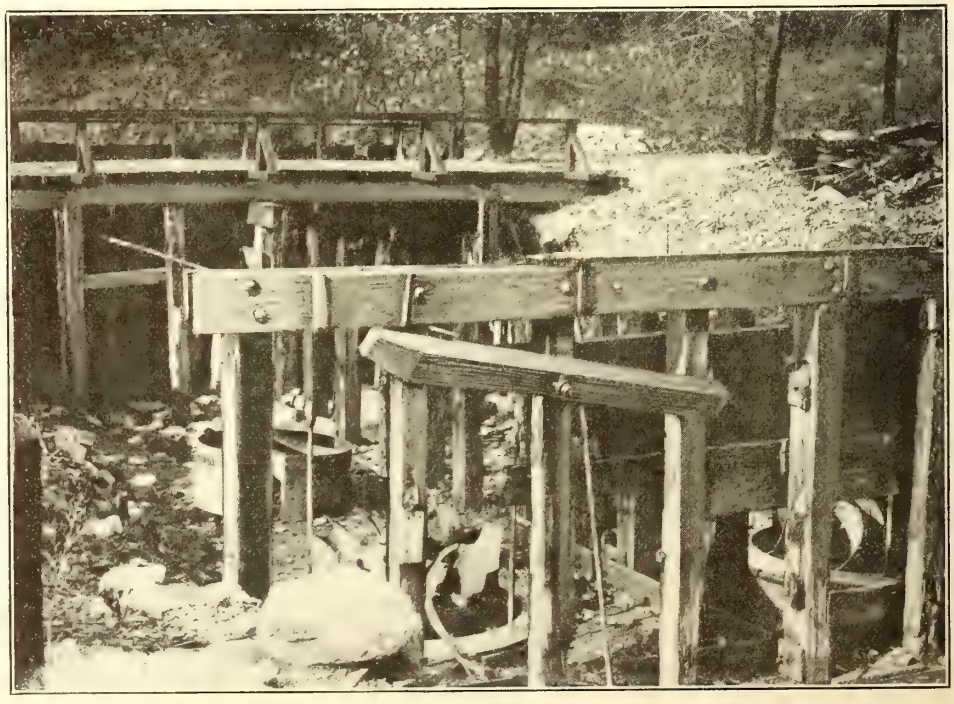
HISTORIC LIGHTING PLANT AT APPLETON, WIS.

The illustration shows all that is left of what is thought by many to have been the first commercial incandescent electric lighting plant in the world. This picture was taken recently by H. G. D. Nutting of the *Electrical World*, at Appleton, Wis. It shows the steel shells of the old vertical waterwheels now broken to pieces and lying on the ground. The wood construction is what is left of the harness and support, and on the other side of the little bridge are the needles holding the water back in the flume, which is till connected with the Fox River.

This plant has been mentioned by many writers and referred to by Samuel Insull in speeches and in reminiscences of early days. While it is held by some that it was the first incandescent lighting station in the world, recent researches of William E. Keily of Chicago, who has given considerable thought and time to investigating historical events in the industry, seem to indicate that this was the third Edison electric lighting station in operation.

According to the best data which Mr. Keily can obtain, the Holborn viaduct in London was started either on Jan. 12, 1882, or April 11, 1882, these two dates being fixt by separate authorities. The historic Pearl Street station in New York was started on Sept. 4, 1882. The record of the Western Edison Light Company of Chicago, which took the contract from the Appleton Edison Light Company for two K dynamos, to be operated from water power and to light 550 lamps, was dated Aug. 15, 1882. Edward T. Ames, still living in St. Joseph, Mich., was sent by the Western Edison Light Company of Chicago to install that machinery. He has stated that the Appleton station was started on Oct. 15, 1882. This makes it the first Edison electric lighting station to be driven by water power and the first Edison station in the West.

[*Editor's Note:—Those interested in the history of the first steam-driven electric central station in America will find an authentic article describing the Pearl Street station in New York City in the January, 1918, issue of this journal, page* 598.]



A Remarkable Photograph Showing What Is Thought to Be the Remains of the First Hydro-Electric Plant in the World. It Was Built in 1882, and Started on October 15 of That Year.

NOVEL ELECTRIC STRIP HEATERS.

For crane cabs, valve, meter and pump houses, watch and signal towers, turn table cabs, theatre ticket booths, exposed and remote rooms—these are some of the locations in industrial plants and factories where the new strip type, steel jacketed, electric heater units have found application.

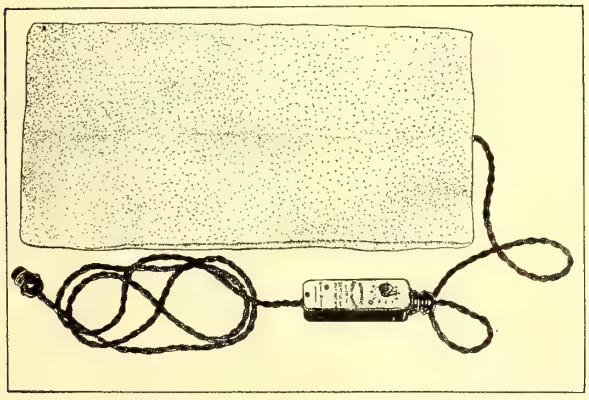


New Electric Strip Heaters Which Are Well Adapted to Heating Small Booths and Closets.

These units may be connectecd to either D. C. or A. C. circuits—115, 230 or 250 volts. As electric lamps are placed where light is wanted so these units are distributed where heat is required. The dimensions are 3/16 x 1½ x 23¾. Such heaters take up a minimum of room and give enough heat to keep a small booth comfortable.

NEW AUTOMATIC CONTROLLER FOR HEATING DEVICES.

A Western concern is manufacturing an automatic controller that regulates the amount of current delivered to any heating appliance and maintains the heat of the appliance at an even temperature. This device is made in two types, one for alternating current and the other for alternating and direct current. The controller consists of a thermostat, composed of copper and iron riveted together, which is placed immediately over a heating coil and connected in series with the load. The heat from the coil causes the thermostat to break the circuit whenever the temperature rises above a certain point. The handle on the outside of the case can be set at any point lettered from A to K, on the scale. *A* corresponds with zero degrees, *B* with 10, and *C* with 160. The turning of the handle causes the contact point which touches the thermostat to move downward and bend the thermostat. Thus the more the thermostat is bent the more heat is necessary and the higher the temperature required to cause it to bend still further and break the circuit. By the use of this device it is claimed that 40 per cent of the energy now used in the excess heating of irons, percolators, toasters, chafing dishes, etc., can be saved, as the exact amount of heat required can be obtained and the excess eliminated.



An Automatic Electric Controller Operating on the Thermostatic Principle and Designed for Use with Heating Appliances, Such as Pillowets, Blankets, Etc.

3,000,000 H. P. AVAILABLE AT NIAGARA WOULD SAVE COAL.

C. A. WINDER, in a recent address here before the Schenectady Section of the American Institute of Electrical Engineers, urged the use of Niagara Falls power as one means of solving the coal shortage problem. Mr. Winder spoke as follows:

"While the Nero of smug indifference and ignorance is fiddling away, the great coal fields of the earth are being burned up. While millions of horse-power are passing unused over vast water falls, great industries are languishing. Water power sites have virtually been roped off and *'Verboten'* signs posted by our national legislators. Now that the coal supply diminishes and water power is throttled, what chance has the electrochemist, the greatest user of power, to expand to meet the increasing demands of the present day? The electrochemical industry is vital to the success of the great world war; that water power is vital to this industry will be shown in the following paragraphs," he said in part.

"The electrochemical industry can be well divided into three classes.

"First—Those that can't be moved from the country by any means and will stay regardless of the cost of power.

"Second—Those existing at present, and to a greater or less extent depending upon natural conditions for existence and growth.

"Third—Those having no footing in the country or not as yet in existence.

"The first includes copper, zinc and rare metal refining and electric steel production and is perhaps, as a class, the largest user of power. Class two included, in the order of their importance, the following: Aluminum, ferro alloys, carbid, artificial abrasives, alkali, chlorin, phosphorus, sodium, cargon, disulfid, grafite and similar products. Class three would then include nitrogen fixation and possibly products we know little or nothing of at this time, there being no power consumed within our boundaries for products of this class.

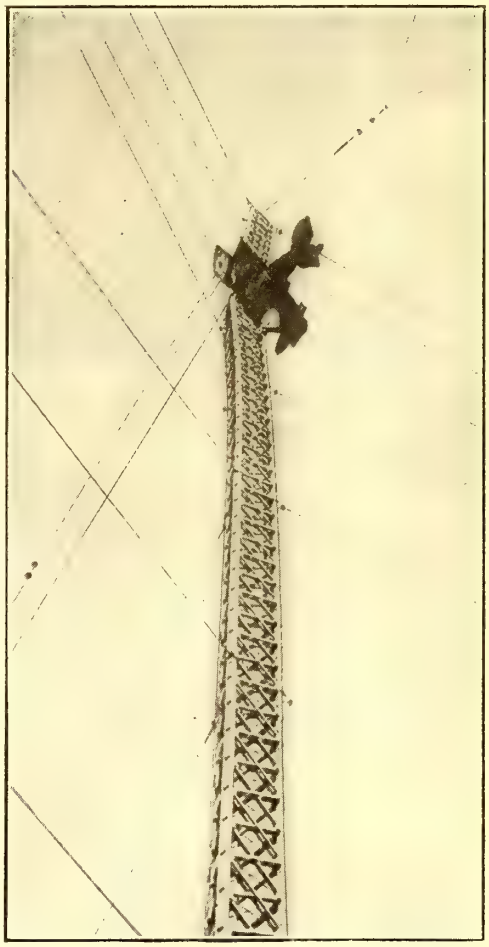
"Not a shell is made that is not shaped by electrically made abrasives. The electric furnace from which the armor plate is poured used electrodes made from coal by the aid of electric power, the resisting power of this same steel is given by electrically made ferro alloys. Merchant vessels are now using smoke buoys in which quantities of phosphorus and other electrochemical products are burned, emitting large quantities of smoke, thus protecting the boat from the submarine. High explosives utilize chlorin, aeroplanes, aluminum, and observation balloons produced by the aid of silicon. In fact, every tool of the modern army is in some way dependent on the electrochemical industry. Furthermore, our military preparations are already calling for very considerable quantities of many electro-chemical products for which ordinary demands are small or non-existent and which were therefore not produced at all or produced in extremely small quantities. The increased demand for our vast army will be enormous. England, for instance, always

(*Continued on page* 792)

SEAPLANE CRASHES INTO RADIO TOWER.

The extraordinary and remarkable photo here reproduced shows a British seaplane caught in the steel girders of a wireless tower over 300 feet high. The plane, while emerging from a thick mist, hit the tower and was caught firmly in the steel lattice work. The pilot, who was stunned, was flung from his seat and fell on one of the planes, where he lay unconscious over 300 feet from the ground. The seaplane's engines were wedged into the interstices of the girders so that the body of the machine stuck out at right angles.

A small body of bluejackets were at work painting the tower. One of them, a seaman of the Naval Reserve named Rath, climbed up the inside of the mast until he reached the machine, and then crawled out onto the plane to hold the pilot until help came. Two more men, Ordinary Seaman Knoulton and Deckhand Abbott, past a rope out to him, which Rath secured to the body of the pilot and lowered him to safety. The gallantry of these men is accentuated by the fact that the mast was badly damaged, and might have at any moment collapsed. The damaged fuselage was only held in a horizontal position by the engine being jammed between the girders, and at the height of 300 feet the wind caused the mast and the machine to sway severely, threatening to fall. The pilot owes his preservation to the intrepid gallantry of these three men, who, while alive to the risks they ran, performed the rescue without regard for personal safety. The Albert medal will probably be awarded them for their bravery.



A Remarkable Accident Which Occurred in England, a British Seaplane Being Caught in the Steel Girders of a 300-Foot Radio Tower. The Aviator Was Rescued, Miraculous as It May Seem.

JUMBO GETS HIS HIDE VACUUMED.

Jumbo, the elephant, likes to have his hide cleaned the modern way, that is, with a vacuum cleaner. The illustration shows a husky pachyderm receiving his morning bath—à la vacuum. The electric vacuum cleaner is finding wide-spread application in many parts of the country for thoroly and expeditiously cleaning animals. Time was when the only bath the elephant enjoyed was that when he happened to get near a tank of water or a lake so he could fill his trunk and spray himself. Now, the elephants belonging to such pretentious shows as that at the New York Hippodrome receive a thoro cleaning every day. The animals look better and feel better—just the same as humans do. The elephants really seem to enjoy the novelty.

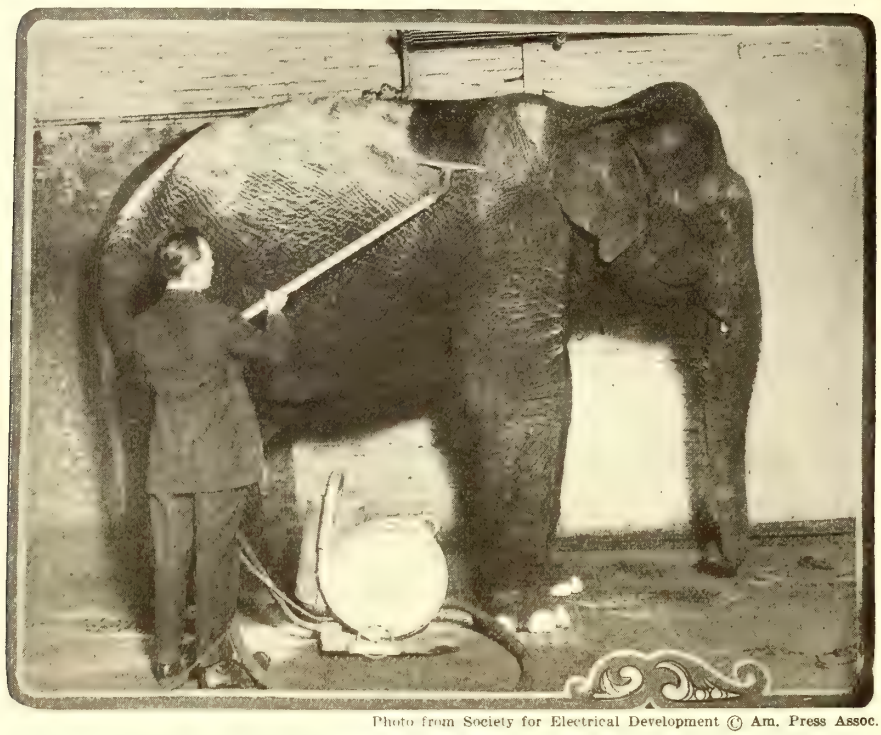


Photo from Society for Electrical Development © Am. Press Assoc.

Electricity Is Daily Finding More Ways of Lightening Our Labors—Here, Jumbo, the Elephant, Receives a Thoro Morning Scrubbing—a la Vacuum.

"HOOVERIZING" ELECTRIC CURRENT.

A wide margin exists for the reduction of household consumption of electricity, in furtherance of fuel and freight saving. For instance, despite the remarkable development of cheap, durable, metallic-filament incandescent lamps the past few years, there has been no reduction whatever—in fact, an increase, rather—in the use of old-fashioned carbon-filament lamps, which the modern lamps should have displaced, says the weekly bulletin of the U. S. Food Administration. Carbon-filament lamps give less light than modern lamps and consume more electricity. The chief element in their continued use is the fact that they are given free to householders by many electric-light companies, whereas metallic-filament lamps are sold. It would pay every consumer of electricity many times over to purchase modern lamps and economize by reductions in electric-current bills. Old-fashioned and ineffective types of lamps are also used for street lighting and should be replaced with large economical incandescents of the latest types.

ELECTRICAL PRODUCTION OF RAIN.

According to an Australian patent applied for by Mr. J. G. Balsillie, of Victoria, electricity can be utilized to promote the falling of rain over dry regions.

The specification states that the atmosphere is known to comprise several distinct regions. The section of the atmosphere concerned with the process subsequently described is termed the troposphere. The earth's surface is always negatively charged, and in fair or clear weather the troposphere is nearly always electrified positively; in wet weather, however, negative electrification of it is usual. The troposphere contains transient masses of electrified particles which vary or alter the normal sign and potential gradient of zones of the troposphere. The invention is based on the diminution or cancellation by artificial means of the potential gradient existing in fair or clear weather between the elevated zones of the troposphere and the ground, so that clouds are formed in the affected troposphere zone and rainfall is procured. The invention utilizes an electrical conductor used to form a path for a flow of energy between the earth and such tropospheric zone or cloud, the conductor being connected to a good electrical earth at the lower end, and at the upper end having a terminal of electrically conductive material which will insure intrinsic electrical connection with the cloud or tropospheric zone. A potential of the order of 320,000 volts is maintained between the conductors, causing coalescence of the aqueous particles and deposition upon the earthed conductor. In a modification a single earthed conductor is supplied with high tension alternating-current by means of an alternator inductively coupled by a transformer with a closed oscillating circuit, comprising a spark-gap and a condenser, which, in turn, is coupled through a tuning coil. Deposition of the aqueous particles occurs upon and in proximity to the conductor.

HEAVY DUTY ELECTRIC PHOTO-PRINTER.

By V. G. Ellis.

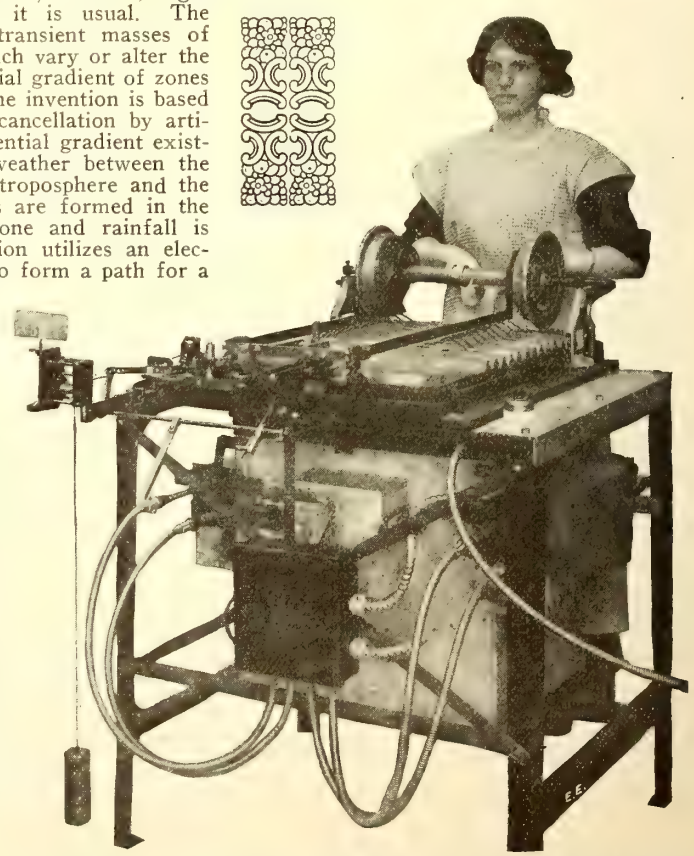
This photographic printing machine is in use by a concern making large commercial photographs in big quantities. It has an automatic time switch making and breaking the circuit for six 500 watt tungsten lamps about once every minute, all day long. By means of a clock-work, it is set to give a print any desired length of exposure to the light. Each lamp can be turned on and off individually as well as adjusted in different positions so as to regulate the intensity of the light on certain parts of the negatives to be printed.

The switch has sliding contacts, mounted on a marble base which is inclosed in a sheet metal box. The wiring is arranged as shown in the photograph of the device.

The automatic switch terminals are of brass, insulated by fiber over which a flexible copper bar moves with perfect contact and without appreciable friction.

As the bar slides over to the opposition it lights a red pilot lamp, thus furnishing illumination in the machine while the photographic paper is being put in place over the negative. When the switch bar is half way across the contacts the red lamp is connected in series with the white lamps, preventing the current from being entirely broken at any time during the operation.

Before this machine was perfected great difficulties were experienced on account of arcing switches and unreliable timing, but this construction has given the users satisfactory service for several years.



With This New Electric Photograph Printer the Young Lady Can Turn Out Ten Photo Prints Where One Was Produced Before.

AN ELECTRIC SHELL FOR FIGHTING U-BOATS.

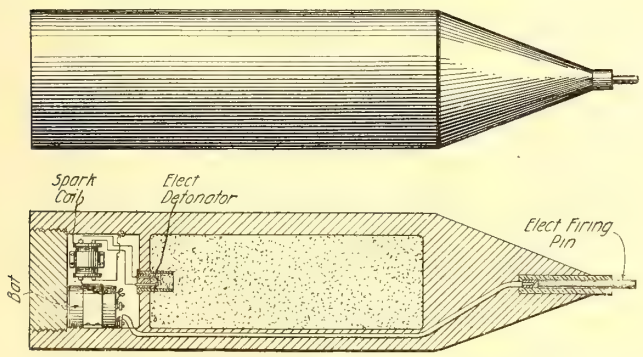
It has remained for Mr. Lee A. Collins, of Louisville, Kentucky, to invent a new electric explosive shell for combating submarines.

This shell is one which explodes after being fired from a gun or other projectors or when dropt from airplanes and the like into the water, for warfare against submarines, torpedoes and the like. The inventor provides in this connection two electric conductors exposed to the outer surface of the shell with insulating means separating the electric conductors. This insulating means is soluble or made conductive when in water. Another object of the invention consists in providing a normally open circuit adapted to be closed upon contact of the two exposed terminals with water or other conductive means, thus causing an explosion. By attaching time fuses to the electric detonator it is possible to cause an explosion to take place at a predetermined time after the shell comes in contact with conductive means, instead of the instant that the shell strikes conductive means.

The invention also covers means for coating outer exposed conductors with a non-conductor covering, such as sealing-wax, paraffin or other suitable means which can readily be removed when shell is to be fired, thus preventing accidental contact, which would prematurely explode the shell.

These exposed conductors must have all insulation covering removed at outer exposed surface when ready for use. Heavily insulated covered conductors lead from the secondary of spark coil and thru wall separating the chambers to the respective terminals of a detonator, which may be of any suitable type. One form being a bulb containing fulminate of mercury and a platinum wire within, connecting the electric terminals leading from the spark coil. The detonator is in contact with or rests against the explosive, which may be a charge of guncotton or other high explosive, placed within the forward chamber. Obviously, therefore, as soon as the platinum wire within the detonator is energized from the spark coil, the explosive explodes, thus causing destruction to the shell and all objects within reasonable radius.

In operation, when a shell is fired from a gun or dropt from an airplane or otherwise discharged into the water at an enemy vessel, submarine or torpedo, one conductor and the outer portion of the shell, which in this form is a conductor, will come into contact or be submerged into the water when it strikes the point of aim and closes the circuit of the battery thru the primary of a spark coil. As a result, the primary of coil will induce a current into the secondary of the spark coil and energize the detonator thru wire. Upon energization of the detonator the explosive is exploded and, of course, will destroy the shell and any objects within its radius such as submarines, torpedoes or other vessels.



Electric Shell For Fighting Submarines. When Dropt In the Water It Becomes Active Due to Insulation Being Dissolved At Point, Closing Detonator Circuit.

In lieu of a spark coil a more powerful battery may be used and the ignition wires would be connected directly to the terminals of the detonator. Under some circumstances, it may be more desirable to form the insulating medium of dry salt or like mineral, which will readily become a conductor of electricity upon coming into contact with water and thus close the battery circuit to the spark coil.

A NEW SECRET TELEPHONE TRANSMITTER.

In order to permit privacy in telephoning, a Chicago inventor has developed a device shown in the accompanying illustration which can be used with any telephone mouthpiece. By its use, it is said, that telephone conversations can be conducted in a very low tone and in a whisper, under many conditions. It is pointed out that the device is not permanently attached to the telephone and is therefore not a fixture.

The device is held on the mouth-piece of any telephone, and is held securely by means of the horse-shoe shaped wire held by the two springs, which snaps over the mouth-piece of the telephone.

To use the muffler most effectively, the inventor states that the upper lip should be prest gently against the mouth-piece, speaking slowly and articulating distinctly *with the lips*—almost a whisper (not down in the throat).



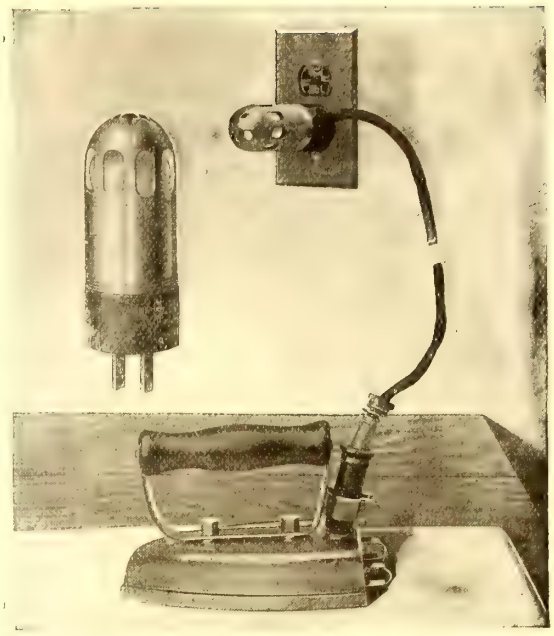
A Newly Marketed "Secret" Telephone Muffler. It Fits Onto Your Regular Telephone and Is Removed in a Second.

If used correctly you will be plainly heard at the other end, it is claimed, and no one near you need hear your conversation, thus permitting privacy and confining business and personal affairs strictly to yourself and those with whom you talk

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In Peoria, a hilly city in central Illinois, 300 automobilists operate automobiles without gasoline, that being the number of electric pleasure vehicles used in the city.

One ton of saffires will be used during the year 1918 in one factory where the jewelled bearings of electric meters are made. The jewels are purchased in the rough and are put thru finishing and drilling processes which require a degree of skill comparable only to that of an experienced watchmaker.



Something Every Housewife Wants—a Positive Indicator That the Electric Iron Is "On" or "Off." The Tell-tale Lamp Solves the Problem.

PILOT LAMP WARNS WHEN ELECTRIC IRON IS ON.

A new heater control just brought out is equipt with pilot lights which serve as a safety check on the woman who uses an electric iron or other extension device and on the workman who operates an electric iron in a factory, clothing shop or similar commercial establishment.

They enable the operator to play safe and avoid waste of current. The pilot light acts as a silent watchman and signals *danger* when the heating device is left in circuit unattended.

Take the case of an electric iron, for instance, on an ordinary padded ironing board: place it in circuit and leave it with "heat on," for say fifteen minutes or more. The probabilities are that quite an impression will be made in the pad, and quite possibly on the board also; perhaps the iron will even burn its way right thru the board. And then again, if the iron is left to itself long enough with the current on, the chances are that a serious fire may result. These new Heater Control switches have been brought out particularly to minimize fire hazard of this sort.

A wide variety of designs has been made to suit practically any condition desired. Each includes a pilot lamp and a 10-ampere double-pole indicating switch.

The flush types are mounted behind attractively finished face plates, and the pilot lamp signals thru a ruby bull's-eye. They are ornamental in appearance and are designed especially for use in the home.

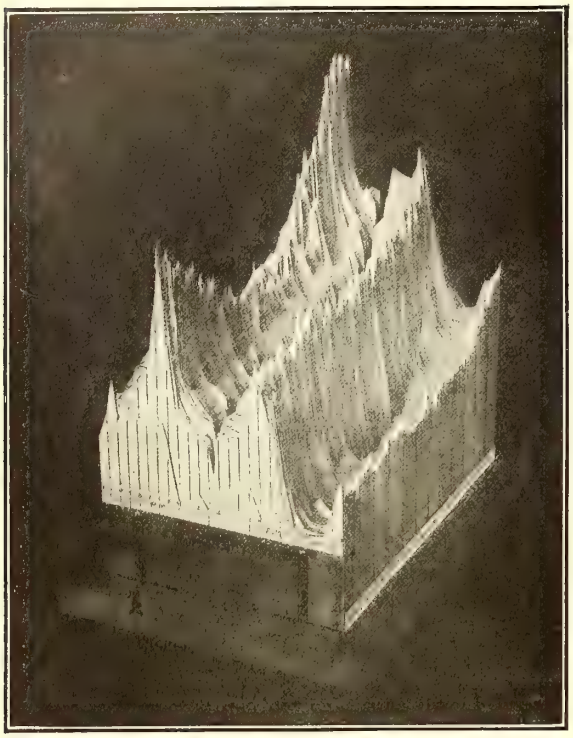
Surface types are for use in factories. They provide for regular base lamps as pilots but candelabra base lamps may be employed by using adapters.

USING EXHAUST STEAM.

More attention than ever before is being paid this winter to careful use of exhaust steam in power plants. It may be applied to innumerable purposes, such as heating feed water for the steam boiler, for many washing purposes, heating buildings, pasteurizing and sterilizing, and the like. A small investment in additional boiler-room equipment, such as an exhaust-steam heater, will effect savings of several hundred dollars a year in the coal bill of even a moderate sized power plant.

ANNUAL ELECTRIC LOAD RELIEF MAP RESEMBLES "ROCKIES."

The familiar daily load diagram or "graph" is plotted by practically all electric light and power companies. The accumulation of these curves soon becomes a mere record, usually filed away in some manner and always available for reference, and for the study of load conditions. When considering the load thruout the year it is difficult to obtain a comprehensive idea of the whole since it is necessary to glance *separately* at the greater portion of 365 sheets. Such a record locks up a desired vision in confusion.



No—This Is Not a Picture of the Alps! It Is a Composite Load Relief Map, Showing the Rise and Fall of the Electric Power Consumed in Philadelphia, Day By Day, For One Year.

The Annual Load Relief Map here illustrated is a device for visualizing the entire load of the year and is described by Wm. Le Roy Robertson in the A. I. E. E. proceedings for December, 1917. Each daily load diagram is marked off on card board and cut out. The cards are stacked up in proper daily sequence, mounted and provided with graduations for kilowatts, hours of the day and months of the year, all properly arranged. The annual load relief map here illustrated shows the Philadelphia load during the year 1916.

Day Load. A distinctive feature brought out by the annual load relief map is the contour of the day load which is consistently uniform throughout the year, always picking up between 7:00 to 8:00 a. m., having a valley at noon and then falling off punctually at about 5:00 p. m. This stands out clearly on the annual load relief map, and especially well, if one will imagine the absence of the night load where it overlaps the day load at 5:00 p. m. The day load corresponds closely to the regular average working day.

Night Load. The night load which picks up rapidly at 8:00 p. m. in mid-summer, and at about 4:30 p. m. to 5:00 p. m. in winter, corresponds closely to the lighting load. It depends absolutely upon the hour of sunset for its beginning and falls off rapidly, shortly after reaching its peak value. After midnight, it settles down to a low value and drops off almost entirely when the street lighting goes off near sunrise. In summer a deep valley will be seen in the morning, between the "fall-off" of the night load and the beginning of the day load, while in winter the loads overlap in the morning, filling up this valley.

Peaks. During the summer months there are three distinct peaks—one occurring about 8:00 a. m.; one about 5:00 p. m.; and the third about 8:00 p. m. With the approaching fall and winter months, and as the sun sets earlier each day, the 8:00 p. m. peak moves back toward the 5:00 p. m. peak and near the end of September the two peaks overlap, giving a combined peak greatly exceeding any other peak, which rapidly increases in height until the middle or latter part of December, when it becomes the greatest peak of the year. As the spring months approach the combined peak diminishes and finally near the end of March disintegrates, forming again the two separated peaks. While the above is a well known fact, the annual load relief map presents the changing condition in a most striking manner.

NEW AUTO TAIL LIGHT SIGNAL.

A novel automobile signaling device is provided in this new attachment for motor cars. It is claimed by the concern now offering this new signal to the public to represent an added convenience and comfort to motoring. It was perfected by H. Hartman, a well-known New York inventor.

Usually the driver of his car has to extend his arm from the seat to warn other cars in the rear, of what direction he is going to turn or if he is going to stop. By the aid of this new electrical invention, all one has to do is to push a button on the steering wheel and the arm will indicate which way the driver intends turning. When the car is going to stop, both arms fly up.

Two buttons mounted on a small base are attached to the steering wheel—one for *right* and one for *left;* when both buttons are pushed the stop signal is set.

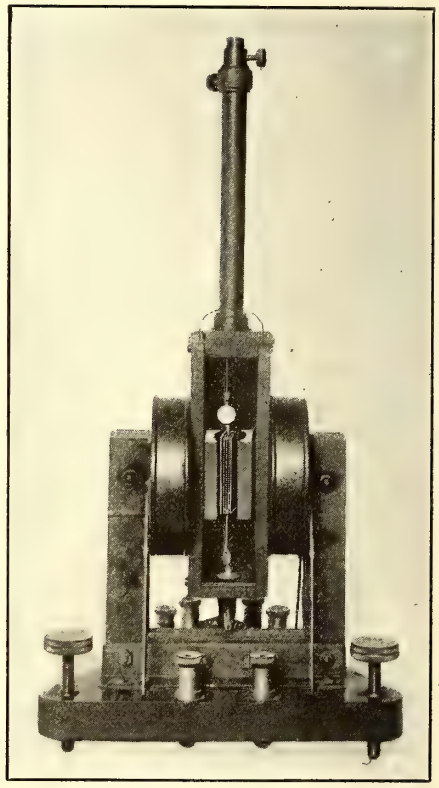
To inform the operator that his signal is working O. K. a small lamp flashes up on the push button base and a red light shows on the attachment. An ingenious arrangement flashes a beam of light on either or both arms so that they may be seen at night. The arms are worked by solenoid magnets, which close contacts for the lamps at the same time. An ordinary 4.5 volt battery, such as used in pocket flashlights, is sufficient to work this signal.



An Electric Semaphore and Tail Light For Autos. Its Arms Point to the Direction Which the Auto Is About to Take.

ALTERNATING-CURRENT GALVANOMETER.

Herewith is illustrated the new Northrup alternating-current galvanometer. The maker points out that it is especially adapted to the following uses: (1) For the accurate measurement of the resistivity or conductivity of salt solutions and other electrolytes; (2) for the measurements of the resistivity of molten salt; (3) for the measurement of the resistivities of molten metals; (4) for the measurement of any resistance in which small irregular emfs. exist; (5) for the comparison of small inductances using the bridge method and (6) for the comparison of capacities using the bridge method.



Something Every Laboratory Requires Is a Good "Alternating Current" Galvanometer. This Is One of the Latest Types, Fitted With Reflecting Mirror.

The galvanometer is mounted on a base of ebonite provided with leveling screws. The field magnets are laminated. Magnetizing coils are wound on non-metallic spools, which are placed on the field poles as close as possible to the moving coil. Pole-pieces are given a hollow cylindrical form about the moving coil, this special shape preventing the coil, when on closed circuit, from assuming a position of unstable equilibrium due to currents induced in its circuits by the alternating magnetic field. The moving coil is long and narrow, so that its moment of inertia is small, thereby permitting high sensitivity with a quick period. The entire hanging system is exposed to view through a glass front. The central housing is of non-conducting material to prevent the formation of eddy currents.

The sensitivity is adjustable thru a wide range, the strength of magnetism being variable by varying the current thru the field coils.

A LUMINOUS BUTTON FOR PULL CHAIN SOCKETS AND SWITCH PLATES.

For attachment to the end of the pull chain of the pull-chain type socket and for

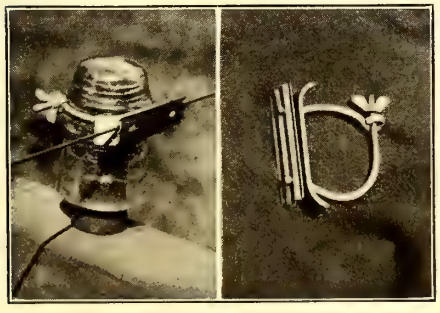


By Attaching This Luminous Bead to Socket Chains and Switch Plates, It Becomes An Easy Matter to Locate Lamp Control Points In the Darkest Room. They Glow In the Dark.

use with switch plates, a New York concern is now offering the trade a special radio bead and radio button which makes it possible to quickly locate in the dark a light chain, push switch or gas jet. These beads and buttons are made up of such a size as to radiate ample light, it is claimed, to be plainly seen at distances from 10 to 15 feet. The bead is made up so that it can be easily attached to the pull chain by cutting off the large ball at the bottom of the chain and slipping the last ball into the enlarged portion of the top of the bead and then pinching the wires close together. Besides the uses mentioned, it is pointed out that these devices are of practical use in lofts and cellars, where it is difficult to locate obstacles and lamps under other conditions.

NEW INSULATOR CLAMP REPLACES TIE-WIRE.

The insulator clamp shown is designed to prevent line trouble caused by the use of copper tie-wires on telephone and other lines. Besides preventing line trouble, it saves time when constructing new lines and also when repairing and rebuilding old lines, as it can be detached and attached more quickly than tie-wires. This clamp can be used over and over again, whereas tie-



To Save Miles and Miles of "Tie-Wire," An Inventor Suggests the Use of This New Insulator Clamp.

wires have only "junk" value when once used.

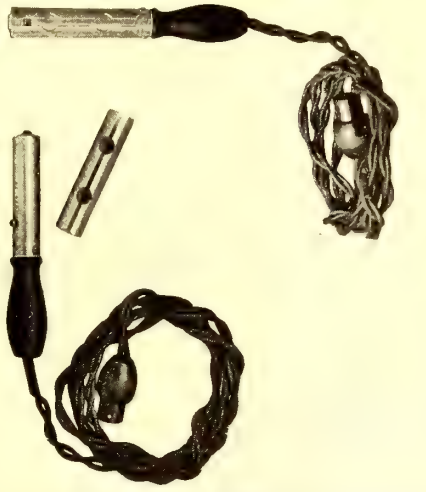
The cost of manufacturing is but little higher than that of the copper tie-wire.

Contributed by A. J. VIKEN.

AN ELECTRIC CIGAR AND PIPE LIGHTER FOR AUTOISTS.

Push the button and light your cigar or pipe without a cuss word, if your car is fitted with this new electric lighter. It is made for 6 volt storage battery only, and not for regular electric lighting or power circuits.

This Cigar Lighter is very neat in appearance, takes up little room, will not "drain" the battery and will add greatly to the equipment of the finest and most luxurious of cars. The spiral coil element is so arranged as to allow its use with cigar, cigarette or pipe. The casing is finished in polished nickel and the handle is of wood with ebony finish. It is furnished complete with protector sleeve and five foot cord directly connected to lighter and either one or two point Edi-swan standard automobile attachment plug.



Every Autoist Will Appreciate the Comfort of the Electric Cigar Lighter.

A COMBINATION ELECTRIC CURLER, HAIR DRIER AND WAVER.

Ladies, both young and old, will find this new electric curler, hair drier and waver—all three in one—a great convenience. It dries the hair quickly after a shampoo.

To use the curling iron it is simply necessary to remove the comb. To use the waver, remove the shield and comb. The device is claimed to produce beautiful lasting waves or curls.



An Electric Curler, Hair Drier and Waver For Milady.

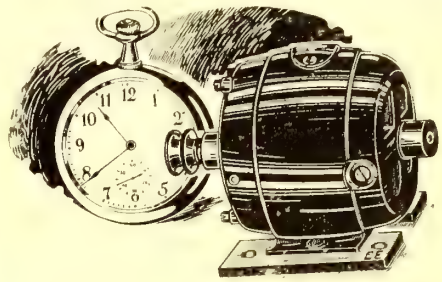
The heater and cord revolve together, so that the cord does not kink while in use and the temperature is so regulated in the heater that it cannot burn the hair.

CLEANING WARSHIPS' HULLS BY ELECTRICITY.

The old methods of cleaning ships' hulls, which was a laborious and lengthy process, is being replaced by electrical methods. Formerly, it was customary to allow 170 to 200 man-days for the work, but recently several electrically-driven machines have been found to be both speedy and effective. Brushes and scrapers are used, and by their means, at a moderate expenditure of electricity in driving the operating motors, an 18,000-ton battleship can be completely cleaned in twelve hours, and vessels drydocked after having been cleaned by this method have been found to have remained quite free from any subsequent marine growth.

COMMERCIAL 110 VOLT MOTOR SIZE OF YOUR WATCH.

One of the largest electric motor manufacturers has brought out a line of extremely small motors in every size from 1/200 to ¾ of a horsepower. Like a good



Commercial Electric Motors No Larger Than a Watch Are Now Built Regularly.

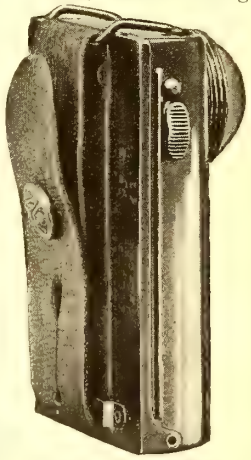
watch, they run sure and true, doing the work to which they are assigned, year in and year out, with little or no attention The 1/200 horsepower electric motor here shown in comparison with a watch shows how the electrical engineers have developed and perfected the motor so that a perfect machine, armature, field winding, bearings, and all results in a minimum of space.

WAR INVENTIONS CLOSELY GUARDED.

Pursuant to recent legislation empowering the Commissioner of Patents to withhold the issuance of Letters Patent on the devices adopted by the Government for use in carrying on war, Commissioner Newton has refused patents on over sixty-five inventions within the past few weeks. At the present time a corps of West Point and Annapolis graduates trained in technical problems of war, carefully consider the hundreds of patents granted weekly for details of military significance and choose those on which patent proceedings should be suspended during the war. The inventors thus deprived of patent rights may offer their devices to the Government and sue after the war for compensation.

NEW ARMY FLASHLIGHT FOR U. S. SOLDIERS.

This new army flashlight is designed especially to meet the needs of soldiers and sailors. It is small in size, light in weight and can be conveniently carried in kit or coat-pocket. It is claimed to give more light than many very large flashlights—plus special service impossible with ordinary types of flashlights. For instance it can be buttoned on the coat, leaving both hands free; can be fastened on the belt; can be hung on any peg; can be carried by its handle, as a lantern; can be stood upright on its base, as a reading lamp; can be hung above a mirror, as a shaving light. Renewal batteries can readily be purchased in any town in the United States and Europe. It is especially adapted to the wants of the Home Guard and Boy Scouts. For policemen, watchmen, detectives, reporters, sportsmen and all other classes of men who need to have both hands free, this lamp should prove extremely useful.



Latest Army Flashlight for Soldiers.

At War With The Invisible

By R. and G. WINTHROP

TO you of the present generation, secure and prosperous in these happy days of universal brotherhood and peace, the world-destroying War of the Planets, that engulfed every shred of our vast planetarian system at the opening of this century and pitted with frightful force planet against planet, is already becoming a mere tradition—a gruesome, historical record of the unwise past.

As you glide along the turbid canals, on your summer trip to Mars, with the peculiar reddish water lapping at the sides of the blunt-shaped gondolas, you pause for a few moments to contemplate the enormous magnetic pillars from which were launched the world-crushing electrites; or you climb the grass-covered Battle Hill on Venus to gather souvenir fragments of the crumbling Flame Tower, whose battered sides now seem to be sinking into the crest of the hill. But, strive as you may to revive the images of that bygone age, your interest is only historical and you cannot sense the the feeling of horror that comes over us older people when we revisit these time-scarred, battle-seared scenes of a past in which we struggled against complete extinction.

I do not expect, therefore, to reproduce in your souls the emotions that moved me in that time of strain and stress—I cannot hope to picture in your minds my own mental conflicts of dread and triumph, of life and love and hope, when a fear-maddened universe fought desperately against a new force—more bitter and relentless than any that warring mankind had ever before faced—the Invisible Armada of the Air. But I want to bring vividly to your minds the knowledge of that event, one among a thousand of the Great War, so that you may see how the Supreme Intelligence, working thru the mind and hand of man, rewards fiendishness and malevolent ambition.

It was in the year 2011 that Mars thrust this new engine of frightfulness into the strife. The terrific struggle was ending its third bitter year and the contest between righteousness and unholy greed seemed to be ending with victory on our side. As the real character of the war had become apparent, one after another the planets had joined the forces pledged to destroy the menace of Martianism. The huge V-planes of the Allies now surrounded Mars in a flashing ring, gradually crushing down her stubborn resistance, and we looked forward with eager hope to the approaching end. Then came the stupefying shock of Philadelphia's destruction.

I was in Paris at the time, representing the *New York Century* at the reception to the Commission from Venus. Around the table of honor were gathered the keenest minds of the allied planets. The president of the visiting commission, the Honorable Peros Venasarol, had hardly begun the opening of his address, when the vibrator on my pocket phone signalled. At the moment, the president's daughter, Ava, sat at my side.

In these days, when a journey to another planet is as common as a week-end trip to Japan was in my time, the presence of Venusian women in our social life is accepted as a matter of course; but in 2011 their ethereal glory still held us enthralled, and Ava—Ava was the quintessence of them all.

I was one of the committee appointed to interpret the Earth to the visiting commissioners, but I interpreted it only to Ava. Her presence had called forth in a flash my very soul, and I laid it at her feet with such generous intensity that she accepted it as graciously and as sweetly as a child takes a flower. Ah! that lilt in her voice—the mysterious, fascinating chime of the bells on her wrist—the bells that no one could see—the bells that were to save us from the Martian horror . . . But I am forgetting the reception and the summons of the pocket phone.

With an impatient jerk I drew out the phone, set the silencer so as not to disturb those near me, and adjusted the receiver to my head. Immediately I could hear Ingals, my managing editor. His voice was tremulous with excitement.

"For God's sake, Elvan, hurry back!" he gasped.

"What's up?" I asked.

"I can't tell you—hell's broke loose on Earth!"

"Won't to-morrow do?" I suggested. "The Honorable Peros—"

"Oh, damn the Honorable Peros!" shouted Ingals. "Start now, I tell you." And he shut off with a jerk.



". . . 'The Bells Are Inside,' Ava Explained."

We look upon the present World War with awe because we know it to be the biggest conflict the world ever saw. But Napoleon's wars, Alexander's wars, no doubt were looked upon with exactly the same kind of awe by the then existing humanity, because those wars were the biggest up to those respective times.

What of the future? Suppose the Martians, whose civilization is infinitely older than our own, one day take it upon themselves to conquer the planetarian World, in order to keep their race from extinction, on their dying planet? It's only a step further from the present Hohenzollern idea. For some day the gulf between the planets will surely be bridged. What then? Read this intensely interesting story of the future. We guarantee you will like it.

I glanced around at the assemblage, at the venerable high commissioner, now fully launched forth on his impressive message and, finally, at Ava. An inexplicable fear, vague and uneasy, wound like a cold, thin wisp of steel around my heart. With quick resolve I drew out my notebook to find the index sign of the American Air Service. In another moment I was talking to the manager. There was a night express leaving London, he informed me. Whispering a hasty explanation to Ava, I made my way from the hall up to the roof of the building.

About a dozen planes were lined up on the starting platform and I selected the swiftest looking one of the lot. It was a long, grey Bullet Racer. The aerist, a light-hearted boy still in his teens, assured me he could make the station on time with half his cylinders dead.

Watch in hand, I crept into the asbestos-covered compartment, seated myself by his side and we slid into the night. In a few moments we had cleared the city and were heading straight for London. Instead of following the well-marked route over Calais we took the direct Dieppe path, hoping to gain a few precious seconds by the lessened mileage and the lighter traffic.

For five minutes we breasted the darkness with no sound but the purr of the motor and an occasional click of the altitude lever as the plane rose or dropt to escape the suction holes that our indicator showed us in advance. Then a light flashed out of the black, winking red and white. It was the signal station at Dieppe, floating ten thousand feet above the city. Half the distance was behind us and I had ten minutes left. I turned to my companion with a murmur of satisfaction.

"You'll do it," I said with satisfaction.

"It's easy," grinned the boy. "Last year I pushed a V to Mars. *There's* where the lads move. A hundred a minute with the deflectors off and five hundred when they're on. I'd be there now if they hadn't smashed my back."

I turned with a look of inquiry toward his arched spine.

"Chunk of 'lectrite," he explained. "A grain of it humps you up."

As we sped over the Channel the cloud that covered the sky opened towards the west and I could see Mars glowing dull red, like a baleful eye on the horizon.

"Whatever has happened in America," I thought, "at least, it can't be due to the Martians. Thank Heaven, they are bottled up securely."

My ruminations were suddenly checked as the aerist snapt off his motor and pushed the snub nose of the Bullet at a steep angle towards the earth. We had reached London.

The immense dock of the American Air Service was thronged with excited groups of people. Rumors of an awful cataclysm in America were being stridently discust, and many passengers hesitated to board the *Eagle,* which stood ready on the inclined platform, her black, carbonoid body spotted with even rows of lights from the observation port holes.

One Mercurian had made himself the spokesman for the timorous, and loudly exprest the fears that animated them all.

"Don't tell me it's an earthquake," he was shouting with the volubility and exaggerated gestures that mark the speech of his people. "Whoever heard of earthquakes around Philadelphia? It's the Martians. They've broken loose again."

"Impossible," objected one of his auditors. "The V-planes are hedging Mars so close a fly couldn't get thru."

"That's what they said in twenty-ten," sneered the Mercurian. "Then the electrites began slamming us. I tell you, the Martians have outguest us again. You listen to me—the *Eagle* won't get half way across. Take my advice and stay here."

"If it's the Martians," observed a placid voice in back of me, "they'll hit us here just as quick as over there. I can't see the sense in getting scared off the *Eagle.*"

I turned with a smile of approval to face the speaker. As I suspected from the accent, he was a Jupiterian, huge in bulk and glittering with gold leaf and jewels.

"What has happened?" I asked. "I received a message calling me back to New York, but there were no details."

"There are all kind of rumors. One says Philadelphia is gone. Another tells us all America is wiped off the Earth. Whatever it is, this is no time to stand back in fear. I'm going over."

I fell in with his stride as he turned, and we walked aboard the *Eagle,* whose powerful blades were already slicing the air.

At sunrise the next morning, as the *Eagle* soared across Staten Island, I stood on her dew-wet forward deck and gazed ahead with a peculiar sense of vague fear as to what sight might greet me. I gave a gulp of relief as the outlines of the great city flew rapidly into vision. Before I could dwell any further on the meaning of Ingal's message, the great airship began settling toward her dock.

Without a moment's delay I hurried to the Century Building and soon was winding thru the long lane of writers' desks to the editor's office.

Again a feeling of undefined apprehension chilled me as I opened the door and Ingal's tired eyes met mine. No sleep had closed his—the pupils were pin points in two sunken, blue-grey pools.

"Elvan! Good!" A look of relief lit up his drawn features and he leaned back in his chair. "For the love of glory, Elvan, get over there quick and give us a straight story of this convulsion," he implored. "You're the only one can do it. All the tykes around here have gone insane, I believe. Look what this putty-brained ass says—" He held up one of the scribbled sheets and read from it in a voice ragged with exhaustion: "'No such scene has ever been seen before. The scene beggars description!'"

"Is it as bad as all that?" I asked soberly.

"It's worse," Ingals assured me, becoming grave. "Philadelphia is buried a mile deep and Lord knows who's next."

"Surely, you don't expect—"

"I certainly do. Those vampires of Mars—"

"Mars!" I started in surprise. For the temperamental Mercurian to be seeing Martians behind every catastrophe was quite natural, but Ingals— "How could they?" I protested.

"I don't know. That's what I expect you to find out." His voice rose in grotesque wrathfulness. "Don't stand there theorizing, you blue-headed son of an inkbottle! Get on the job! If I don't soon have something sensible to work on I'll go toppy."

Some ten minutes later I stood on a little height in what had once been Fairmount Park, gazing down on the starkest desolation that the Earth had witnest since Sodom and Gomorrah. Where once five million human beings had lived and loved and joyed and sorrowed, a vast body of sluggish, oily water stretched before the eye. The entire southern part of the city had either sunk or vanished into the air, and the Schuykill and Delaware Rivers, rushing together, had converted the site into an inland sea.

Up towards Germantown and Ogontz, where the land was hilly, the water had not entirely covered the ground and a few heights projected above the surface, barren of any habitation or other sign of life, and showing by their tortured appearance the agony of destruction thru which they had past.

(*Continued on page* 803)

IN THE APRIL "E. E"

The April issue of the ELECTRICAL EXPERIMENTER *will be replete with numerous timely and valuable articles on Electricity, Radio and Chemistry of interest to all readers, both young and old. Don't miss it. It will provide many hours' instructive reading. All the latest advances in Science will be there—as well as fresh news and pictures from the war front. Among the April features scheduled there appear the following:*

"At War with the Invisible"—conclusion of this gripping story of war and science, by R. and J. Winthrop.

"The Phenomena of Electrical Conduction in Gases.—What is Ionization?"—by Rogers D. Rusk, M. A.

"Research and Its Importance to Human Progress."—by Dr. W. R. Whitney of the General Electric Co.'s, Research Laboratory. A special article which every American should read.

"Electro-Static Experiments"—Part II—by Frederick Von Lichtenow.

"A new Electro-magnetic Ship's log."

"A marvelous Electrical Tobacco Leaf Sorter" by H. Hartman, C. E.

"How Electricity Changes Modern Stage Scenery Instantaneously"—by George Holmes.

"How Science Takes X-ray Movies of living bodies by the aid of Electricity."

"The Chemistry of Selenium—What Happens in a Selenium Cell"—by Albert W. Wilsdon.

"Experimental Physics"—Lesson 12, by John J. Furia, A. B., M. A.

"Wavemeters—Their Uses and Construction," Part II—by M. W. Sterns.

"The New Electrical Laboratory and Prize Story Contest."

Experimental Physics

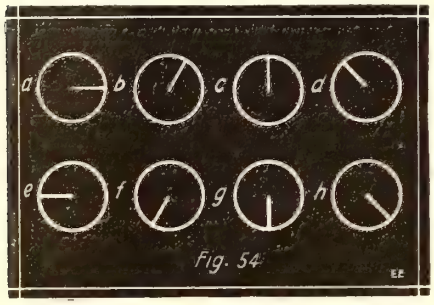
By

JOHN J. FURIA, A. B., M. A. (Columbia University)

LESSON 11

Photography (Concluded)

IN lesson 10, the important elements entering into photography from the standpoint of Physics were discust in detail, together with the elements of color theory. Our chief consideration was the *obtaining of the image,* either reduced

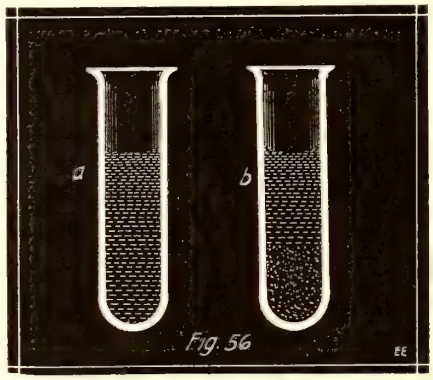


Series of Simple Pictures, Which, When Presented to the Eye in Rapid Succession, Give the Effect of a "Moving Picture."

or enlarged as required. In this Lesson, in order to conclude the subject, most of the space will be devoted to the *retaining of the image* even tho this phase of the subject falls chiefly within the realm of Chemistry, rather than Physics. (It should be noted here that because of the close relationship between Chemistry and Physics, one can rarely treat of any topic in one of these subjects without bringing in the other.)

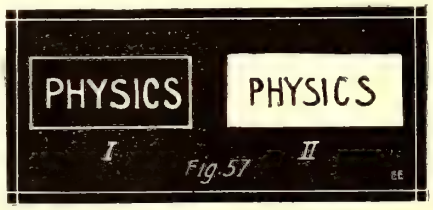
Experiment 61:—When an ignited piece of charcoal is rapidly rotated, we cannot distinguish it, but, however, the appearance of a circle of fire is produced. In a similar manner, rain, tho falling in drops, appears in the air to be a series of liquid threads. This phenomenon is due to the *persistence of vision.* The explanation is that the impression of an object on the retina of the eye remains for some time after the object has been removed or displaced, so that when the speed of the motion is sufficiently great, the object is seen in its new position while its image in the old position is still imprest on the retina. It is this principle of the persistence of vision that makes motion pictures possible. Cut eight squares of heavy manila paper two inches on the side and find the exact center by faintly drawing the diagonals of the square. With these points as centers, draw circles with a radius of one-half inch. On the first, draw heavily its radius in position indicated in figure 54 (a), on the second as in (b), on the third as in (c), etc., for all eight discs. If now they are placed one on top of the other and fastened at the left in book form by paper fasteners, on running the leaves quickly with the fingers, (because of the persistence of vision) a *moving picture* of the radius is produced. The moving picture produced on the screen by production thru the complicated machine in the theatre operator's booth is simply enlarged views of the objects in successive series of slightly different positions.

In the ordinary black and white photography most of the operations must be performed in a safe light, red in color (reason to be given later). The following little lamp can be constructed at a very low cost and will give satisfaction in even the most delicate work. A box 6″ by 6″ by 4″ should be made of ¼″ wood and the ends joined and glued so as to be light-tight. A grooved frame is made for the front, three parts of which are rigidly fastened together and the fourth tight fitting but not fastened. A piece of window glass can be cut to fit and



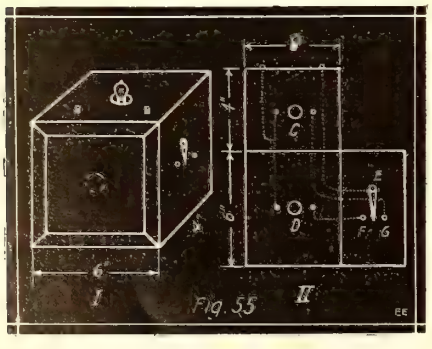
Showing the Effect of Light on Silver Bromid (b) After Adding Developer. Solution (a) Not Exposed, Hence Not Changed by Developer.

stained, or else a piece of ruby glass can be purchased for a few cents. The fourth part of the frame is not rigidly fastened



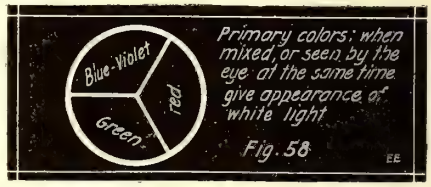
This Illustrates the Photographic "Negative" and "Positive." Note That Either Is Negative and the Other Positive.

for convenience in getting at the inside of the box when necessary. In the center of the back (inside) a miniature socket and three volt lamp are attached and a similar socket and lamp on the top (outside). A pair of binding posts are then attached on the top and a two-point switch (consisting of three thumb tacks and a piece of metal) is attached on one side. Connections are made as in figure 55-II (A and B are the binding posts; C and D, the lamps and E, F, G, the three point switch). To make a real good job of it the inside of the lamp can be enameled white and the outside stained and varnished. This little lamp can now be used both for "dark room" and other purposes. Two dry cells are required to run it. Turning switch to F gives red light and turning to G gives white light.



Simple Home-Made Duplex Lamp, Handy for Dark Room and Other Purposes.

Experiment 62:—The retaining of the image after it is formed falls entirely in the field of Chemistry and is based on the principle that chemical action is often caused by light. For example, the fading of dyes is caused by the chemical action induced by light. The formation of starch



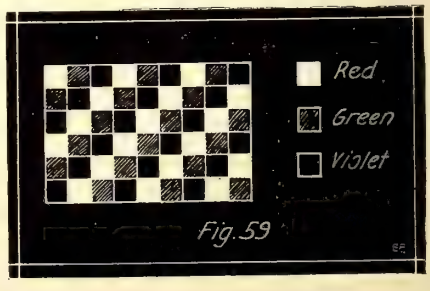
When the Colors Indicated Are Mixed, by Rapid Rotation, the Effect of "White Light" Is Produced.

from the elements in water and from carbon dioxid which is breathed out by human beings, occurs in the leaves of plants only under the influence of sunlight, so we see that the most important of all chemical actions (since life depends upon it) is caused by light. If equal volumes of ferric chlorid and oxalic acid* are mixed in the safe red light of the "dark room" and then an equal volume of potassium ferricyanid added, the color changes but slightly. If, however, this same process is carried out in daylight the result is a pronounced blue color. The ferric chlorid and oxalic acid when mixed in the dark or safe red light do not react, but when mixed in daylight do react and form another compound-ferrous chlorid; whereas ferric chlorid on being mixed with potassium ferricyanid does not react, ferrous chlorid does, and the result is the compound called "Turnbull's blue." This illustrates the process of *blueprinting.* The blue-print paper is coated with a compound similar to those mentioned above (according to the manufacturer) and when light strikes it a chemical change results. On washing with water where light struck the paper it changes to Turnbull's blue, and the unchanged material is washed away.

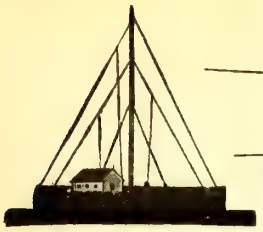
Experiment 63:—(To be performed in dark room.) Take equal amounts of silver bromid solution in two test tubes, (see Fig. 56). Make sure that none but the safe "red light" strikes the first test tube (a) and expose test tube (b) to white light.

* Solutions of these chemicals are to be used.

(*Continued on page* 799)



This Highly Magnified View of Plate Used for Color Photography Shows Probable Arrangement of the Colored Starch Grains.



RADIO DEPARTMENT



Notice to All Radio Readers

As most of our radio readers are undoubtedly aware, the U. S. Government has decided that all Amateur Wireless Stations, whether licensed or unlicensed, or equipt for receiving or transmitting, shall be closed.

This is a very important consideration, especially to those who are readers of the ELECTRICAL EXPERIMENTER, *for the reason that we desire to continue to publish valuable articles on the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have publisht in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools thruout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment. Remember that you must not connect up radio apparatus to any form of antenna.—The Editors.*

An Exceptional Amateur Radio Station

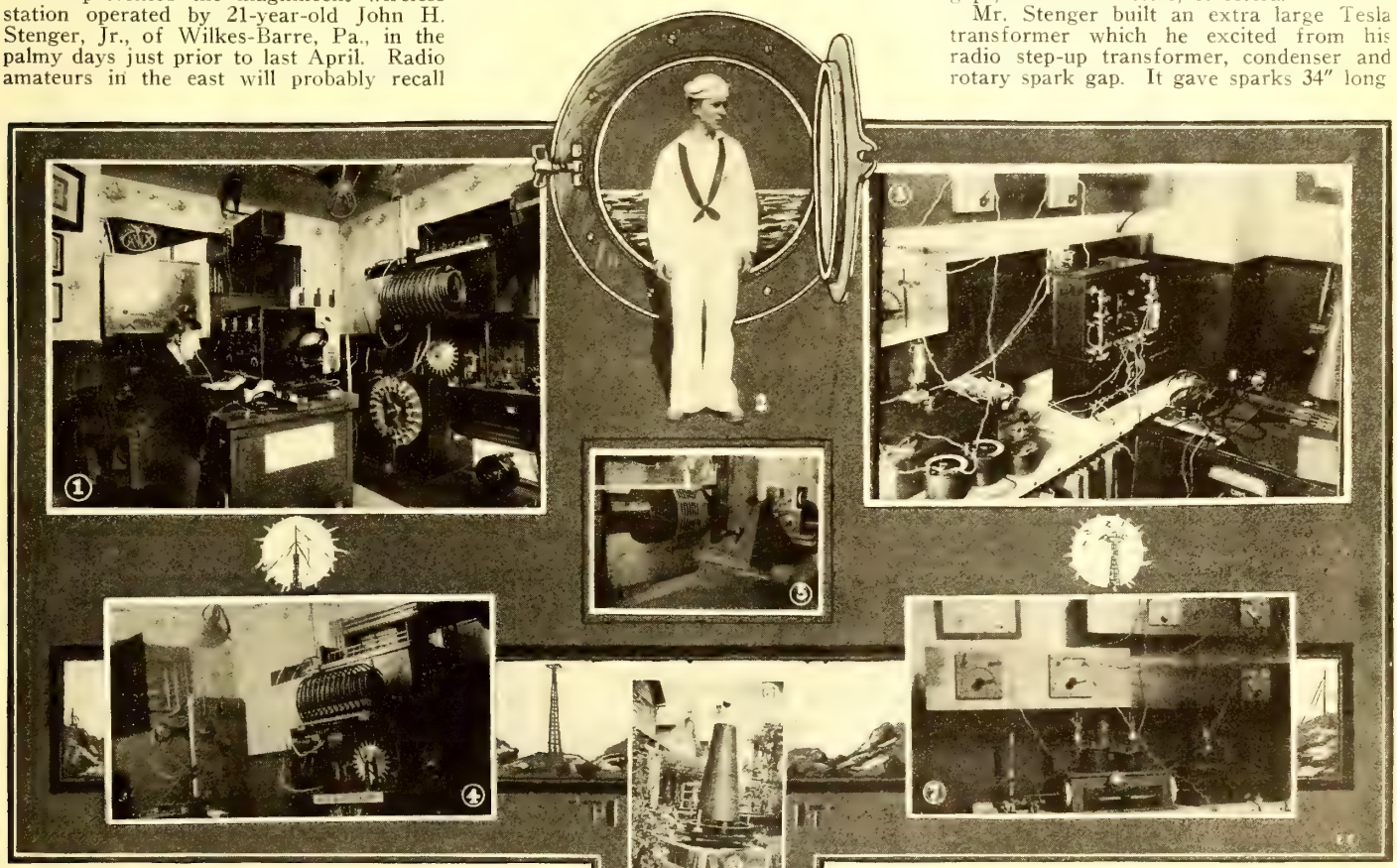
WAR is War—we all know that. But look at the accompanying set of photos showing some of the glories of amateur radio days before the war. This represented the magnificent wireless station operated by 21-year-old John H. Stenger, Jr., of Wilkes-Barre, Pa., in the palmy days just prior to last April. Radio amateurs in the east will probably recall the station who used to answer to 8.Z.S. The station was dismantled April 12, 1917, in obedience to the President's proclamation. Its operator, John H. Stenger, Jr., enlisted in the U. S. Navy May 1, 1917, as landsman, electrician-radio. He is now at the U. S. Submarine Base, New London, Conn., as Electrician-Radio, U. S. N. His photo in uniform is shown herewith.

Youthful Mr. Stenger has done the "big thing"—enlisted where his services can be of the highest value to his country. We present the accompanying photographs thru the courtesy of his father—a co-partner in the enjoyments formerly afforded by this excellently equipt radio laboratory. There were many such stations thruout the country that ambitious and ingenious American boys had perfected and built. Here is where the "ideas" were evolved—and now the country benefits.

Look at the details of this particularly high grade experimental wireless station here illustrated. It was fitted out in true professional style. The transmitting plant was a beautiful and efficient piece of work, including as it did a 1½ K.W. transformer, oil condenser, interchangeable rotary spark gaps, radiation meters, et cetera.

Mr. Stenger built an extra large Tesla transformer which he excited from his radio step-up transformer, condenser and rotary spark gap. It gave sparks 34" long H. F. X-Ray equipment was also on hand

The receiving equipment comprised a 2 step tubular Audion amplifier, experimental apparatus, etc. The antenna was a large affair and very well built. It was supported by a 40 ft. chestnut pole, surmounted by a 60 ft. steel tube, giving 100 ft. elevation. The aerial contained 10 wires, spaced 2 ft. apart, and measured 91 ft. long, spreader to spreader.



These Photographs Show Vividly the Home-made Radio Stations Existing Before War Was Declared. It Was Owned and Operated by 21-Year-old John H. Stenger, Jr., of Wilkes-Barre, Pa., Who Is Seen Above in His Uniform of "Electrician-Radio," U.S.N.

WIRELESS STATION IN FRENCH TRENCH.

The present illustration shows a radio station and the operator standing outside the dugout in a French, second line trench.

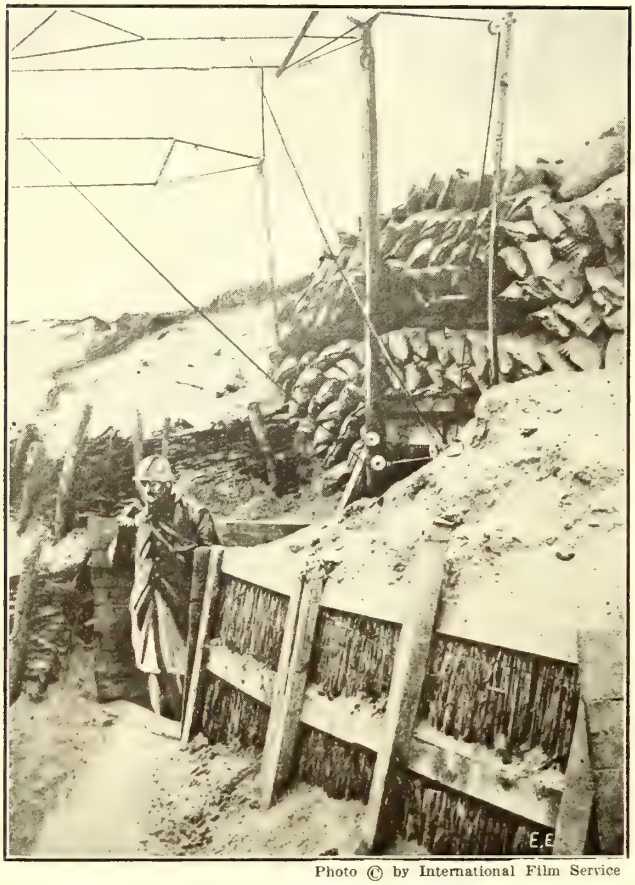


Photo © by International Film Service

In a Second Line French Trench We Find This Interesting, Battle-Front Radio Station. The Aerial is a Low Affair, so as Not to Be Easily Seen by the Enemy. The Apparatus Is Placed in the Dug-out at the Right.

These men are almost continually under bombardment the enemy making every effort to destroy the stations and the aerials. The aerials extend but a short distance above the top of the trenches of course, as becomes clear from the photo, as otherwise they would soon be destroyed by shell or machine gun fire from the enemy. The radio apparatus is located in the dug-out shown; note the heavily reinforced roof of sand bags to withstand shell fire. Some of these dug-outs form entrances only to an elaborate underground operating room or gallery. This gives better protection and less interference due to noises from shell and rifle fire.

DECEMBER MEETING OF THE I. R. E.

A very interesting paper was presented at the December meeting of the Institute of Radio Engineers at the Engineering Societies Building, New York, on December 5th.

Many notable radio men were on hand and the attendance was large, mostly due to the fact that the paper had a good advance notice and the interesting topic of "Radio-telephony on the Union Pacific Railroad" was discust. Dr. Frederick H. Millener, the author, described with many amusing incidents the work of almost ten years spent in experimenting and installing wireless telegraph and telephone sets on moving trains and in main stations.

The first researches were made on a specially constructed flat car, about ten feet in length, and weighing a couple of tons, fitted with storage cells and other apparatus. On each of the cars were set two short poles and a crude four wire aerial was strung between them. An illustrated slide was here shown and the crowd of curiosity seekers about the radio-car almost swamped the small car and its operators. This car was kept in the yards and experiments were made from the laboratory located in a small shop nearby. It was possible to sound various kinds of warnings on the car and to start, stop and reverse its motion by Radio. An arrangement was also worked out so that a tower man could send a signal and an automatic arm or light would operate and warn the engineer in the cab. But this nearly always failed to work at a critical moment and not the some few thousand times in succession that is required of a device which is to be practically adopted.

At this juncture in the game certain patent suits started, claiming infringements, and therefore the work was abandoned for a time, also certain needed apportionments didn't quite materialize in the budget.

After a time work was again resumed and better quarters were fitted up and a number of stations erected along the main line of railroad; these maintained direct connection constantly. Work was also done in Radio-telephony and a number of arcs of different types were experimented with. Also some were tried with gases contained in the surrounding chamber; a disastrous attempt at using illuminating gas put the gas idea out of the running.

The Radio-phone worked fairly well between the establisht land stations but some difficulty was experienced with the set installed on the train. The voice had a peculiar manner of dying away suddenly and then after a time coming back again.

It was also tried in conjunction with the then existing telegraph lines, using the same as aerials, but it did not answer very satisfactory and this scheme was dropt.

Later a regular research laboratory was establisht on wheels, being in the same class as the safety and other exhibition cars. A pullman dining car was made over and a large aeriel set a few feet above the roof. Also at one end a collapsible mast capable of extending about 80 feet was fastened for experiments on sidings. A large generator and a gasoline engine were installed to furnish power. One end was partitioned off for sleeping quarters. The rest of the car was devoted to the experimental laboratory and judging by the lantern slide shown of it, it was some class! With carpet on the floor, rest chairs and what not—well it certainly looked more like a grand salon!

Nevertheless much important work was accomplisht, and exhaustive tests were made and charts calibrated of results. The ten years of experimenting fell thru when war was declared and the laboratory hung out its shingle, "closed for the season!" The paper was a change from some of the technical papers that have been read and Dr. Millener's personality did much to get the "high-brows" in the audience in good spirits and all of those present appreciated his coming East to speak before the Institute on so interesting a topic.

TEACHING U. S. AVIATORS RADIO-TELEGRAPHY.

"Learn to do by doing" is the motto of Uncle Sam's new military aviation service. And let no one tell you that action is not suited to the instruction. One of the first things new recruits have to do is to learn wireless telegraphy. Mark the application of their motto: They learn the art by talking across tables with one another by wireless. Here is a class in action. An airman's first step in learning the science of radio, which he will shortly be called upon to use over the German trenches in France, is to master the International Morse Code. The men here shown are cadets at one of the "Ground Schools" practising the sending of dots and dashes, which are immediately reproduced on the tape before them. This permits them to lengthen or shorten their motions until they are wholly accurate. The teaching of Radio to the thousands of new aviators now being schooled by Uncle Sam is a man's-size job. Radio instructor officers have been recruited from civilian walks of life for this purpose, in many cases.

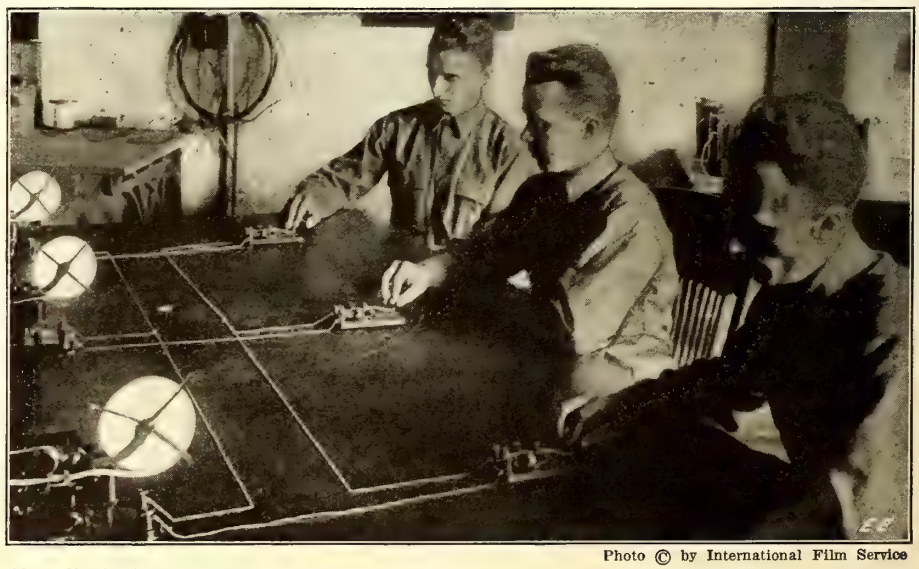


Photo © by International Film Service

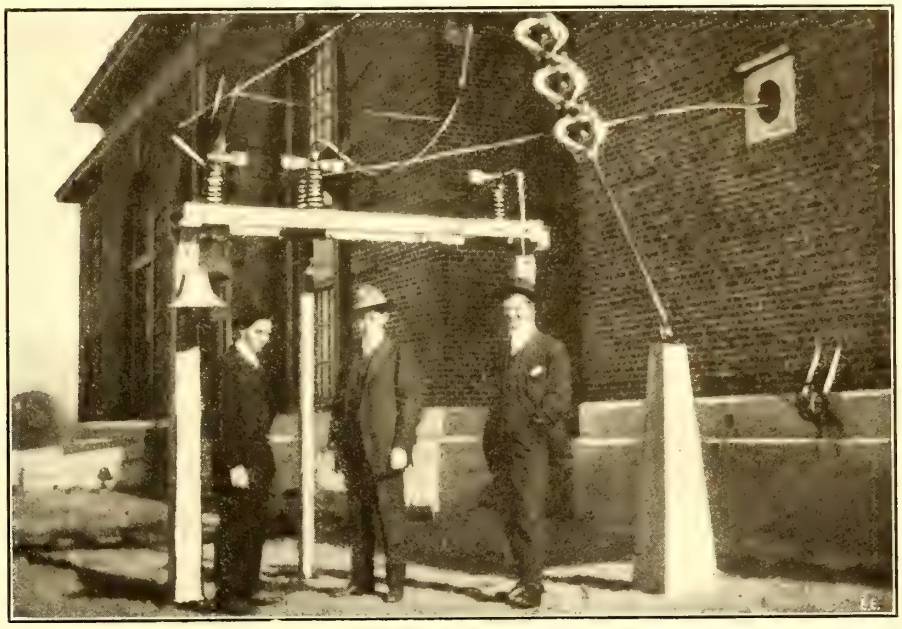
How Uncle Sam's Aerial Fighters Learn Radio. They Practise the Dots and Dashes at First, the Signals Being Reproduced Before Them on the Tape Registers. This Allows Them to Check Up Their "Sending Fist."

Visiting Arlington via the Talo Club

By W. J. HOWELL

IT all happened along about the time that "Arlington" was first put into operating condition, that the members of the Talo Club got the idea that they wanted to visit the place and see for themselves just what really was down there that made so much noise in the 'phones at ten P. M. every night. To think was to act, and it was found that one of the Eastern trunk lines was running excursion trains down to Washington and back to New York, thereby giving about ten hours in the Capitol to see the sights while the cost would be in the "Amateur" limits of money, which in this case was three cold dollars.

There were four of us who went, and a slight mention of each one will not be amiss. "Woody" was the big guy who had the reputation for wearing sand-paper collars, in other words, a roughneck, while "Mac" was an expert brass polisher at one of our leading hotels. Then there was "Dickey," the *Secretary* of the outfit, and myself, who unfortunately had to hold down the job of *President,* because none of the bunch wanted the honor and they had to have some one to blame if things went wrong.



". . . . . Going Outside to Watch the Antenna 'Spark,' Which it Didn't, We Found the Famous Aerial Switch, Mounted on Two Short Poles With a Ship's Bell Attached. Guess They Ring the Bell When Signals Come Down the Lead-in." Author Is Central Figure in Photo.

Well, it was decided to beat it to Washington and that we meet at the station and take the mid-night train, arriving there about six A.M., Sunday morning. Of course, we all brought something to eat, but "Mac" was the winner of the first prize, for he came with sandwiches made of slices an inch thick, and butter enough to feed one at the present "Hooverized" rate for an indefinite period. The ham was in the same class, and upon our requests he mentioned that the food supply was gotten by talking to the cook and appropriating a little at a time. What he talked about we couldn't find out, and it must have been exceedingly interesting, but at any rate, we helped "Mac" to eat what he had and saved ours. I brought some steamed chestnuts, but the jokes that were pulled off were enough without having to eat them besides.

'Long about this time the train started, but not before a meeting had been called to order and more work done then in a short time than we ever did formerly, but the idea that we were starting broke up this business stunt and we tried to get as little sleep as possible while passing thru Trenton, West Philadelphia, Wilmington, Baltimore and other small towns along the right of way. About five A.M. "Dickey" and I took a little trip thru the train, and as we were in the second car, and the outfit consisted of ten coaches, we had a good chance to see the human animal at sleep, for believe me, the shapes that people can get into when sleeping in day coaches makes one wonder if their hair hurts when they bend it!

We ended up at last on the back platform and watched the sun break thru the southern "ether" and it was needed in its thermal form because it was rather cold down there in November. Daylight at last came in all its glory and made me think that the sun-dodgers of our town miss something when they sit up until all hours listening to radio signals and then turn in just as it gets light. Washington very shortly was reached and we piled off.

After washing off the "real-estate" of five states and one district, we started out and kept our eyes open for a place to fill up our insides, and believe me, we felt in the need of something after walking, for Washington apparently got a divorce from itself, because one has to walk a long time to even cross the street. During this time we had about twenty fellows with all kinds of automobiles ask us to allow them to show us Washington for the mere sum of a dollar a piece, but there being four of us and Audions about the same price, we decided not to indulge. At last after much hunting we discovered Bryant's Lunch Room about four blocks from the Capitol building and stopped there to eat, but we often look back and wonder if Bryant was in the food business at the time. Breakfast being finished we got under way and looked over the Government buildings there-about, but the aerial on the Bureau of Standards attracted first attention while off in the distance could be seen the Washington Monument and the Towers of Arlington.

Passing on down the avenue we came to 14½ street, and while we found the street all right we couldn't locate the *half,* so we curbed our interest on that pavement and wandered on looking for a car that "Mac" said would take us to Arlington.

Well, we walked and walked some more and still no car, but our trip took us past the Monument which was not open for business, altho it was an early riser and was up when we got there. Looking at the top gave us a permanent bend in the back of the neck and was good training, for we sure needed aid in finding the top of the Radio Towers later on. Walking on from there about a mile, led us to where a car was waiting to make the trip to Arlington, and we piled on.

Passing over the Potomac River and into Virginia, was a short trip, but we nearly killed "Mac" because the car went right past the Monument, and while there we had asked "Mac" if it was the one we were looking for and, of course, he said no, thereby making us use some more leg power in order to find it. Pretty soon the conductor yells out *"Radio,"* and we found ourselves jumping off at a little two-by-four wooden shack with a sign that stated that this particular spot was what is known in the amateur world as "Radio, Va."

Crossing the track a path led us down into a small depression, thru which past a stream of water which kept the *grounding system* moist, but at the time of our visit we found that when crossing the little foot bridge the stream tried to moisten the footal supports of the party, besides keeping the buried copper wires in working condition. At the top of the slight rise was the radio station, and altho we had seen it before crossing the track and had taken pictures of it, the bunch took some more, for it certainly was worth all the trouble of getting to Washington just to look at those towers. Pictures that have been publisht do not show the spectator the real thing and make him feel that his own little aerial at home is a mere bird cage compared to the one before his eyes.

Climbing upward we came to the main building and walked boldly in all the while expecting some one to throw us bodily out, but nothing happened, so we gathered courage and started to inspect the plant. Fortunately "Mac" had been down before, and while there, took some pictures and became pretty well acquainted with one of the operators. In the mean time, he had had the pictures enlarged and brought them along, all of which made things somewhat easier for us because, as I look back, I don't think that we would have been allowed to wander over the place just as we did, without being told to beat it. That is, unless we could have managed to scrape up acquaintance by trying a little of that "mental telepathy" stuff. It works—sometimes.

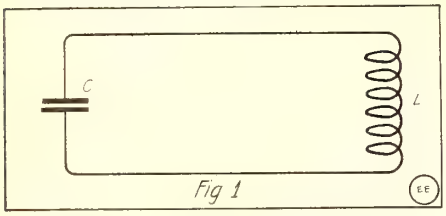
The main transmitting room at that time contained the large 100 K.W. set and a small arc outfit, besides a regular 5 K.W. set for ship work only. The "receiving room" was in the next building, and was built like an icebox with walls two foot thick. The two buildings stood about three feet apart so that no sound of the transmitting set would reach the operator in the receptor room. Two men are always on duty, one in the transmitting room and one in the "listening box," and when the fellow hears a station calling him, he signals to the fellow outside, and he in turn starts up the 5 K.W. set and stops it when signaled. A relay is used so that no high voltage wires pass

(*Continued on page* 800)

The Design and Use of the Wave-Meter

Part I—By MORTON W. STERNS

THE Wave-meter is an instrument used to measure and detect the length, frequency, and amplitude of emitted oscillations. Essentially it consists of an inductance connected in series with a condenser, either or both of which may be variable. For standard



The Simplest Form of Oscillating Circuit, Comprising a Capacity "C" and an Inductance "L," Connected in Series. The Basic Circuit of the Wave-Meter.

wave-meters of great precision the oscillation constant $\sqrt{LC}$ is generally kept constant in order that the decrement of the instrument shall remain constant over its entire range. This is done by making both the inductance and capacity variable, i.e., by fastening a variometer to the condenser shaft. The type of wave-meter generally in use at present is the variable capacity type, having numerous coils for a great range. Formerly, the wave-meter having a fixt capacity and variable inductance was much used.

It is generally conceded that the Wave-meter is the most valuable instrument in a Radio Laboratory as it can be used for:—

1.—*Measurement of wave-length. (Transmitted or received.)*
2.—*Measurement of decrement.*
3.—*Measurement of inductance.*
4.—*Measurement of capacity.*
5.—*Making resonance curves.*
6.—*Making various antenna measurements.*
7.—*An exciter emitting waves of predetermined length.*
8.—*Measurement of mutual inductance.*
9.—*Measurement of the coefficient of coupling.*
10.—*Measurement of the distributed capacity and natural period of coils.*

These various applications of the wave-meter will be taken up in due course.

Having imprest upon the reader the importance of the wave-meter, its great adaptibility and various uses, we will now undertake a general review of a few elementary principles in order to make the paper intelligible to the great number of young men just taking up the subject of Radio at the various schools of the Army and Navy, as well as radio students in general.

Realizing the breadth of the field to be covered in the space available and the necessity of keeping the paper very elementary, it is to be expected that certain topics may be neglected.

Figure 1 represents a simple circuit consisting of an inductance and a capacity connected in series. If the condenser is charged to a given potential and then allowed to discharge thru the inductance, oscillations will be produced whose frequency will depend upon the value of the inductance L, and the capacity C.

Let us now consider this simple proposition with respect to a Radio Transmitter as shown in Fig. 2.

Suppose the condenser C is connected to some source of high voltage alternating current, such as the secondary of a step-up transformer. When the potential of the condenser rises to a value sufficient to break down the gap G, the condenser will discharge across the gap and set up oscillations in circuit 1, of a frequency depending on the values of L and C.

If now another circuit L'C', consisting of an antenna having a capacity C' with respect to the earth, and an inductance of a value L', is brought near circuit 1 (i. e., coupled to it) energy will be transferred from the first circuit to the second circuit by pure transformer action. If the values of L'C' are adjusted so as to give circuit 2 the *same frequency* as circuit 1, then (ignoring gap action and coupling) the greatest amount of energy is transferred from circuit 1 to circuit 2, and an ammeter placed in the ground lead of circuit 2 will register the maximum current or circuit 2 is said to be in *resonance* with circuit 1.

The last paragraph demonstrates clearly the principle of resonance on which all wave-meters and decremeters work.

We will now proceed to show how the values of inductance and capacity affect the frequency of the oscillations in a circuit, and how, knowing any two of the three factors (wave-length, inductance, or capacity) the other can be found.

The wave-length (λ) multiplied by the number of waves per second (n) must equal the velocity of propagation (V).

$$\text{or } V = n\lambda \quad (1)$$

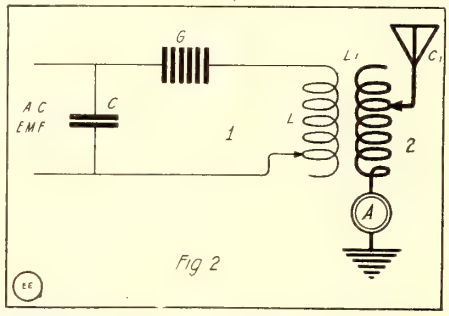


Diagram Showing How Maximum Current is Developed in An Inductive Circuit—C 1, 2, A—When Such a Circuit is Tuned to "Resonance" With an Exciting Circuit—C, G. L.

Where V is the velocity of propagation of radio waves (the speed of light) 300,000,000 meters per second.

$$n = \frac{1}{2\pi\sqrt{LC}} \quad (2)$$

expressing L in henrys and C in farads.

Equation (2) can be found in any text book on Alternating Current.

Substituting in Equation (2) the constants necessary to change L to centimeters and C to micro-farads we have:

$$N = \frac{5.033 \times 10^6}{\sqrt{L_{cm}\ C_{mf}}}$$

Putting the value of n back in equation (1) we have:

$$300{,}000{,}000 = \frac{5.033 \times 10^6}{\sqrt{L_{cm}\ C_{mf}}}\ \lambda$$

$$\text{or } \lambda \text{ meters} = 59.6\ \sqrt{L_{cm}\ C_{mf}} \quad \ldots\ldots (3)$$

Equation (3) is known as the fundamental equation of radio and much use will be made of it in further papers.

Oscillations taking place in a circuit (or emitted waves) can be of two kinds, damped or undamped.

Fig. 3 represents a damped wave discharge of the limit allowed by law (logarithmic decrement 0.2) which require 24 complete oscillations before the amplitude of the last oscillation is reduced to one per cent of the first. It is discharges of this type that are in use the most at present. They are produced by quenched and rotary gaps, etc. Waves of this type are received on ordinary receivers using crystal, plain Audion receptors, etc.

Undamped waves are represented by Fig. 4. Here we see that there is no damping or decay between successive alternations but that they remain of a constant amplitude.

Waves of this type are coming more and more into use, especially for long distance communication. As can be seen they represent a continuous flow of energy and are produced by the arc, Oscillion, radio frequency generator and other means. In receiving these waves a special type of receiver is required, embodying either a tikker to break up the waves, or a separately variable source of oscillations (such as the oscillating Audion) to "heterodyne" or produce beats with the incoming waves.

Referring back to Figure 3, we shall consider what the *Logarithmic Decrement* is and how it is measured. Each wave train is composed of oscillations which are supposed to die away so that the ratio of any oscillation to the one preceding it is constant, as the ratio of A' to A.

This constant ratio is known as the damping of the circuit and the Naperian logarithm of one oscillation to the one preceding it is called the *Logarithmic Decrement* of the circuit.

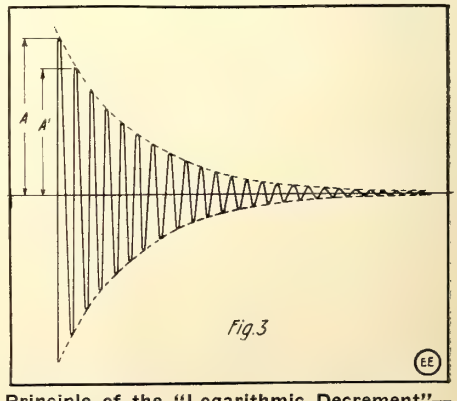
Exprest mathematically $\delta = \log_e \frac{A}{A_1}$

Where δ = Logarithmic Decrement
and e = base of Naperian Logarithms (2.71828).

The logarithmic decrement determines to a great extent the broadness of tuning and the amount of interference produced. Hence the U. S. Government's limit that no transmitter shall produce waves having a greater logarithmic decrement than .2.

An instrument whose purpose is to measure the logarithmic decrement of a circuit is known as a decremeter, which is nothing more than a wave-meter with an indicating instrument in circuit to indicate current ratios. More will be said about the decremeter and its uses in the following installments.

Suppose now we are to design a wave-meter having a range of from 200 to 3,000



Principle of the "Logarithmic Decrement"—Each Wave Train Decays In the Manner Shown, so That the Ratio of Any Oscillation to the One Preceding It is Constant, as the Ratio of A¹ to A.

meters, with 20% overlap between coils, and so designed as to give small distributed capacity, low internal decrement, etc.

The first thing to decide upon is the condenser; this is generally designed so as to give a variation of six times its minimum capacity. By this I mean that the capacity at 175° on the condenser should be six times the capacity at 10° on the condenser.

We use this value because, as shown by the curve in Fig. 5, the variation of more than six times the minimum capacity of the condenser does not vary the wave-length as rapidly as the addition of a new coil.

The condensers used in commercial wave-meters vary from .0015mf. to .008mf., but .003mf. is generally used.

The wave-meter is seldom calibrated below 10° or above 175° because the per cent capacity change per degree is so small that the tuning becomes too sharp for accurate work.

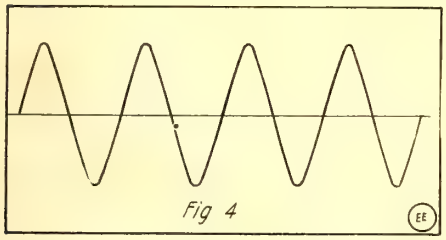
In designing our wave-meter let us assume a capacity of .0005mf. at 10° and .003 mf. at 175° and make our inductance coils conform to these limits.

We will now consider the coils which will be made of the pancake type, wound with *litzendraht* (insulated stranded cable, each wire being insulated) and *banked* by layers. These exploring coils will be connected to the meter by a flexible 3½ ft. leather covered cord.

The lower limit of the meter is 200 meters and this is at .0005mf.

$$\lambda = 59.6 \sqrt{LC} \quad \text{equation (3)}$$

Where L is the inductance in cm. and C



Illustrating the Principle of the "Undamped Wave" as Used in Radio-Telegraphy and Telephony. There is no Damping or Decay Between Successive Alternations.

is the capacity in microfarads to give a wave-length λ. $\lambda^2 = 3550\ LC.$

$$L = \frac{\lambda^2}{3550\ C}$$

$$L = \frac{40{,}000}{3550 \times .0005} = 22{,}500 \text{ cm.}$$

At the upper limit where C = .003mf. and L = 22,500 cm.

$$\lambda = 59.6 \sqrt{22500 \times .003} = 490$$

Now to allow an overlap of 20%, the minimum wave-length of coil No. 2 must equal 80% of the maximum of coil No. 1.

$\lambda = .80 \times 490 = 392$ meters at .0005mf. capacity. Therefore:

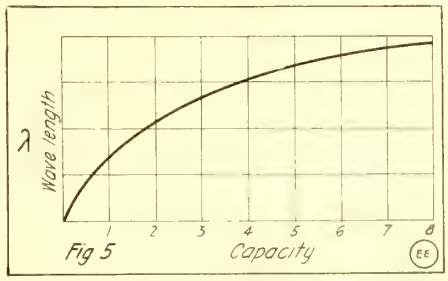
$$L = \frac{(392)^2}{3550 \times .0005} = 86{,}400 \text{ cm.}$$

$$\lambda \text{ max.} = 59.6 \sqrt{86{,}400 \times .003} = 960 \text{ meters.}$$

Following this method we find we need four coils which are tabulated below, showing the individual inductances and range of wave lengths.

Coil No.	Inductance in cms.	Wave Length Range
1	22,500	200—490 meters
2	86,400	392—960 "
3	338,000	774—1900 "
4	1,310,000	1520—3740 "

It is, of course, understood that the reason we have the high upper range is because the four coils are necessary to reach 3,000 meters and the upper range of the fourth coil is 3,740 meters. This is generally not objectionable, but in case it is, it simply necessitates the selection of a different capacity variable condenser.



Graph Illustrating the Reason For Using a Wave-Meter Condenser Which Gives a Variation of Six Times Its Minimum Capacity.

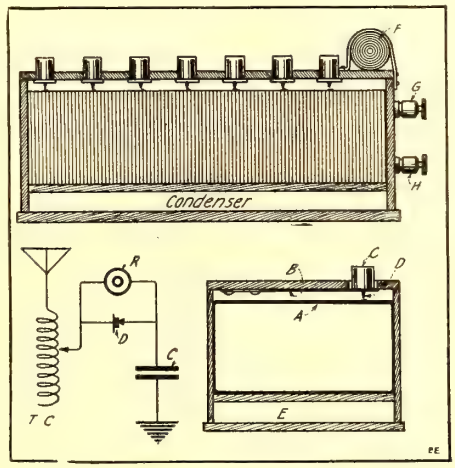
The next step will be to determine the size *litzendraht* to be used and this is largely a matter of experience and keeping the meter decrement low (3x16x38 litzendraht is much used). Next a standard mean diameter is selected so that the bobbins of all the coils are the same size; and using Perry's Formula the number of turns are easily calculated.

(To be continued)

"SECRET SERVICE" POCKET RADIO RECEPTOR.

This is a "real" pocket receiving set, one that actually receives while you are out on the street or any other place. The set consists of a special tuner, condenser, detector, 'phone and an "invisible" aerial. The tuner is 4 inches long, 2½ inches deep and 1½ inches wide. As shown in the illustration, A is the wire of the tuner, B is a strip of spring brass, C is a knob of brass soldered to the spring strip, D is a needle point (not steel) soldered to the spring strip, E is the condenser (fixt), F is a detector made of a blown-out cartridge fuse as described in the April, 1917, number of the ELECTRICAL EXPERIMENTER. All the spring strips B are connected to binding-post G by means of a wire. One end of the wire on the coil is connected to binding-post H. Selectivity is obtained on this tuner by pressing the buttons C.

The aerial is composed of a long flexible wire sewed in a zig-zag way in the back of a coat and insulated by empire cloth.



A de Luxe Pocket Radio Set For Secret Service and Like Work. Rapid Tuning is Accomplisht by Pushing on the Various Contact Buttons—One at a Time.

A ground is obtained by running a flexible wire thru the trousers to a brass heel plate.

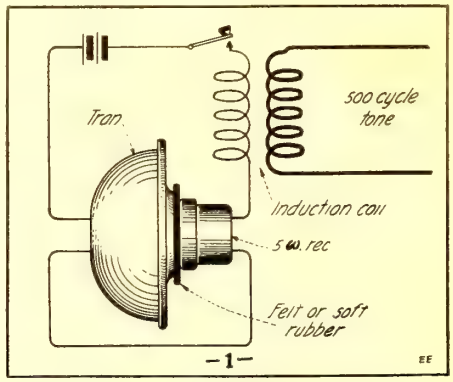
In operation the tuner is held in the coat pocket. By pressing the buttons of the tuner, messages are received in the dots and dashes corresponding to the radio-telegraphic code.

Contributed by HARRY E. FUCHS.

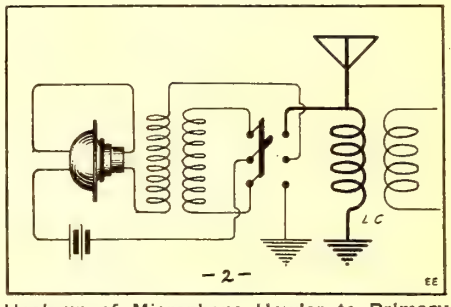
HY-TONE TESTER FOR MINERALS AND CODE PRACTISE.

Being a steady reader of your paper for nearly two years, I thought I would send you in a little stunt which I have been using and found very reliable and satisfactory. It is a high frequency tone device for testing sensitive spots on crystal detectors and wired up as shown in attached sketch. By building up the felt pad, any range from about 300 to 1,000 cycles per second can be obtained, and it produces a pure musical tone of constant amplitude and strength, with no scratching or frying noises whatever. There are no adjustments to make or anything to get out of order.

A five ohm telephone receiver is used as it takes less battery, operating on from two to three dry cells. A regular 75 ohm re-



Clever Form of "Microphone Howler" For Radio Tests or Code Practise Work. It Gives a Pure Note of From 300 to 1,000 Cycles, Depending Upon the Distance Between Microphone and Receiver.



Hook-up of Microphone Howler to Primary of Loose Coupler "LC," So That Tuning May Be Practised in Natural Manner.

ceiver can be used, but this will require more battery, from 6 to 8 cells. This also makes an excellent wireless practise set. I wired it into my set with a small three-pole knife switch as shown, but almost any hook-up will do. In connecting up the battery, however, it will only operate with the current in one direction, or the current must flow to build up the permanent magnetism of the receiver and not neutralize. Am sending you this idea for I know it works perfectly, with no trouble or bother whatever.

Contributed by CURTIS KISSELL.

RADIO CLUB OF AMERICA NEWS.

The Radio Club of America held a meeting at Columbia University on October 27, 1917. Two important papers were read, namely, "Thermo Couples in Electrical Measuring Instruments" and "Radio Frequency Instruments" by Dr. H. O. Taylor and Mr. Charles G. Kahant, respectively.

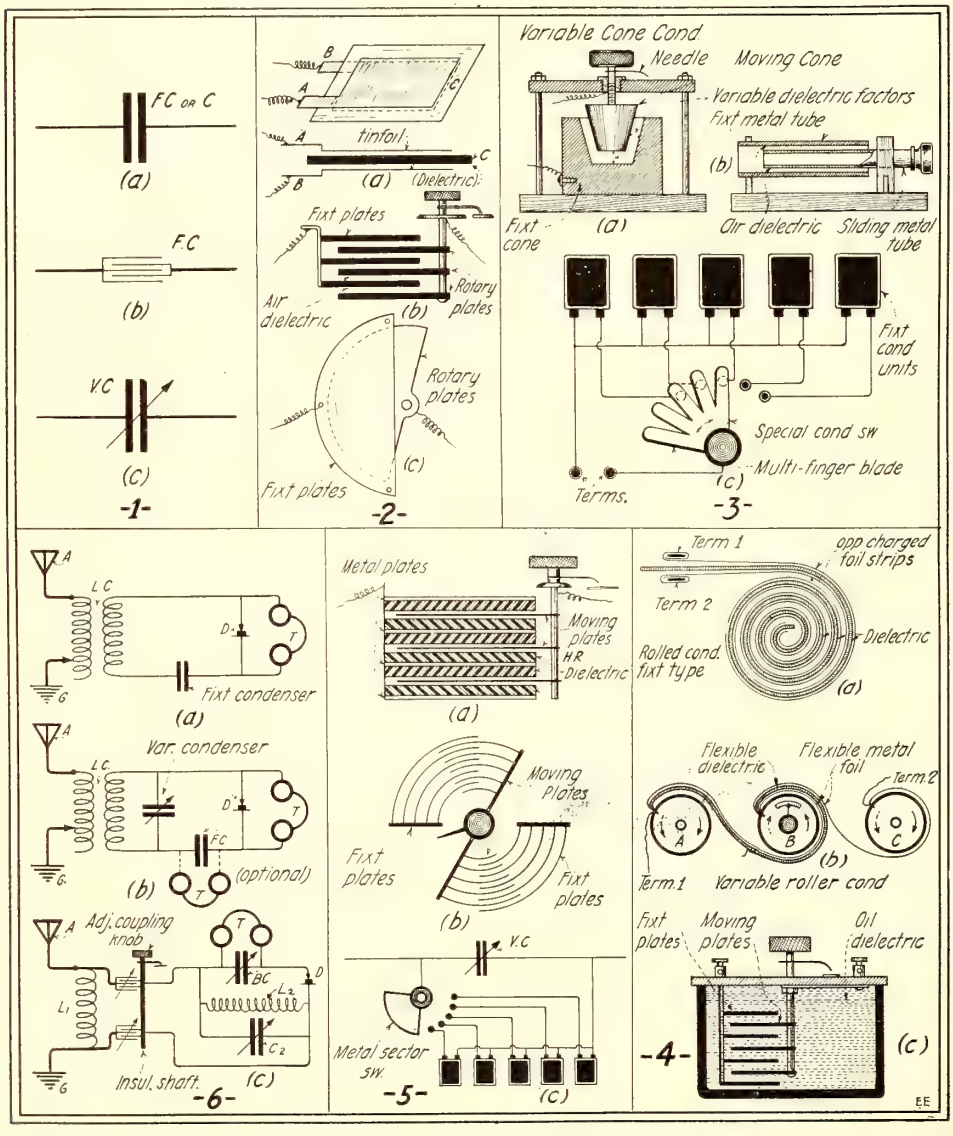
The How and Why of Radio Apparatus

By H. WINFIELD SECOR, Assoc. I. R. E.

No. 7—Radio Receiving Condensers.

From time to time we will describe one particular instrument used in either the radio transmitting or receiving set, explaining just how it works, and why. We have received so many requests from new readers asking for such explanations, that we have decided to publish this matter in serial form. In the course of several issues all of the principal transmitting and receiving apparatus will have been covered. The subject for the seventh paper is RADIO RECEIVING CONDENSERS.

PRACTICALLY all modern radio receiving sets employ some form of condenser or capacity, either in the form of a definite fixt capacity or else in the form of a variable or adjustable capacity. The aim of this installment of the *"How and Why of Radio Apparatus"* series is to describe in detail the principal types of condensers found in modern radio receiving apparatus, as well as their use and connection in these circuits.



The Principal Types of Radio Receiving Condensers Are Here Illustrated and Their Action and Use Described for the Benefit of the Student.

Referring to the diagrams herewith, Fig. 1 shows how fixt and variable condensers are represented in diagrams and hook-ups of radio receiving apparatus; Fig. 1-A showing a fixt condenser and B, a second way of representing a fixt condenser, while C shows how a variable or adjustable capacity is indicated, viz., by drawing an arrow thru the two plates diagonally. Fig. 2 illustrates the construction of simple fixt and variable condensers. Fig. 2-A illustrates the construction of the simplest form of fixt condenser, having a dielectric C, charged by means of two tin-foil or other conductive plates A and B. The metal charging leaves placed on alternate sides and in contact with the dielectric are always cut somewhat smaller than the insulating medium, to prevent leakage, and the possible chance of short-circuits. The small fixt condensers found in a great many radio receiving sets are made up of from ten to fifteen paraffined paper sheets, about two by three inches, interleaved with alternately charged tin-foil leaves. Every other tin-foil leaf is connected to a common terminal, as at "A," while the balance of the alternate metal leaves are connected to the opposite terminal "B."

Before going any further, it is well to note that the metal charging plates or leaves of any condenser merely serve to distribute the electric charge from either terminal to the insulating medium, called the *dielectric,* and this dielectric is the member that retains the charge, and *not* the metal electrodes. This being the case, and as becomes evident, the capacity of any condenser depends upon the coefficient of electrostatic induction of the dielectric. This factor is generally called the "specific inductivity" of the material used as the dielectric, and as a basis to work on, air is taken to have a specific inductivity of 1 at standard atmospheric pressure; the inductivity of any other substance is measured by the ratio of the capacity of a condenser, when its plates are separated by that substance, to the capacity of the same condenser when its plates are separated by the same thickness of dry air.

This specific inductivity factor is also known as the "K" value of the dielectric. Any electrical or radio text-book contains a table of the various insulating mediums used as dielectric in building condensers and the corresponding "K" values. A very complete table of these values and of particular service to radio men, appeared in paper No. 3 of this series (see Feb. 1917 issue) and also contains the necessary formulae for computing the capacity in micro-farads of any condenser.

Resuming, Figs. 2-B and C illustrate in a simple manner how a rotary, variable, air dielectric condenser is constructed. A central rotary knob and shaft have rigidly mounted thereon one set of semi-circular plates, which may be turned so as to interleave with a corresponding number of fixt or stationary semi-circular plates. The condenser is provided with a scale which is sometimes calibrated to read in m.f., direct, or else a calibration curve is supplied with the instrument. Low-priced condensers are not usually calibrated, but the capacity may be computed for any position of the rotary plates by means of the formulae in the third installment of this series, above referred to. One terminal leads to the fixt plates, while the second terminal leads to the rotary plates of this type of condenser, and in fact this applies to all other similar types of variable condensers. A variable condenser of the *moving cone* type which has been used considerably in laboratory work is illustrated at Fig. 3-A. This condenser involves the use of male and female conical members, arranged in the manner indicated, so that the inner cone can be raised or lowered by a precision screw adjustment, and the distance between its end and the bottom of the conical chamber of the fixt electrode, as well as the thickness of the air space surrounding the small cone can be varied, and likewise the capacity. Another simple form of variable condenser which has been used extensively in various types of receiving sets, both domestic and foreign, is shown at Fig. 3-B and utilizes one fixt and one sliding brass member, or other non-magnetic metal tubes. The sliding tubular member is sometimes provided with an indicating needle which reads over a scale secured to the base of the instrument. This condenser has a fixt thickness of dielectric, but the length of the active condenser insulation is variable to quite a fine degree.

Fig. 3-C shows what is commonly known as an "adjustable condenser." In this form of condenser the capacity is varied by means of a special switch provided with a multi-fingered blade, so that the capacity of each unit switched into circuit is retained as each successive unit is switched in.

(*Continued on page* 796)

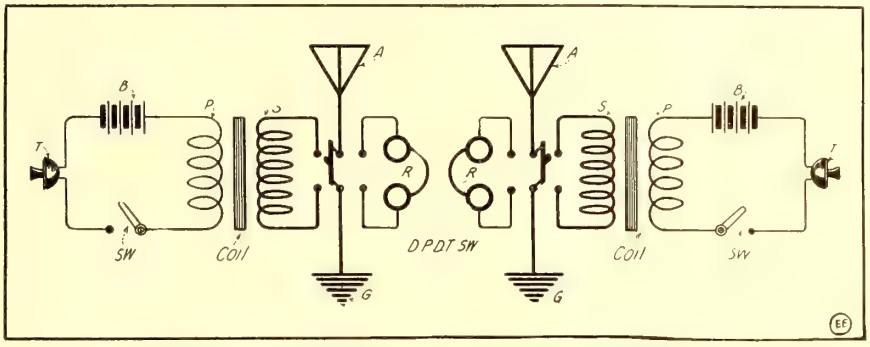
A SECRET RADIOPHONE.

By Seefred Bros.

The object of this article is to show how one can use a Radiophone and still not interfere with the radio-telegraph. The voice is very clear, due to the fact that there are not any other disturbances going on while talking. The voice has a ghostly sound. This experiment was carried on by us for several years, and has given very good results. It will usually only work in the daytime in cities, as the arclights on street corners interfere quite a bit at night.

Following is an outline of the talking and hearing instruments:

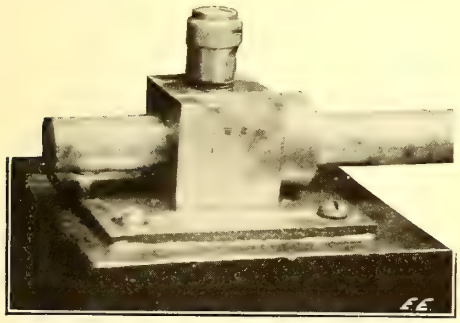
1. The larger the antenna, ground, coil, and source of current, the greater the distance.
2. The higher the resistance in the receivers the better it is.
3. Long distance transmitter (microphone) is preferred.
4. Dry batteries are all right, but would prefer a storage battery for larger coils.



In the Above Diagram of Radiophone Hook-Up A=Aerial, B=Battery, G=Ground, P=Primary and S=Secondary of Spark Coil, and R=Telephone Receivers.

GOOD BEARINGS FOR ROTARY GAPS.

When rotary gaps are to be mounted separately from the motor shaft the question of obtaining suitable bearings must be considered. I have devised a simple bearing which does not necessitate the making of a pattern and casting, which process is usually expensive.

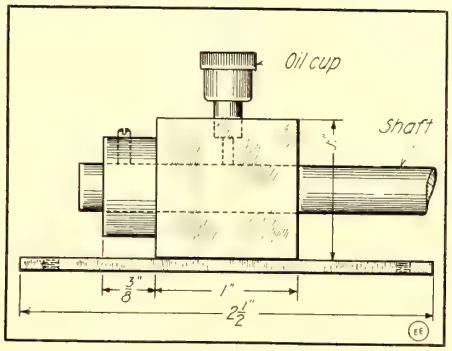


Photograph of Finished Bearing For Rotary Spark Gap.

Obtain full two inches of 1-inch square brass rod and saw off the piece into two equal parts. These rods must be exactly one inch square. Center them in a lathe chuck separately, and drill the hole desired. After taking from the chuck it is necessary to ream out the hole. Drill a hole at the top of each bearing block and fit a small oil cup into same. This cup should have a piece of felt fitted into it to keep the oil from running out too easily. Obtain two sheets of brass 2"x2½"x⅛" each, and drill a hole in the corner of each for screw fastenings.

The bearing is complete after the brass sheet is soldered onto the bearing block. Do not solder around the bearing block but apply the heat directly to the sheeting and apply the solder between the bearing block and the sheeting. If the lathe work is done accurately the bearings will match exactly.

A necessity for each bearing is a movable collar held against the block on the shaft. This collar can be made by turning out on the lathe from 1" round brass stock ⅜" wide. Into this is drilled a hole the size of the shaft. A small set screw is fitted into a threaded hole. In turning out the bearing be sure and drill the holes thru the sides of the rod which were manufactured square, otherwise the bearing will not be true, since it is impossible to file a brass surface absolutely accurate. The accompanying drawings show the general design of the bearings and collars.



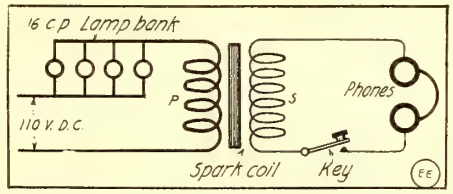
Working Drawing of Rotary Spark Gap Bearing, Fitted With Oil Cup.

Contributed by F. MAC MURPHY.

A GOOD SUBSTITUTE FOR A PRACTISE BUZZER.

The drawing shows the hook-up of the apparatus. The source of current is the 110 volt D. C. power mains. The "Transformer" (if it could be called such, consists of a 1" spark coil having its vibrator shunted with a piece of wire) connected in series with a bank of 16 C. P. 110 volt lamps, which are in parallel. The key is an ordinary telegraph key and the 'phones are the regular, high resistance 'phones used in radio work.

The volume of the sound can be varied in two ways. The more lights in parallel the louder the sound, or if it is impossible to diminish the number of lights and the core of the spark coil is accessible, its removal or partial removal will cause a smaller volume of sound in the phones. This method of substituting a power current for that of a buzzer has several advantages over other methods utilizing the light current as a source. First, it does not click when the key is deprest as most of the other methods do. Second, an Omnigraph or other form of automatic transmitter can be used with it without being rebuilt to suit the high power. This idea was original with me, and I hope it will benefit other amateur radio men as much as it has myself.



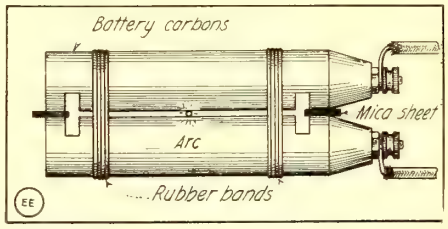
Unique Hook-Up For Learning the Code By Connecting Spark Coil to 110 Volt D. C. Circuit.

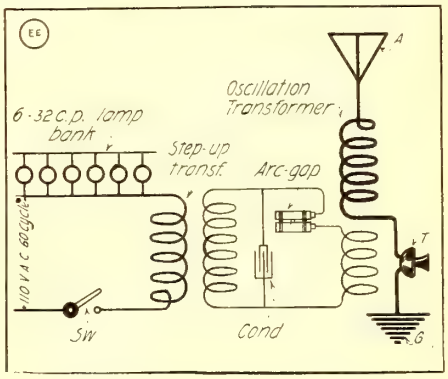
This device should not be used on A. C., but on D. C. It produces a note resembling "N A A" on the 100 K. W. spark set. The tone heard is due to the pulsatory nature of direct current as produced by a dynamo.

Contributed by PAUL G. WATSON.

AN IMPROVED RADIOPHONE ARC GAP.

Herewith is described an improved arc gap for use in radio-phone work. The carbons are of the ordinary hard variety that can be found in most any dry cells. The advantage of having grooves sawed in each end of the carbons is that it keeps the arc from running along the edge to the end and burning the mica sheets. The mica sheets can be obtained from old fuses. The rubber bands are placed around the carbons to hold them in place and still keep them insulated.





Hook-Up and Detail of Novel Carbon Arc Gap For Radiophone Experimenting.

The color of the arc should be of a blue-purple to give a smooth tone. A white glare is not good as it shows the carbons are burning. The carbons must be at least 1/32" apart to obtain the best results. In this way the voice will be clear and strong, while the arc will be very faint. We find that it is better to have the carbons placed side by side instead of end to end, as it keeps the arc running back and forth on the smooth round side of the carbons, and keeps them cool. Otherwise by having the arc at the ends of the carbons, it stays in one place and tends to heat up and burn the carbons.

We have experimented with this radiophone for three years and have succeeded in talking *thirty miles* distant.

Contributed by SEEFRED BROS.

Now is the time to study up thoroly on Radio and Electricity! You will find hundreds of valuable articles in back numbers of the "Electrical Experimenter."

THE CONSTRUCTOR

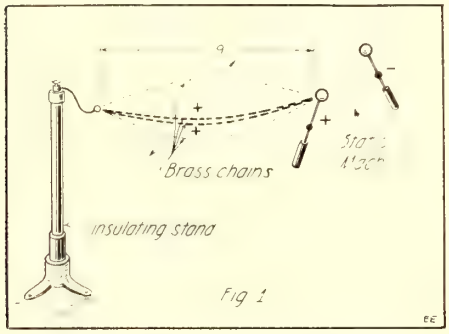


Electro-Static Experiments

By FREDERICK VON LICHTENOW

PART I

THE attractive and repulsive forces peculiar to *Static Electricity* enable the person experimenting in this field to perform "stunts" which he could not possibly produce with the aid of any other kind of electricity. How-

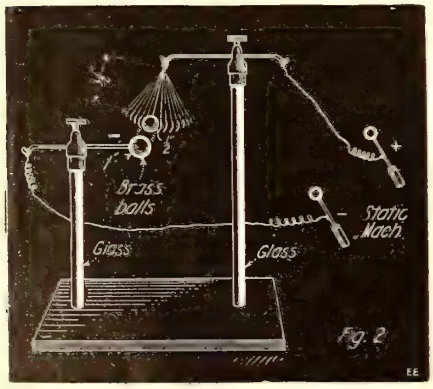


The Experiment of the "Opposing Chains," Which Shows in a Striking and Novel Manner the Repulsive Effect on "Like" Charged Bodies. The Two Chains Are Both Charged Positive.

ever insignificant these may appear to the uninitiated, for the true experimenter they carry a deep meaning back of them. Experimenting in Static Electricity is playing with the electricity of the earth in microform. This fact alone throws a vast amount of fascination into this odd and yet so *natural* branch of electrical science.

Static Electricity evidences itself in probably more ways and certainly requires less apparatus for its production and experimental conduction than any other form of experimental electricity. A rod of glass and a piece of silk or a sheet of hard rubber and a piece of fur, together with some bits of tissue paper, are sufficient apparatus for the practical study of its elementary principles.

A small static machine, however, such as the "Electro" *Wimshurst* type is required for the successful reproduction of the following experiments, which will help the novice in grasping the principles underlying them.



The Static "Ball Pendulum," a Simple and Pleasing Experiment. It Illustrates the Principle of Alternate Attraction and Neutralization.

Experiment No. 1—("Opposing" chains).

Here is a simple and yet quite pronounced way of showing the repulsive effect on *like* charged bodies. Two very light and equally long brass chains, such as are usually found around static instruments for connection purposes, are suspended side by side by their respective ends as shown in Fig. 1. They must hang well off the table and under just enough tension to form only a slight downward curve. The electrodes of the machine are then set beyond sparking distance when with a few turns of the crank handle the chains will be caused to press sideways, each strongly repelling the other, in which position they will remain for some time after the machine has been stopt, gradually and slowly falling back into normal position with the leaking away of the static charge.

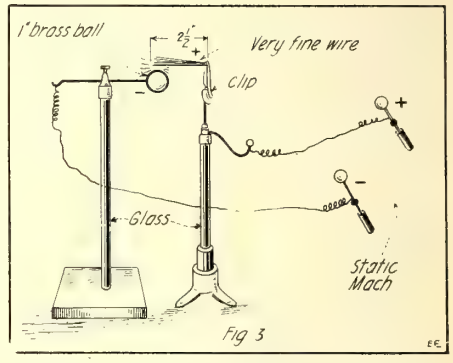
If the discharge balls are brought within sparking distance, so that sparks may pass at certain intervals, the chains will set up a rhythmic motion—separating upon being charged, meeting again upon neutralization—as long as the plates are rotated.

Experiment No. 2.—(Static "Ball Pendulum").

Figure two shows the apparatus needed in this experiment, which clearly illustrates the principle of alternate attraction and neutralization, helped along by the weight of the ball in gathering momentum, which in the end effects the pendulum motion. This latter, naturally, continues as long as the machine is working. Both balls consist of solid brass and should be kept in a well polished condition. The smaller, swinging ball, ½ inch in diameter, is suspended by a piece of very thin copper wire, 3½ or 4 inches long, having a loop on its upper end to insure the necessary free movement. The larger one, measuring 1 inch in diameter is stationary, while the whole is supported upon insulating stands. No sparks must occur across the static machine gap.

Experiment No. 3.—(Static "Vibrator").

Working under the same principle as that involved in experiment No. 2, the static vibrator, as I will call it, forms another highly interesting piece of apparatus. The smaller ball is here replaced by a short piece of very fine, perfectly straight copper wire, about 2½" long, held rigid in a clip as indicated in Fig. 3. The free end of this horizontally placed wire must reach nearly across the entire width of the brass ball, without however touching it in the least, and center upon it. Both should be separated by a gap of from ¼ to ½ inch, this depending entirely on the size and condition of the static machine employed. With the discharge rods set far apart and machine put to work, the wire will immediately be attracted to the ball, since both are oppositely charged, as quickly released under the neutralizing spark, attracted again under the new charge and so on, which, assisted by the springy element existing in it, will cause it to vibrate at an incredible speed.



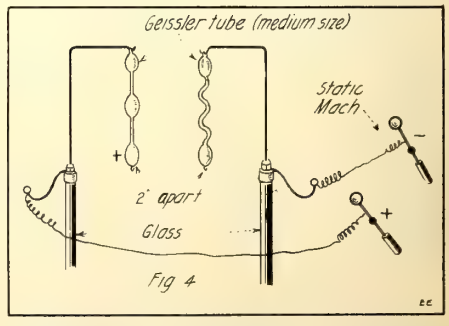
The Static "Vibrator"—a Very Fine Wire Is Suspended by a Clip, as Shown, Just Above a Charged Metal Ball. A Small Static Machine Works This as Well as All the Other Experiments Here Described.

Experiment No. 4.—("Cushioning" effect of spark).

This experiment not only affords a spectacular way of lighting *Geissler tubes* and causing them to swing at the same time, but it offers a good chance, for the study of the "cushioning" effect of the static spark.

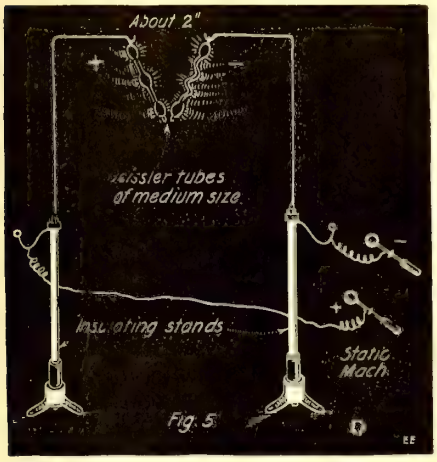
Two medium sized Geissler tubes of equal length (of the rarefied gas and not the heavy liquid type) are suspended a couple of inches or so apart from insulating stands connected to the respective poles of the static machine (Fig. 4).

With the passage of the electric charge they will at once approach each other, being attracted as a consequence of their opposite polarity, when upon meeting by their lower globes the spark discharge will take place thru their entire lengths, strongly lighting them up for the moment. Being released under the effect of the neutraliz-



Experiment to Demonstrate the "Cushioning" Effect of the Static Spark. Two Geissler Tubes Are Freely Suspended, as Illustrated. When Set Swinging the "Spark Cushion" Prevents Their Touching and Breaking.

ing spark, they fall back into their former positions only to be attracted to one another again with the approach of the new charge (Fig. 5). This in repetition causes a sort of swinging motion on the part of the tubes, which in the end—one would



The Swinging Geissler Tubes—a Beautiful and Striking Experiment. Every Time the Tubes Approach, a Spark Jumps Between Them, Lighting Them Up Momentarily. They Then Fly Apart, the Action Repeating Itself as Long as the Static Machine Is Worked.

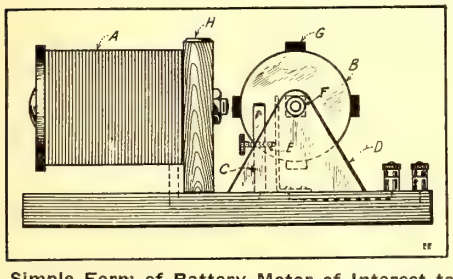
think at least—must lead to their striking hard together; but they never do. Every time they meet, the resulting spark acts as if it were a cushion placed between them; in fact, they sometimes seem to cling together for the instant, while the discharge is taking place, which on the other hand forces them always to a fresh start, in this way limiting the momentum gained by the tubes on each trip. They will perform in this manner as long as the machine is in action, the terminals of which are to be separated beyond their spark limit.

On working out these static "stunts" I had in mind not only the beginner, but the less capitalized experimenter who, unable to buy the more expensive auxiliary apparatus, may not be satisfied with the average run of experiments belonging in the tissue paper-tinfoil-pithball class.

(To be continued)

SIMPLE BATTERY MOTOR.

Herewith I give a diagram and description of a small battery motor. This motor is quite simple and is easily constructed, besides being very powerful for its size. It can be made in any size, but the small sizes give the most satisfaction. The magnet (A) is made by fitting a machine bolt 1½" long thru the ⅜" upright (H) and winding the bolt with No. 26 insulated magnet wire. The rotor (B) is a cylinder of wood, 1½" in diameter and ½" thick. On



Simple Form of Battery Motor of Interest to the Young Experimenter.

its circumference and at equal distances are placed four iron nuts (G). These can be screwed on with flatheaded iron screws.

The shaft can be made of any durable metal, as it has no electrical function to perform. On the shaft, close to the rotor, is placed another nut (F) with its corners pointing midway between the nuts on the circumference. A copper brush (E) is placed near enough to (F) that the points will force it back a short distance. This will make contact with the point (C). The standards (D) are then put on and connections made as in the diagram. The action is as follows: When one of the points of (F) push back the brush it closes the circuit and makes (A) a magnet; (A) then turns the rotor by pulling on the iron nuts. The circuit is opened just before each nut reaches the magnet. The momentum of the rotor brings the next nut in position. If the motor does not start at once spin the armature with the finger.

Contributed by CLIFFORD BROWN.

AN EXPERIMENT IN MR. MACE'S MAGNETIC CURRENTS.

By Thomas Reed.

The very interesting articles by Mr. Mace on "Magnetic Currents" calls to mind, and I believe explains, a phenomenon well known to skippers of small boats, which has never been satisfactorily accounted for. I refer to the "spinning" of a card-compass.

The "dory compass," so called, is composed of a magnetic bar attached to a circular card imprinted with the compass-points. The card, of course, turns with the magnet, and the points are read off against an upright line inside the case, called the "lubberline."

Now very often, as the boat thrashes about in a choppy sea, the card begins to spin. It takes on a rapid rotary motion of something like 200 R.P.M. in its horizontal plane, and keeps it up indefinitely. I say "indefinitely," because I have seen it go for minutes at a stretch; but as it is a great annoyance to the skipper, depriving him of the use of the compass for the time being, he always stops it as soon as convenient, by canting the compass case (which normally is kept level by gimbals) till the card drags on the bottom, and the rotary motion is destroyed by friction.

In the better class of compasses, the case is filled with a transparent liquid (alcohol or oil) in which the card and its magnet are immersed, preventing the spinning.

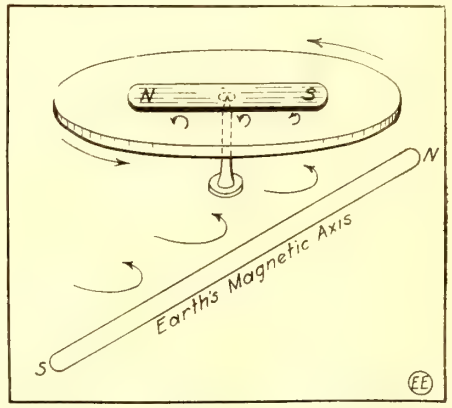
A plain compass-needle, without a card, will not spin. The card seems to act as a fly-wheel, carrying the needle past some sort of *dead centre*.

The spinning seems to be initiated by a succession of "yaws" as the boat is swung off her course by cross-seas. These cause a wide oscillation of the needle; and once these are wide enough, the fly-wheel action comes into play, and the card starts spinning. I have never seen it stop of its own accord, and I believe it would go on until stopt by friction developing at the pivot.

In short, I believe that here we have a case of perpetual motion—except, of course, for friction, which would eventually make the pivot stick. This is a bold statement, because the possibility of perpetual motion is denied. But this is not perpetual motion in the old sense of a force acting against itself; we are merely utilizing an *earth-force* to produce an effect, exactly as a windmill utilizes the wind.

A reference to the diagram will show how I imagine the result to be brought about, in accordance with Mr Mace's theory. In our latitudes, the earth's magnetic axis is very appreciably inclined, which would seem to aid the effect, and perhaps wholly account for it.

It would be a very interesting and not difficult experiment to construct a card-compass especially designed for spinning. Make the magnetic bar rather thin, also beveled and rounded as shown to reduce air-resistance. Attach it on top of the card (it is underneath in the dory-compass) and drill a hole nearly thru from below to form the socket for the pivot. The pivot may



Interesting Experiment with Compass-card and Needle, Which, Under Certain Conditions, Will Spin for Long Periods.

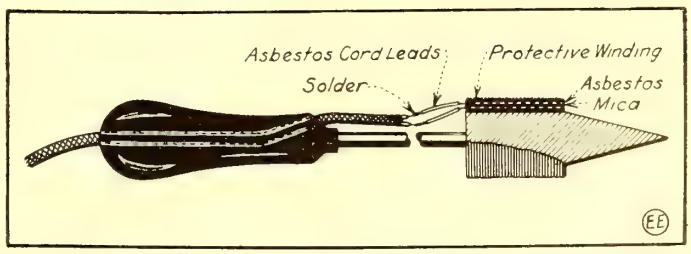
be a fine steel sewing-needle. The card, of thin bristol-board (say 5" diameter), should be as perfectly circular and flat as possible. In operation, it should be covered with a bell-glass to shield it from air-currents; better still, place it in the partial vacuum of an air-pump.

AN EASILY MADE ELECTRIC SOLDERING IRON.

Any experimenter owning a small 110-volt step-down transformer, having a secondary voltage of 15-20 volts, will find the soldering iron here described very useful. When once heated it remains at an even temperature until the current is turned off. To make it, first procure a small soldering copper, of about the size shown. Wrap two layers of thin mica around it, and fasten temporarily with a string. The winding should be of No. 22 or No. 24 German silver resistance wire, the length of which is best determined by experiment. Start the winding about ⅛" from one end, leaving the lead several inches long, and spacing the turns about 1/16".

When as much wire as possible is put on, cover with a layer of mica and wind a similar layer over this. Fasten the end securely, and bring out another lead. The whole winding is now covered with several layers of thin sheet asbestos, and a layer of fine copper or iron wire is wound tightly over this to protect the inner coils.

The leads are covered with asbestos for several inches and are then soldered to a flexible cord which passes thru a hole in the handle. If difficulty is encountered in winding the German silver wire, due to its springiness, it should first be annealed by



Construction of Home-made Electric Soldering Iron. It Can Be Made from a Standard Copper Tip and Handle, as the Drawing Shows.

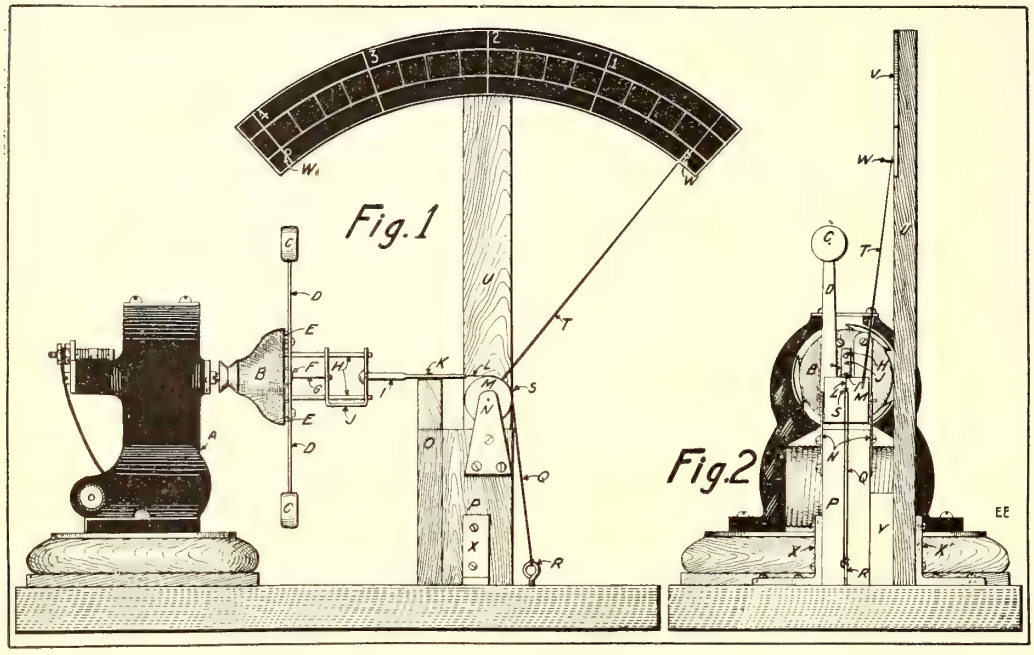
passing a current thru it until heated to a dull red. If the iron becomes too hot in use, the current should be limited by an external resistance, consisting of several coils of No. 20 German silver or iron wire.

Contributed by AN EXPERIMENTER.

A Speedometer for Small Battery Motors

By STANTON C. MOORE

AN easily constructed speed indicator, or more properly speaking, a *speedometer,* for battery motors, that can be made from the odds and ends that are usually found in the ever-useful scrap-box, will no doubt commend itself to the "Bugs" who, being debarred from using their radio sets, are engaged in Electrical Experimenting.



Here Is a Neatly Worked Out Direct-Reading Speed Indicator For Use in Testing Small Battery Motors or For Giving a Steady Indication of the Speed, Where This Is Essential. It Can Be Calibrated to Read R.P.M. if Desired.

While working with a certain device I had occasion to make and break a circuit at certain intervals and also be able at will to alter the intervals and jump to any one of four different degrees of rapidity. I tried an electric clock, but in order to change the period of make and break it was necessary to stop the pendulum to slide the bolts up or down the rod. This was fatal to the device I was working with, so after trying various other schemes, I adopted a modified form of commutator driven by a toy motor. By varying the speed of the motor with a rheostat the periodicity could be changed with ease. However, I found that to get any one of the four degrees of speed that I required, it was necessary to use the "cut-and-try" method of putting in or cutting out resistance until the proper speed was secured.

This was even worse than the clock arrangement had been, but the logical thing to do in this contingency was to devise a method of determining quickly and with certainly just when the right motor speed for the desired periodicity had been obtained. Hence the speedometer here described.

The drawings are presented mainly to give a general idea of the principle and the relative proportion of the different parts rather than exact dimensions, as these depend largely upon the size and power of the motor on which you wish to use the device. However, as it might be of assistance in determining what size to make the various parts to suit your conditions, I give in the following directions, the dimensions of the speedometer which I am using on an "Ajax" motor. These, of course, are arbitrary and may be varied to suit conditions and the material which you are able to dig out of the "scrap-box."

The base is made of half-inch mahogany stock, about 4" x 7". The motor, A, is fastened at one end with the shaft set *exactly parallel* with the center of the base.

Part B is made of hard, close-grained wood (such as mahogany), 1" in its larger diameter and ½" thick, with a hole bored thru the center to fit very tightly and accurately on the projecting shaft of the motor. This hole *must* be bored *exactly* at right angles with the face of the part so that when mounted on the shaft it will run absolutely true. It must be noted that in this device the slightest movement in any of the parts is communicated to the pointer and *multiplied about ten times.* For this reason the utmost care must be taken to make every part as accurately as possible. Otherwise the vibration will cause the pointer to wobble to such an extent that even an approximate reading will be impossible.

Parallel to the shaft hole, 3/16" from it, bore two holes just a trifle smaller than the guides, H. These guides are made from six-penny finishing nails but 1¼" long and forced tightly into the holes just bored on either side of the shaft hole. They should be in perfect alignment with each other and with the shaft.

On these guides is fitted the slider J. This is made in the form of a flat-bottomed "U" of brass, preferably, or iron about 1/32" thick and about 3/16" wide, with holes drilled in each leg to take the guides H. It should slide smoothly on the guides but without too much play. A hole is drilled in one leg to take the link, I. This hole should be exactly midway between the holes for the guides so that the centre of I coincides with the center of the shaft of the motor. A very small hole should also be drilled in the center of the opposite leg to take the cord, G.

To make the link, I, cut a six-penny finishing nail about 1¼" long. File the under side of the head square with the shank and make it as smooth as possible as this joint is where most of the friction comes, and this of course, should be reduced to a minimum. The top of the head may be rounded as shown for the sake of appearances. Insert this in the hole drilled in J to receive it. You will have to bend the slider somewhat to do this, but that can be easily trued up again. Now heat the nail about half of its length and flatten it out. File it smooth on both sides and with a hack saw make a slot the length of the flat part.

The arms, D, may be made of iron, if your junk-box refuses to yield brass, about 1/32" thick and 2" long. Width at one end 3/16", tapering to ⅛" at the other. File them up neatly and drill a hole 3/32" from the large end of each, large enough to take No. 2 three-eighth inch, round-headed, brass wood screws.

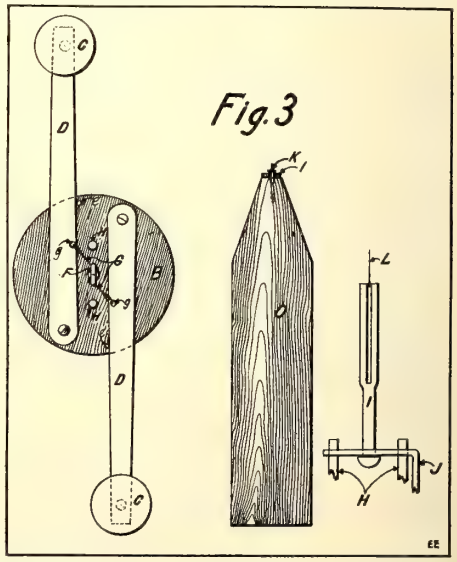
For the weights, C, cut from a piece of sheet lead, about ⅛" thick, two pieces ½" x 1" and fold them in the middle. Drill a hole in the small ends of the arms and slip the folded pieces of lead down over them. Hammer the folds together and you have two arms with a lead weight on the small end of each, the lead sinking into the holes in the arms, thus fastening the weights securely. To make a neat job file the corners off and smooth up.

Five-eighths of an inch from the large end, near the edge, drill a small hole, g, Fig. 3, thru which to thread the cord, G.

These arms are fastened at their large end as shown in the drawing, with a No. 2, three-eighths inch, round-headed, brass wood screw; a washer being placed between the arm and B to minimize friction. The center of the screw should be ⅛" from the circumference of B and 3/16" from a line drawn thru the center of the two guides, H.

A small staple, F, made of *round* wire is now driven into B so that it spans the motor shaft. (I say *round* wire staples advisedly, because if you use the square wire kind such as is employed in tacking down floor matting and linoleum, the sharp edges will cut the cord which we are to thread thru it.) Drive it in all but about 1/16".

Take a short piece of stout cord, something on the order of a good quality fishing line, and put one end thru the small hole in the back of J. Tie the end into a good sized knot so that it will not slip



Detail of the Direct-Reading Speed Indicator Fly-Ball Governor Mechanism and Needle Actuating Means.

(*Continued on page* 805)

My Electrical Laboratory

By WALTER BOCK

(Special prize $5.00)*

HEREWITH are six photos of my shop and Electrical "Lab" including myself—one "Stript for action" and the others—"all drest up and nowhere to go." The photos show most of my electrical apparatus. All told I have approximately 50 pieces of the same, such as spark coils, Tesla and Oudin coils, Leyden jars, glass plate condensers, magnetos, dynamos, motors, voltmeters, ammeters, polarity indicators, paper condensers from .0165 to 1 mf., rheostats, fixt and variable inductances, Geissler tubes, storage batteries, interrupter, etc.

chemical reagents. The things that look like the noses of some "one-pounders" are the tops of my file handles.

Last but not least comes my bench with more than 300 wood and metal working tools such as twist drills, hand drill, drill press, adjustable tool grinder, and so forth. To the left is my 30 drawer stock cabinet, containing machine and wood screws, nails, bolts, nuts, springs, contacts, binding posts, ad infinitum.

**See announcement in Feb. 1918 issue, page 701, wherein we asked for special article, with several photos describing your "Electrical Laboratory." Tell us in not more than 500 words what you do in your "Lab." Make your article interesting and be sure the photographs are good and clear. Address the Editor.*



Owing to the fact that space is limited, (my shop measures 12 feet by 14 feet), I have to put away all apparatus that I am thru using to make room for another experiment. Therefore I have no fixt electrical "Lab." The table of my chemical "Lab" serving the double purpose. One photo shows the "Lab" table with twenty-five of my forty or so pieces of chemical apparatus, such as thistle tubes, test tubes, delivery tubes, retort, Erlenmeyer, and Florence flasks, chemical balance, c.c. graduate, mortar and pestle, etc.

To the right of my "chem. lab" is one of my book cases containing some fifty electrical, chemical, and mechanical books—among others—three volumes, of the ELECTRICAL EXPERIMENTER (I have them all as far back as April, 1915); the Model Library series and Henly's Formulas. Another photo shows some of my 140 odd

RADIO COMMUNICATION BETWEEN FRANCE AND THE UNITED STATES.

A radiotelegraph station destined to establish direct radiotelegraphic communication between France and the United States of America will shortly be establisht by the French Government. It will be situated on the West Coast of France and will maintain permanent and continuous radio-communication by day and by night between France and the United States. It will radiate continuous waves with a wave-length of at least 15,000 meters so it is said.

The contractor must guarantee transmission from the French station to the American station (on any day of the year) of 10,000 words per 24 hours. Moreover, the transmitting and receiving apparatus will be adjusted in such a manner as to allow of continuous transmission and reception at the minimum speed of 4,000 words per hour. Adjustments permitting musical transmission and auditory reception at the speed of 50 words per minute are also provided for.

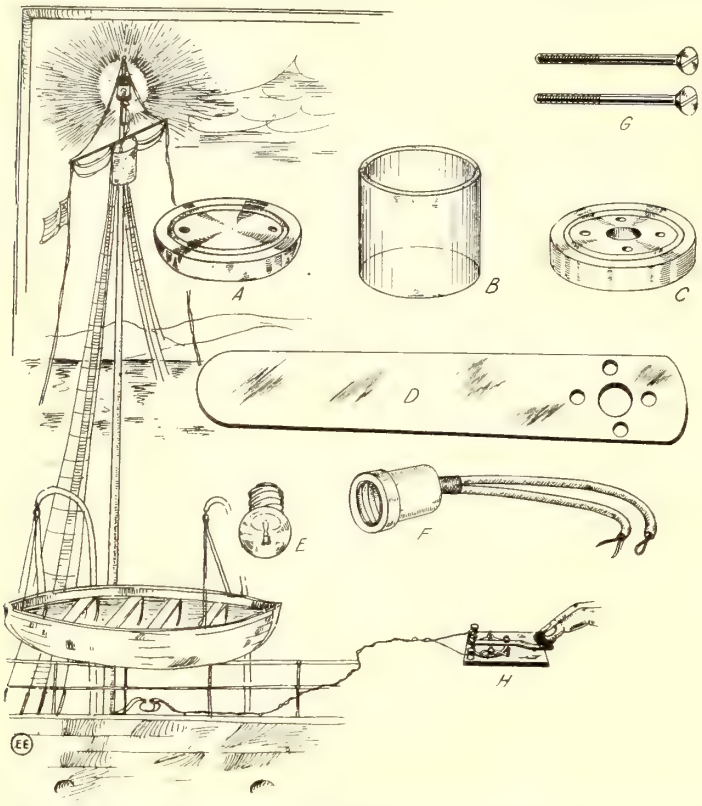
Transmission by the French station of signals destined for reception in the United States of America, and the reception by the French station of signals from the United States, simultaneously and independently, will be correctly and efficiently carried out.

CAMP MEADE PICKS UP RADIOS FROM NAUEN.

Camp Meade's wireless operator (at Baltimore, Md.), Jim McGarrity, caused a tremor of excitement recently when he announced that he had just picked up several messages from the great wireless station at Nauen, Germany. The messages were all in the official German code, and therefore could not be deciphered by anyone here. The headquarters officers would not believe Jim at first the distance to Nauen being more than 4,000 miles. He silenced them by displaying the messages, which were immediately forwarded to Washington.

How to Make a "Blinker Light" for Motor Boats

Every small sailing or engine-driven water craft should be equipt with an efficient "blinker light" for signaling to other craft or to shore. Such a blinker light is described by H. A. Jackson in *Motor Boating*.



Here's a Simple and Effective "Blinker Light" For the Small Motor Boat and Launch. It Can Be Operated From a Few Dry Cells or Storage Battery, the Telegraph Key Enabling Messages to Be Signaled in the Morse Code.

This simply made lamp can be used with equal facility whether it is to be permanently fixt at the mast-head (which is much the better way) or hoisted on the yardarm halliard whenever wanted.

Keeping in mind that the lamp should not be too large, must be seen all around the horizon, and should be neat in appearance, I first tried to buy a plain glass tube of about 2-inch inside diameter and equal length—but found it impossible to obtain. A friend then suggested the kind of glass that is used in oil cups, and my troubles were ended, for I was able to get a glass of ⅛-inch wall thickness (heavy enough to withstand any usage), 2⅜-inch outside diameter, and 2⅜-inch length, at a cost of twenty-five cents. (A good glass cylinder would be one such as supplied on certain radio receiving condensers.)

From the waste pile in the boat yard I then picked a 3-inch square piece of mahogany which was awaiting consignment to the stove, and with a lathe rounded off the top neatly and cut a groove in the lower side ⅜-inch in width and depth and of a diameter equal to that of the glass. I then gave it three coats of spar varnish, and while the last coat was wet, inserted the glass and let it dry. I then had the top and sides of my lamp. For the bottom, I selected a similar piece of wood, left it flat on top and bottom, and on the top cut a similar groove to receive the bottom of the glass oil-cup tube. The center of this bottom piece has a hole bored to ¾-inch diameter for taking a weather-proof tube socket like those used to decorate large Christmas trees outdoors. Having also bored four holes of ¼-inch diameter in the bottom, and put the arrangement together with two thin 2¾-inch brass screws, I had my lamp. Of the four ¼-inch holes on the bottom, two are used for the fastening screws and two for ventilation. I did not insert the glass in the bottom piece of mahogany until the varnish was dry, as this piece should be easily removable for replacing the bulb or cleaning the glass.

When it came to fastening the light, I wanted it to set a little ahead of the mast and above it, so that it would not interfere with the halyards, etc. I therefore took a piece of waste brass 1/16 inch thick, 6 inches long by 1¾ inches wide, bent it to L shape for a bracket and bored holes in it to correspond with the holes in the bottom mahogany piece. In using the long fastening screws mentioned above, I put them first thru the brass. (The illustration shows the brass before being bent and without the screw holes for fastening it to the mast.) The other two small holes correspond with the ventilating holes and the large hole allows the lower end of the weather-proof fixture and the wires to project thru. If it is desired to use this lamp on a halliard, omit the bracket and provide a screw-eye for the top piece of mahogany.

The rest of the outfit consists of a sending key, dry or storage battery, and wires to connect. The sending key can be an ordinary push button, or a regular telegrapher's key. The latter is about twice as expensive as the push button, costing in the neighborhood of $1. But it is much more satisfactory and the light can be made to burn steadily (and so used for an anchor light) by pushing in the right hand arm (see illustration).

The wiring is also very simple, but as the wire is to be used for outside purposes, it should be well insulated. If attached to the mast and painted with a couple of coats of yellow paint, it will not be noticed and the paint will help the insulation. Connect the two wires to those projecting from the bottom of the weather-proof fixture, leading one wire directly to the storage battery (or if you have no storage battery to one dry cell), and the other to the left binding post on the sending key; also run a wire from the right binding post to the dry cell or storage battery. Then, by pressing down the key, you will light the light, and by releasing it will cause the light to go out. A 2 c.p. bulb will be amply sufficient, and the voltage of this bulb should, of course, correspond with the amount of power used. With such a "blinker light" equipment, communication can be carried on at considerable distances.

Important Notice to Subscribers

Due to the congestion existing at the present time in all railroad movements, also on account of the fact that many train clerks have gone to war, there is a congestion of mails all over the United States. It may happen that your magazine will be slow in reaching you, and this delay may be from a few days up to several weeks.

Kindly bear this in mind before sending in a complaint, as the magazine will surely reach you in due time. Only after not having received a certain copy for a period of three weeks should a complaint be sent in.

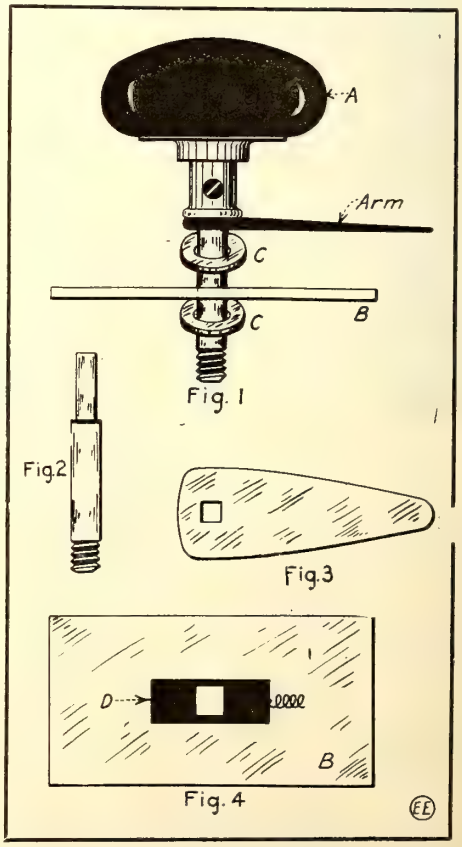
You will confer a favor upon the publishers not to write until this time has elapsed, thereby saving them a vast amount of clerical labor.

HOW TO GET A PORCELAIN KNOB FOR RHEOSTAT.

I was recently in need of a knob for a rheostat and thought I would try an old porcelain door-knob which was not in use. To construct this knob first procure a porcelain door-knob with a set-screw in it. Next take an old buggy bolt and cut the head off and as much of the bolt as desired. As in Fig. 2, file one end square so as to fit in the door-knob and leave the other end threaded for the lock nut. Procure a piece of brass and cut it into the shape shown in Fig. 3, which is 3½" long and ¾" wide at the larger end, with a square hole in it to fit on the square shank, Fig. 2. In Fig. 4, "B" represents the switchboard and "D" is a copper strip with a hole in the center A copper wire can be soldered on this copper strip for connection. In Fig. 1 "CC" are washers and "B" is the switchboard. I have been using this for some time, and it is giving good results.

Contributed by

CLIFFORD LUNDQUIST.



If You Have a Porcelain Door Knob At Hand Here's a Good Use For It—as a Rheostat Control Knob.

Siphons—How They Work

By I. W. RUSSELL and J. L. CLIFFORD

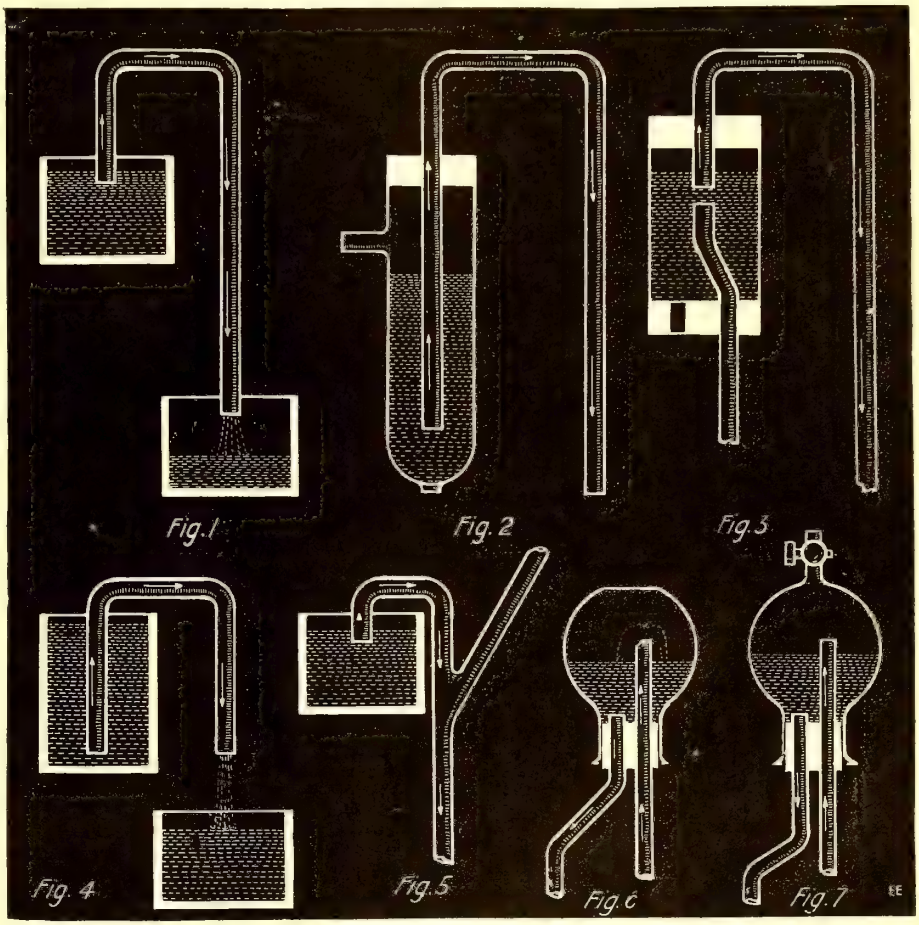
A SIPHON is an instrument for conveying liquid from one vessel to another at a lower level and is usually in the form of a bent tube. The word itself comes from the Latin word "sipho," meaning tube. The principle of siphons has probably been known for centuries; even the ancients were acquainted with the simplest forms of this interesting apparatus. Altho the siphon enjoys the greatest use in laboratories, for the purpose of handling acids, it has a great many other applications. Innumerable forms have been devised and adapted to all purposes. Pipes used for conveying the water of an aqueduct over hills and following the contour of the sides are often called siphons, but do not necessarily depend for operation upon the principle of the instrument defined above.

The simplest form of siphon as illustrated in Fig. 1, consists primarily of a bent glass tube with arms of unequal lengths. In starting this siphon the tube must either be filled with water previous to inserting it in the vessel or, after being placed in the vessel a suction applied to the lower arm. To explain this flow of water from the siphon, let us suppose it to be filled by either method described above and immersed in the liquid. The pressure then at the end of the shorter arm tending to raise the liquid in the tube, is the atmospheric pressure less the height of the liquid in the shorter arm. In the same way the pressure at the end of the longer arm is the weight of the atmosphere minus the pressure of the column of water in the longer arm. Since the column of water in the longer arm is longer than that in the shorter arm, the force acting at the end of the shorter tube is less than that of the longer; consequently a flow of water takes place proportional to the difference between these forces. The flow will therefore be more rapid in proportion to the difference of level between the end of the longer arm and the level of water in the vessel.

In Fig. 4 is shown a type somewhat similar to the first. It consists essentially of a bent tube with arms of equal length. Besides the methods outlined in connection with the first system, this siphon may be started by plunging quickly into a vessel filled to the brim with water. The siphon must be handled skilfully in order not to break the tube and cause the column of water to be forced over the ridge in the tube. Another method is to stop one end with the thumb and inserting the free end into a vessel filled to the brim with water. Upon removing the thumb, the water rises in the tube and is carried over the ridge by its surplus momentum.

A commercial form of siphon intended for transferring acids from one vessel to another is shown in Fig. 5. The principle is nearly the same as the first with exception that the siphon is started by applying suction at the exterior arm. With this siphon, however, there is danger of some of the acid reaching the mouth. In Fig. 6 is shown what is known as the *siphon fountain.* A flask is partially filled with water and glass tubes are arranged as shown in the figure. Upon inverting and with the shorter arm immersed in the liquid of some vessel, a flow is occasioned. As the water is drawn out by way of the longer arm a vacuum is created in the flask, causing the water to rush up the shorter tube, thus forming a fountain.

A commercial form employing this idea is shown in Fig. 7. At the top of the flask there is a valve controlled opening. By stopping up the longer arm and applying suction to the upper aperture, the siphon is started. The valve is then closed and the siphon will then act the same as type 6. For safely and easily handling acids the siphon shown in Fig. 2 has been pronounced by Prof. C. D. Dilts, an authority on siphons, to hold the greatest possibilities. When the siphon is inserted into a bottle of acid the liquid rises into the tube. By blowing in the small tube, the valve at the bottom is closed and the acid is forced out of the siphon tube. With this arrangement there is absolutely no danger of drawing acid into the mouth. A siphon of great scientific interest but of small commercial value is what is known as the automatic siphon illustrated in Fig. 3. The tubes are arranged as shown in the drawing. When this siphon is inserted in a vessel containing water, the water rushes in at the lower aperture and causes a pressure in the larger tube, which causes the water coming up in the lower tube to be forced up into the siphon tube, thus creating a flow. There are many types of siphons other than those shown here which are beyond the limits of this article to describe. As this is an intensely interesting subject, the serious reader will be highly repaid for any labor exerted in experimenting along this line.



A Study in Siphons. These Clever Mechanical Devices Are of Interest to Every Electrical Experimenter For the Purpose of Transferring Acids, Electrolyte From Carboy to Cell or Vice Versa, and Other Work.

METHOD IN EXPERIMENTING.

Experimental work, undertaken in the right spirit, consists in putting a series of questions to nature. The result of the experiment constitutes nature's answer, and when this is correctly interpreted our knowledge of the universe in which we live and of which we form one tiny part becomes more complete. Now if experiments are to lead to fresh knowledge they must be performed methodically. So far as the confirmatory experiments suggested in textbooks are concerned, the conditions are explained by the author of the book, and the experimenter has little to do beyond carrying out the instructions as carefully as possible. But original experiments need to be well thought out beforehand, and when this is done it remains to arrange the manipulative details with a view to getting a clearly defined result, unaffected, as far as possible, by disturbing causes.

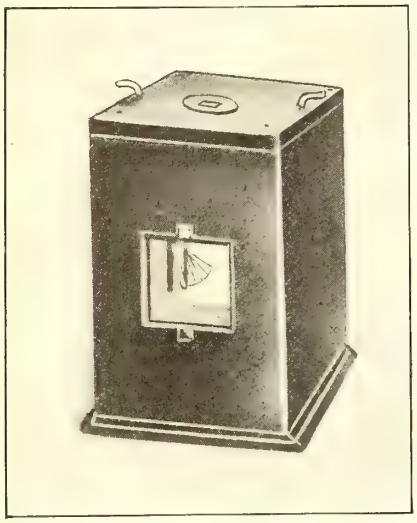
Contributed by H. J. GRAY.

AUTHORS!!!

All matter intended for publication—not only by us, but by any other magazine or newspaper as well—should be written on one side of the paper only and in ink. If it isn't, somebody else must copy part of it off on another sheet before it is given to the printer.

A SPECIAL GOLD-LEAF ELECTROSCOPE FOR RADIO-ACTIVE EXPERIMENTS.

THERE have appeared lately in this magazine several articles on Radium and Radio-Activity. In these articles the experiment of discharging a gold-leaf



Appearance of Finished Electroscope Especially Designed for Conducting Experiments in Radio-Activity.

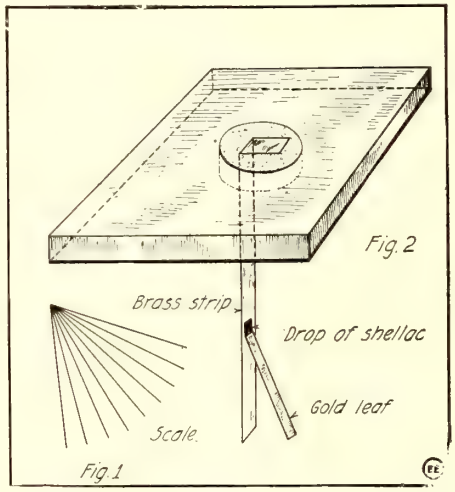
electroscope by some Radio-Active substance is mentioned. This is an intensely interesting experiment, but the ordinary *flask electroscope* is not suitable for this experiment. With the usual electroscope there is no convenient way of bringing the Radio-Active salt near the electroscope and leaving it for some time. Besides there is no way of measuring the collapse of the gold leaf, and the ordinary electroscope in the possession of the amateur will not hold its charge sufficiently well. Because of these difficulties I constructed a special gold leaf electroscope, which, under ordinary conditions, will hold its charge *several hours* and which lends itself especially well for experimenting with Radio-Activity.

As may be seen in the photograph, the electroscope is housed in a rectangular box of ¼" quarter-sawed oak. The box is 3" square at the top and about 5" high. There is no bottom to the casing, and in the front there is a glass window to permit the observer to watch the collapse of the gold leaf. Directly in the rear of the box there is an opening about the size of the front window. Over this opening a piece of semi-transparent paper is glued, on which a scale is drawn as in Fig. 1. This should be put on after the rest is finished so that the scale may coincide with the gold leaf.

The construction of the top of the box is illustrated in Fig 2. A piece of fairly thin brass or phosphor bronze strip about 3½" long and ⅜" wide is smoothed well. Any slight cut or jagged edge is apt to cause leakage. This strip is bent at right angles half an inch from the top, and put thru an inch hole cut in the center of the top. The top of the bend in the strip should be even with the surface of the wood and should not touch the wood at all. The hole should then be filled with melted sulfur. Be sure to heat the sulfur gently, and do not allow it to burn as this destroys its insulating qualities. When the sulfur is hard sandpaper the top so that it is possible to see the top of the strip. The top is put on with thumb screws to facilitate removing and putting on the gold leaf.

Gold leaf can be purchased either at a sign painter's or a paint and varnish store. It would be best to find out when you buy it, how to handle gold leaf, since it is extremely delicate. The piece of gold leaf about an inch long by ⅜ wide is attached to the brass strip by a tiny drop of shellac. It is possible with this electroscope to see the gold leaf and the strip on the scale behind and notice the position before and after charging.

To use this electroscope charge with a glass or hard rubber rod excited with silk or catskin, and notice the position of the gold leaf on the scale. Leave for about fifteen minutes, and if the conditions are favorable, and the electroscope well made, the leaf will be in the same position as before. Take some Radio-Active substance (the writer used Uranium nitrat and Uranyl chlorid) and put upon a grounded copper plate. Charge the electroscope and place over the plate and notice the position on the scale of the gold leaf. After a few minutes again notice the position of the leaf. The electroscope will be discharged. The alpha particles emitted by the Radio-Active substance have ionized the air, permitting the charge on the electroscope to leak away to the grounded copper plate. In this way it is possible to measure the Radio-Activity of different substances by the rate of discharge off the electroscope. The writer has also found that an E. I. Co.'s *Spinthariscope* with the lens removed, would discharge the electroscope. Radio-Active salts (such as all Uranium or Uranyl compounds) can easily be secured at any chemical supply house.



Details of Electroscope For Radio-Active Experiments. It Employs a Single Gold Leaf as Shown, the Movement of Which Is Measured on a Transparent Scale.

This electroscope besides being useful for experiments with Radio-Active substances is a valuable asset to any experimenter's laboratory.

Contributed by JAMES L. CLIFFORD.

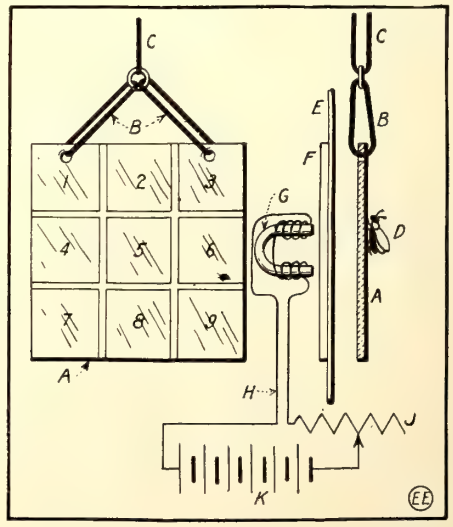
THE MYSTERIOUS BEETLE.
By. C. A. Oldroyd.

This illusion is worked by electricity, and will never fail to keep the audience spellbound. The effect is as follows:

The performer shows a glass plate about one foot square which is suspended from two silk cords B (see sketch), which in turn join the ring that is supported by the cord C. The glass plate A is divided into nine squares, each of which contains a figure starting, of course, with No. 1. These figures and the division lines of the squares are painted with black varnish. The performer shows a "beetle" which, so he explains, he received from an Indian conjurer. The beetle will cling to the glass plate without having any visible support, and will also occupy the squares of the glass plate A, whose numbers are called out by members of the audience.

After these short explanations the conjurer passes the bettle to the audience for examination to show that there are no threads or similar devices hidden anywhere. He also shows that the glass plate is not prepared in any way, and the plate may also be past on to the audience for examination. After this, the performer puts the plate back into its former position, and passes a stick, which he borrows from the audience, between the back of the plate and the curtain E, which is about 6 inches behind plate A. He now places the beetle on square No. 1 and the beetle will cling to the plate. Members of the audience are now requested to call out different numbers and the beetle will slowly move to the square bearing the specified numbers. For instance, if the beetle rests on square No. 1, and No. 9 is called out, the beetle will move from 1 to 5 and from 5 to 9. If the beetle is asked to go back again to No. 1, then it may take the following way: 9 to 6, 6 to 3, 3 to 2, 2 to 1. This proves that the beetle can move in any direction. Small additions or multiplications are also carried out by the ever obedient beetle. After the performance the beetle and glass plate are again past to the audience for examination.

The explanation of this trick is as follows: As mentioned before, behind the plate A at a distance of about 6 inches is a curtain E. Fixt to the back of this curtain is a piece of cardboard F, the same size as the plate A. This cardboard is also divided into nine equal spaces and the position of the cardboard is exactly behind the plate A. The performer's assistant is stationed behind the curtain, holding in his hand a powerful electro-magnet G, which is connected by means of wires H to a resistance J, and a few storage battery cells K. As the assistant hears the numbers called out by the audience he moves the magnet G to the number required. The body of the beetle D contains soft iron wire and the powerful magnet G attracts the beetle and supports it in this manner. The body of the beetle should be as light as possible, and the beetle when completed may be about one inch long. Thin iron wire should be used to form the body and when finished, the beetle should be painted a bright golden color. To make the trick more effective, the room may be darkened and the light of a 50-candlepower lamp may be directed onto the glass plate A. This would show the gold color of the beetle more brilliantly and the beetle will look almost life-like when moving.



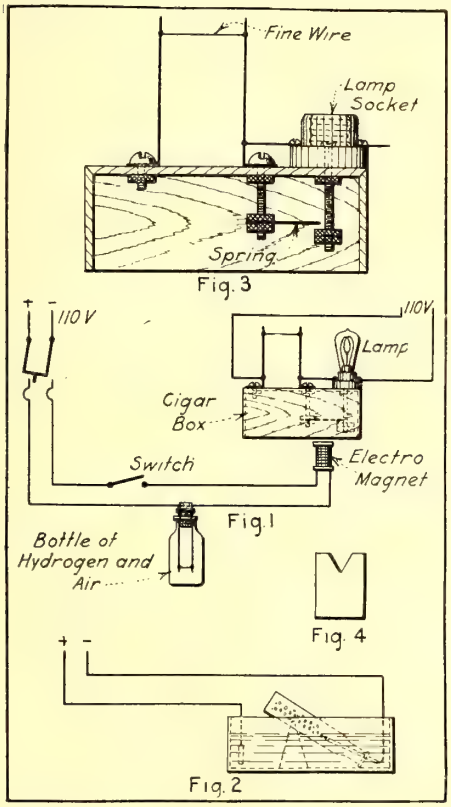
The Mysterious Beetle Is Not So Mysterious After All—For He Is Moved From Square to Square By Means of the Electro-Magnet In the Manner Apparent.

OPENING A LAMP CIRCUIT WITH A PISTOL.

The effect caused by this hook-up is as follows: An incandescent lamp bulb is mounted on a cigar box which also has on it two upright wires, and a small wire connecting them (about No. 36). The uprights and the lamp are connected in series, and they are connected by a lead wire and plug to a lamp socket. The current is turned on, and then the operator walks away some distance, produces a pistol, fires (?) at the wire, cutting it (?), when, Presto! the light goes out!

The way this effect is produced is shown by the diagrams herewith. In diagram 1, the current from the ordinary 110-volt lighting circuit passes thru a switch, a fuse, a fine wire inside of a bottle containing hydrogen and air, an electro-magnet, a strap key or push button, another fuse, and the other blade of the switch. The switch used is a D. P. S. T. with a fuse block. The bottle will be described later, and the electro-magnet consists of about 10 or 15 feet of No. 18 B. & S. gage bell wire wound on a ½-inch diameter iron core about three inches long.

The apparatus at Fig 3 is the cigar box with the lamp socket and wires mentioned above. The lamp socket is of the type with a hole in the center thru which a screw passes to hold it down. The screw used must be about an inch longer than is needed to pass thru the socket and box cover. On the lower part of this, below the nut fastening the socket down, is placed a brass nut with a brass lock nut under it. In securing the socket make sure that the binding post connecting with the lead from the lighting circuit is the one that comes from the center of the socket. The uprights may be of iron wire and are bolted down to the cover. The shove-bolt or screw for the one nearest the socket must be long enough to extend about an inch below the lower side of the cover of the box. After the nut to fasten it to the box cover has been put on, put on another one, then a thin iron plate, and a nut on the bottom. Then we have the plate between two nuts which when tightened will hold it. This plate must be long enough to just miss the bolt which comes thru the socket and as wide as the box, allowing enough room so that it can move freely without scratching against the sides of the box. Then the brass nut on the bolt thru the socket is screwed up until it comes within almost a paper thickness of touching the plate. However, it must not touch. Then the other upright is put on.



It Seems as If the Bullet Severs the Fine Wire Next to the Lamp, Extinguishing It—But Does It? This Trick Is an Excellent One For Parties, Amateur Theatricals, Et Cetera. It Will Puzzle Them All.

The method of collecting hydrogen is shown by Fig. 2. An ordinary iron pan is used, in which there is placed a salt solution and two lead electrodes. The negative electrode is put into the bottle which is filled with the salt solution. When the current is turned on, by electrolytic decomposition, hydrogen goes into the bottle. The bottle should be filled about ⅕ full of gas. It is then taken out, and a cork with two wires bound to it having a fine wire consisting of about two strands of No. 36, B. & S. gage wire across them, is placed in the neck. An ordinary olive bottle has been found very satisfactory for this purpose. The insert shows a convenient stand to avoid "spilling" out the gas while generating it.

Now that the apparatus is completed, the magnet must be hidden under the thing on which the box is to be placed. I put it in my overcoat pocket on the bench by a hatrack and put the box on my overcoat. The jar must be hidden near the place where the gun is to be fired, and the strap key placed where the operator can touch it with his hand or foot.

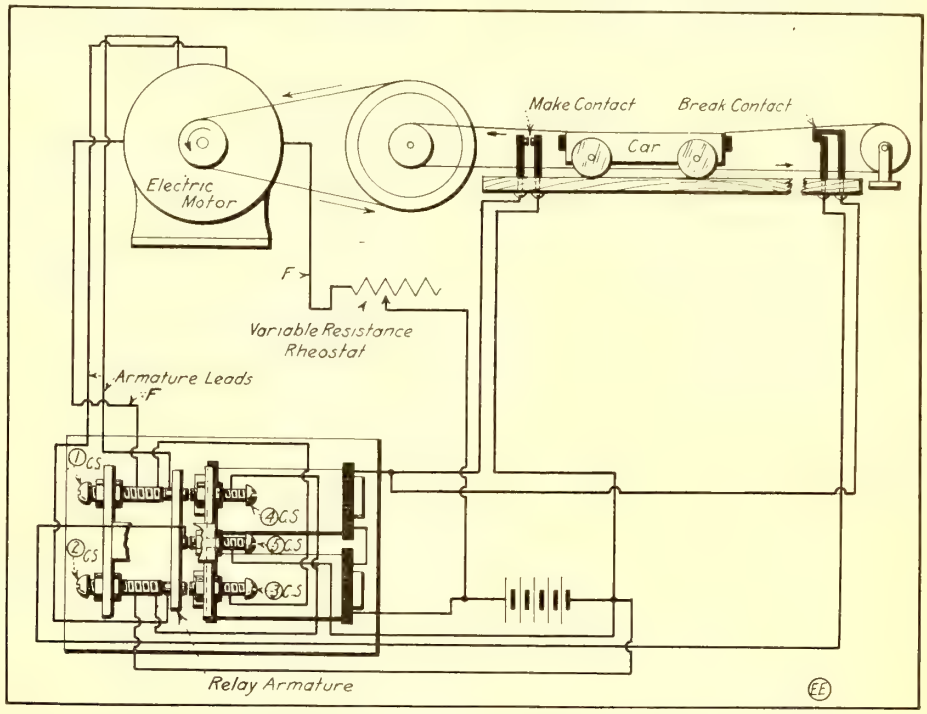
The operation is as follows: When the key is closed, the current excites the magnet, which pulls down the iron plate short-circuiting the lamp. This throws the full 110-volt circuit on the fine wire which breaks as tho it had been severed by a bullet. However, the resistance of the first circuit is so low that there is a heavy rush of current which fuses the wire at its weakest point, which happens to be in the bottle. This fusing causes a spark which ignites the hydrogen and makes the noise required to replace that which the gun would make if it were really fired.

The two circuits may be on the same or different lines, because they are only connected by magnetism.

Contributed by GEORGE S. CARY.

An Automatic Electric Railway

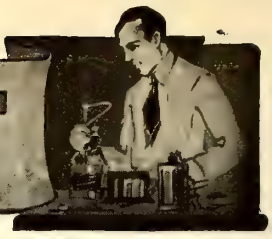
A simple way to run a miniature cable railway mechanically and electrically is shown in the diagram. The apparatus must be operated by a series-wound motor for the connection scheme shown, its armature being connected to the contacts on the relay armature. The field of the motor, thru a variable resistance, is connected to Nos. 1 and 2 contact screw; No. 1 screw being directly connected to No. 3 screw, while No. 2 contact is connected to No. 4 screw. The "make" contact is connected directly in series with the relay coils. No. 5 contact screw is directly connected to the battery, thence to "break" contact, to relay coils, and back to battery. The contact screws opposite each other are connected to opposite sides of the motor field. The forward and backward motion of the relay armature causes the motor to reverse when the relay coils are energized, or *vice versa*, depending on the position of the motor field wires. When motor runs in direction shown in diagram, the power of the car closes the "make" contact, which in turn energizes the relay coils. This causes relay armature to come forward and this action reverses the direction of the motor. On the reversal of the car's motion, the "make" contact opens again, but current is not cut off from relay coils because No. 5 contact screw being directly connected to battery, thence thru "break" contact and relay coils, keeps them energized. The opening of the "break" contact by the car cuts off the current from relay coils, releasing the relay armature and bringing motor back to original position. This action may be repeated as many times as desired. The variable resistance or rheostat controls the speed of the motor.



An Automatic Electric Railway That Electrical Experimenters Will Find Interesting. As the Moving Car Travels Back and Forth On Its Rails, It Trips Electric Contacts Which Serve to Control a Relay Reverser Connected With the Driving Motor.

Contributed by ARTHUR PRIEBE.

HOW TO MAKE IT

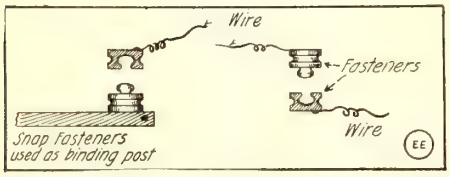


This department will award the following monthly prizes: **First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.**
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of **$3.00** is awarded; for the second best idea a **$2.00 prize, and for the third best prize of $1.00.** The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

LADIES! WATCH YOUR "SNAP FASTENERS"! THEY MAKE GOOD SWITCHES.

The experimenter who is continually rigging up different apparatus, will find that a few "snap fasteners" soldered to different



Ever Hear of an Electrical Use for "Snap Fasteners"? Well, Here we Have a "Switch" Made from One. Watch Your Waists, Ladies!

lengths of wire will come in handy for connecting them temporarily. The dome fasteners can also be used as binding posts.

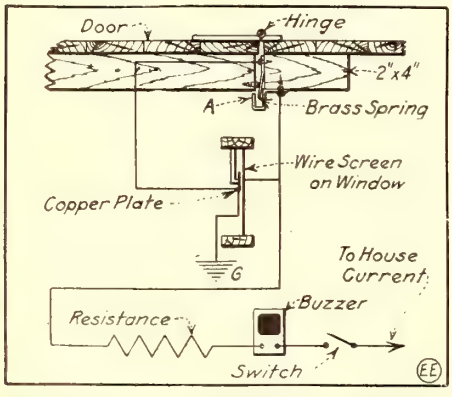
Contributed by S. BELL.

CHICKEN COOP ALARM.

Herewith is a drawing and explanation of how I protected my chicken coop from thieves. By either opening the door or by pressing on the screen window, a buzzer would sound. The coop stands fully fifty feet away from the house, and the incoming wire is hidden under a fence. It works great!

One must be careful to connect the incoming wire to the house current wire which is *not grounded*. The in-coming wire can be led into the house along a fence or any other convenient place.

The action is as follows:—When the door is opened contact is made at A. The wood screw is to adjust the movement of the spring which makes contact. When the wire screen is pushed, it makes contact with the copper plate. Either the screen or the door will operate the buzzer alarm, as they are connected in parallel.



Chicken Thieves!! Beware When This Electric Alarm is Hooked Up to the Chicken Coop.

The switch is to disconnect the buzzer when the door is opened for the day.

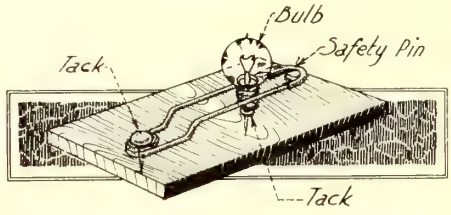
Contributed by VICTOR C. MAZYLEWSKI.

SECOND PRIZE, $2.00

LAMP "SOCKET" FROM A SAFETY PIN.

I herewith submit my idea of an emergency electric lamp socket. This socket may be quickly constructed from a safety pin of large size. It may be placed anywhere. The pin is fastened down by a tack or screw and is bent as shown in the sketch. The lamp is then screwed into the pin.

Contributed by ELLSWORTH EDGERTON.



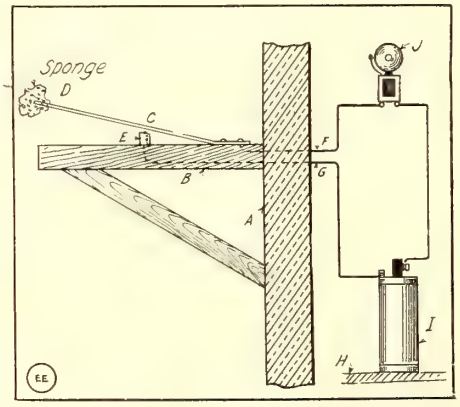
And the Safety Pin—Goldarn it If it Don't Make a Good Hurry-up Lamp Socket.

YE GODS!! ANOTHER RAIN ALARM.

Herewith is a drawing of a simple electric rain alarm. It needs but little explanation.

A is the house wall, B is a shelf, C is a light spring, D is a piece of sponge or absorbent material or a small metal receptacle, E is a contact, F and G are wires, H is a shelf, I is a battery, and J is a standard vibrating bell.

Contributed by HROLF F. LUCK.



Suffering Mackerel! Yes, It's Another "Rain Alarm." And it Works, Yep!

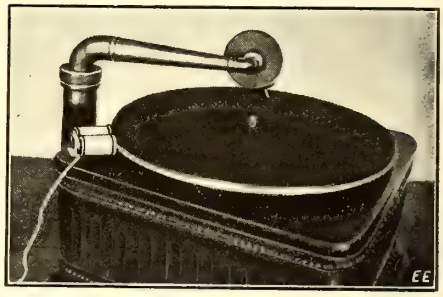
EXPERIMENTERS!!!

Don't forget to write up that little "stunt." It may win a prize. Address all manuscripts to the Editor, Electrical Experimenter, 233 Fulton Street, New York City.

THIRD PRIZE, $1.00

MAGNETIC PHONOGRAPH STOP.

I have found that by placing a pair of ordinary electro-magnets, such as found in



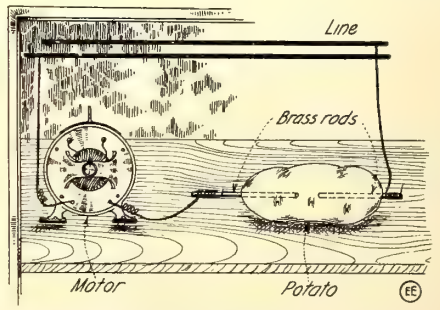
A Pair of Bell Magnets Mounted Alongside of the Record Table Was Found to Stop the Victrola Quickly.

bells, buzzers, etc., along-side of the iron table on my Victrola, that the record is quickly brought to a stop when the current is past thru the magnet coils. It is a simple matter to connect up the magnet circuit with a special trip switch mounted on the tone arm, so that the record table will be brought to a stop quickly as soon as the spring motor is shut off.

Contributed by an EXPERIMENTER.

A "POTATO" EMERGENCY RHEOSTAT.

Are you looking for a rheostat? Then examine the drawing which shows a rheostat made by sticking a brass or copper rod into each end of a potato. The resistance is regulated by bringing the rods close to each other, or by drawing them apart. If this rheostat is used for a continuous period of over one hour, it will be found necessary to replace the potato by a fresh one, as the current passing from one terminal to the other tends to bake it. This makes a very cheap and simple rheostat, even



Two Pieces of Wire Pushed Into Opposite Ends of a Potato Provides an Emergency Rheostat.

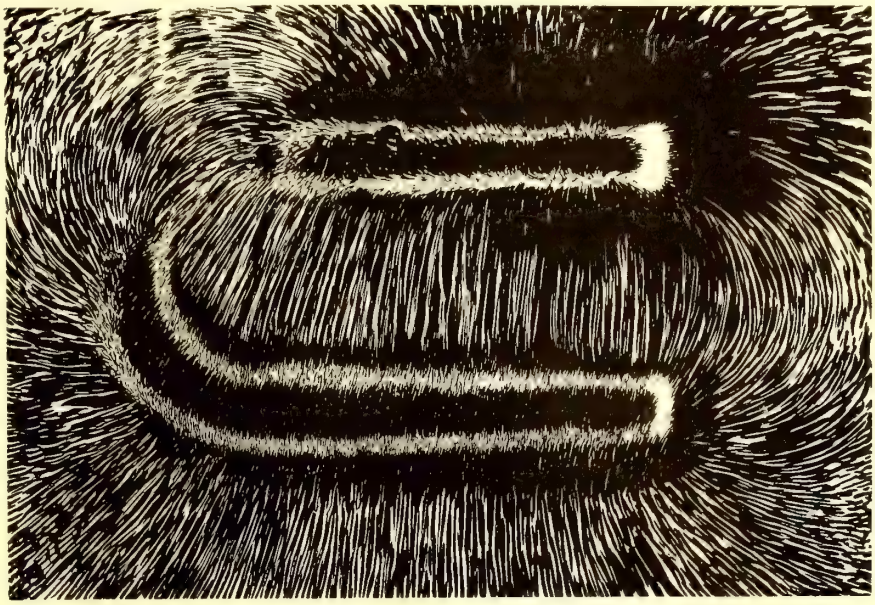
considering the cost of "spuds," which are about $4.00 per bushel. Why not grow some "rheostats?" What next!!

Contributed by RUDOLPH P. KRAJICK.

A Remarkable Magnetograph

Herewith is submitted a print of a "double" magnetic field of a horse-shoe magnet. The cause of this peculiar field is that the steel from which the magnet is made was faulty and therefore causes an unnatural field. However, there seems to be a break in the original magnet, which is a single piece magnet.

Contributed by HAL C. BRANAMAN.



This Photograph of a Magnetic Field Is Unique in That It Shows the Relatively Large Change Produced in the Magnetic Flux About a Horse-shoe Magnet by a Faulty Piece of Steel. A "Soft Spot" in the Steel Might Cause Such a Disturbance.

A "REVERSE CURRENT" CUT-OUT FOR BATTERY CHARGING.

The following is a description for making a *reverse current cut-out* for use with six-volt charging systems. The material that was used in the cut-out did not cost anything, the parts and pieces being selected from my collection of "junk."

The magnet spool consists of an iron bolt with two pieces of sheet brass for the ends. The top end is threaded so that the head will turn down and jam into place. About an inch of thread should be left outside to make winding easier. The bottom end has a shoulder cut on it and then the sheet brass riveted on. The bottom spool head should have extending tabs on it, so that it can be screwed to the wooden base without damaging the windings. All holes in the spool heads should be laid out and drilled before assembly of the spool. In order to insulate the windings, it is necessary to glue a thin piece of fibre to each of the heads, and to wrap 2 layers of paper around the core.

The mountings are made of sheet brass. The support for the armature and its spring must be made separate from the spool head, because it would be practically impossible to bend this tab over after the windings are in place. The contact plate must be insulated from the spool head. The contact spring must be insulated from the armature.

The armature and tension spring were taken from a DeVeau buzzer, but this combination may be readily made if such a combination cannot be secured. The chief point is that the tension on the spring is adjustable by means of a threaded rod and nuts. The contact spring should be made of spring brass with a flexible conductor soldered thereto.

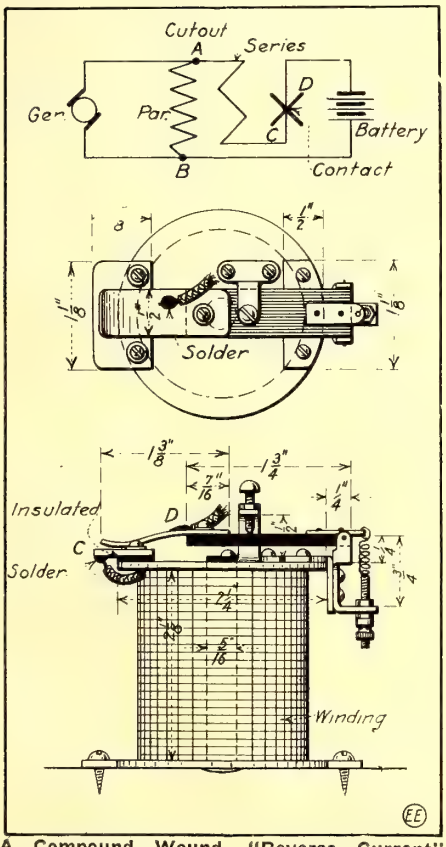
There are two windings on the cut-out. The inner is a *high resistance* "Shunt" winding, and should consist of about ¾ pound of No. 32 magnet wire. (I obtained this wire from a field winding on a fan motor.) Between the inner and the outer windings there should be several layers of paper. The outer winding is a *low resistance* "series" winding and should consist of three or four layers of No. 18 wire. (I have found bell wire very satisfactory.) The outside of the windings should be well covered with tape and shellacked thoroly to exclude dampness.

The connections should be made as per diagram. Make sure to have the connection at A, make the two windings in parallel *aiding*, not bucking. The other end of the series winding should be connected to the contact plate. The connection from the contact spring goes to the line.

Adjustments: Tighten tension on spring until the cut-out will release when the charging current drops to zero. Then turn down the stop pin until the cut-out will operate when the current builds up to charging value. In making these adjustments, be sure that the armature does not come in contact with the core as then it will take greater tension on the armature spring.

These directions are intended only to supplement the accompanying sketches. I have actually made the cut-out herein described, and since it has been in operation, I have not had a single bit of trouble. In order to keep out dirt, it is well to make a cover for it. It can be used on automobile lighting plants, etc.

Contributed by DAVID MATHESON



A Compound Wound, "Reverse Current" Magnetic Cut-out for Battery Charging. It Is Automatic in Its Action and Prevents a Storage Battery from Discharging Back Thru the Dynamo.

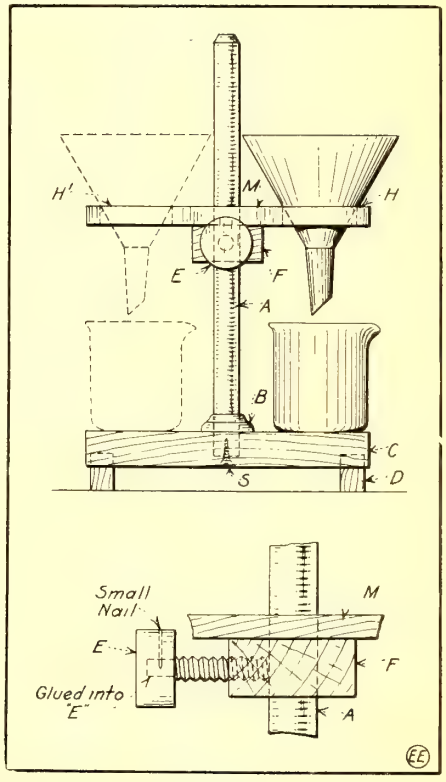
A GOOD FILTER STAND.

Those who follow the "Experimental Chemistry" course in the ELECTRICAL EXPERIMENTER and conduct the experiments will find the apparatus described in this article very useful.

The base (C) is six inches square and cut from oak ¾-inch thick. At each corner small pieces of ½-inch dowel (D) are inserted in holes bored ½-inch deep. The round upright (A) is ¾-inch in diameter and secured in the base by a screw (S).

The piece (M) is of oak, ⅜-inch thick x 6 inches long x 2 inches wide. To this bar is glued the piece (F), 2 inches square and 1 inch thick. A wooden set screw is made and a half-inch hole in (F) as shown in drawing. A hole large enough for (A) to slide thru is bored thru (M) and (F). Two 1½-inch holes, H and H¹ are bored in (M) to hold funnels. A wooden rosette (B) may be added.

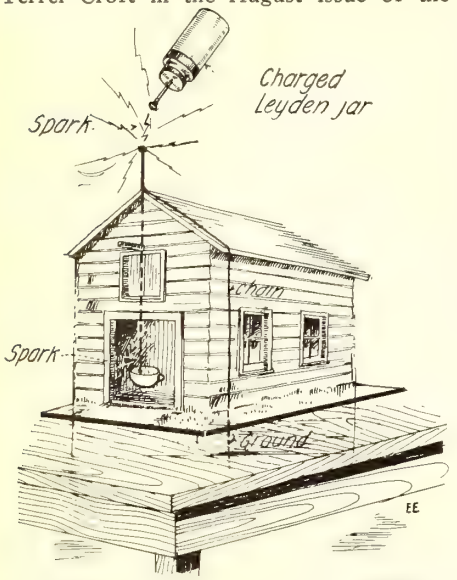
Contributed by D. S. HARDING.



Here Is a Good Home-made Filter Stand for the Amateur Chemist and Photographer. It Can Be Built Any Size Desired and Made to Carry 3 or 4 Funnels.

LIGHTNING EXPERIMENT.

I was much interested in your article on "Thunder-Storms and Lightning Rods" by Terrel Croft in the August issue of the



A Practical Demonstration of the Efficiency of "Lightning Rods." The Leyden Jar Discharges to a Cup of Alcohol, Igniting It, if Lead Wire Is "Ungrounded."

ELECTRICAL EXPERIMENTER, and therefore take pleasure in submitting the following experiment, which I believe will explain thoroly the effect of the lightning rod.

A small wooden building is made, thru which passes a brass rod extending to about 2 or 3 inches from the ground, beneath which a metallic container filled with alcohol is placed (a tin box cover will do). When a charged Leyden jar (or a spark from a static machine) is approached to the top of the rod, a spark will instantly ignite the alcohol, but when a chain or wire running to earth is attached to the top, it will be found that the alcohol will not catch fire, thus *proving the efficiency of the lightning rod.*

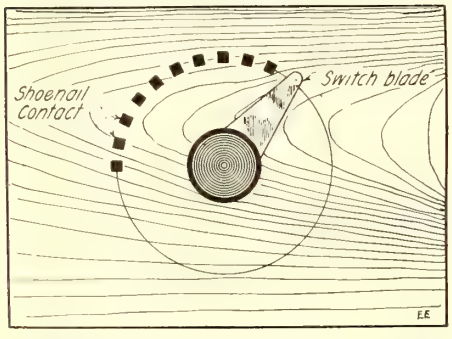
Contributed by EDGAR SINCLAIR.

WHO SAID SHOE-NAIL SWITCHES!!!

In the September issue of the ELECTRICAL EXPERIMENTER, there was a request for some genius to come forward with an electrical use for old "shoe-nails." The said genius has arrived! Hail, hail!!

Shoe-nails make excellent contacts for multi-point switches, such as those used for receiving transformers, loading coils, etc.

The nails are driven into the panel and the leads are soldered to the projecting



Attempt No. 1 At Utilizing Shoe-Nails For Switch Points. Even Mr. Hoover and Dr. Garfield Must Rejoice At the Economics Exemplified.

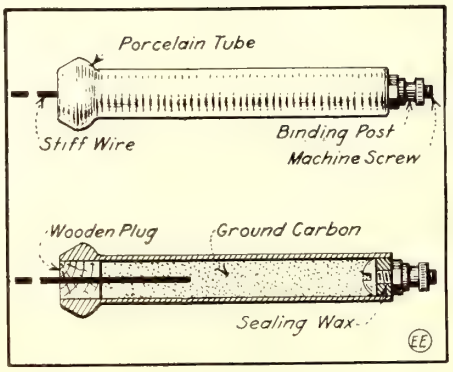
ends. The panel should be thin and of some hard substance to get proper results. Next!!

Contributed by THEODORE SEXTON.

A SIMPLE 110-VOLT RHEOSTAT.

Take a porcelain tube such as is used for house wiring. Procure an 8-32 machine-screw, about 1 inch long, with a head that fills the center of the tube, leaving about ½ inch of the thread projecting beyond the end, Fasten the screw in with sealing wax, taking care that the head on the inside of the tube is not covered. Put a binding post on the screw. Take ground carbon about as coarse as the sand from No. 2 sandpaper and almost fill the tube with this carbon. Plug the end with a wooden plug and bore a small hole thru the plug. Now take a piece of stiff wire slightly smaller than the hole and a little longer than the tube. This rod is to increase or decrease the resistance at will by simply pushing it in or pulling it out. The sealing wax, binding post and carbon I obtained from old dry cells.

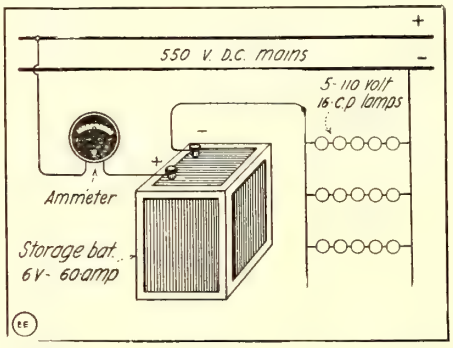
Contributed by ROBERT EASTMAN.



A Simple 110 Volt Rheostat Made of Porcelain Tube Filled With Ground-Up Carbon.

CHARGING STORAGE BATTERIES ON 550-VOLT CIRCUIT.

Charging storage batteries on a 550-volt D.C. circuit can be easily accomplisht, as shown in the diagram, by using incandescent lamps in series with the battery so as to reduce the voltage. Use lamps of 110-volt rating each in series of five, being sure to have the lamps in each group of the same candle-power and current consumption. The lamps may be sixteen, thirty-two, or even higher candle-power. The higher they are in candle-power, and therefore in



Method of Charging Low-Voltage Storage Batteries From 550 Volt D. C. Circuit Thru a Bank of Lamps.

the current which passes thru them at full voltage, the greater will be the charging current for the battery.

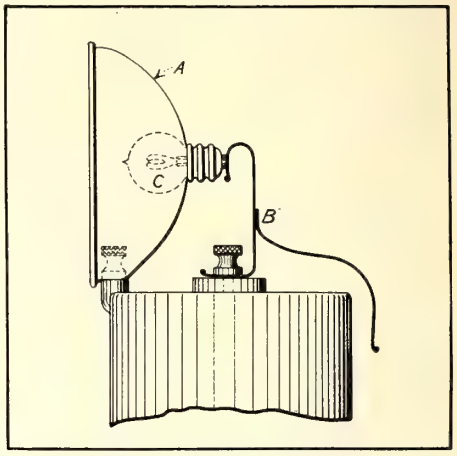
Contributed by PETER J. M. CLUTE.

EXPERIMENTERS!!!

Don't forget to write up that little "stunt." It may win a prize. Address all manuscripts to the Editor, Electrical Experimenter, 233 Fulton Street, New York City.

A DRY CELL LAMP MOUNT.

Procure a reflector (A) from an old "miner's" flashlight and make an 8-32 screw hole in it near the outer edge. Fasten this to the negative pole of the battery with a regular battery nut. Make a brass spring clip (B) about ⅜ of an inch wide, with



A Home-Made Dry Cell Flashlight. It Can Be Constructed From Odd Parts and Gives Excellent Results.

an 8-32 screw hole at one end. Bend as shown and fasten on the carbon terminal of the battery. To turn off lamp turn clip to one side, breaking the circuit.

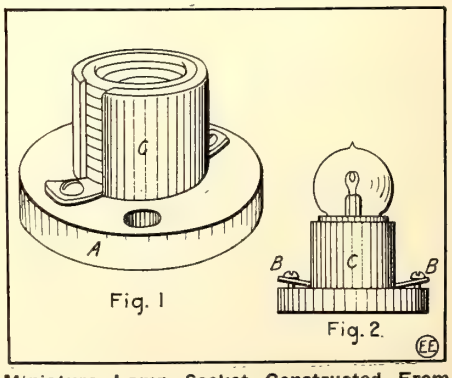
For flashing fasten a piece of spring brass to clip (B) as shown in the figure. This is operated with the thumb. This outfit can be easily adapted to extended carbon types of dry cells.

Contributed by P. B. KINGSLEY.

MINIATURE RECEPTACLE.

In the sketch A is a wooden base 1¼ inches in diameter and ¼ inch thick. B and B are small brass strips ⅛ of an inch wide and ⅜ inches long making contact with the center point of the bulb, and the other being soldered to the wire spiral in the wooden socket. C is a piece of wooden dowel stick ½ inch thick, with a hole for the bulb to fit in snugly. A wire in the shape of a spring is fastened inside the wooden socket by means of a pin bent so as to be used as a staple, and one end is soldered to a spring contact B. Arrange the wire in C so that good contact is made with the side of the bulb.

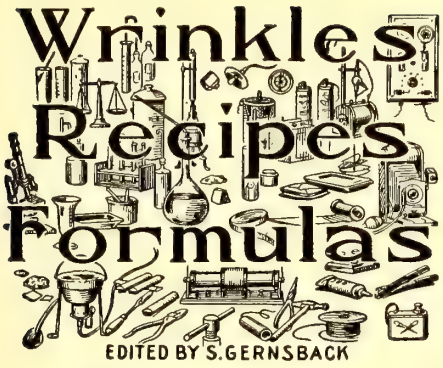
Glue the wooden shell C to the base A. If small brass machine screws can be tapt in strips B and B as binding posts, it will look neater than to put a hole thru the brass parts for the wire to pass thru, and twisting the wire around itself.



Miniature Lamp Socket Constructed From Wooden Shell and Base, In Which a Wire Spiral Is Secured to Form Screw Thread For Lamp.

If good contact is made all around, the receptacle will work as good as one bought from the dealers.

Contributed by WALTER SCHRODER.



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

RESTORING THE COLOR OF MAHOGANY.

Add ½ ounce of Alkanet root, cut small, to a pint of linseed oil and when this has stood for about 5 or 6 days add ½ ounce powdered gum arabic and 1 ounce of shellac varnish. Let this mixture stand near the fire for a week and then strain. Wash the mahogany well with soap and water, before polishing with this recipe. This recipe should be handy to experimenters for polishing the bases of their apparatus.

Mahogany Stain. Dissolve Burnt Sienna in vinegar.

To make paper transparent. By dipping the paper in fresh-distilled benzine, paper becomes transparent. This is handy for experimenters who desire to trace designs without using ordinary tracing paper. The paper becomes opaque as soon as the benzine evaporates and it will be necessary to moisten paper again. Ink will not run on its surface when damp.

Contributed by H. HORTHINGTON.

CEMENT FOR CELLULOID.

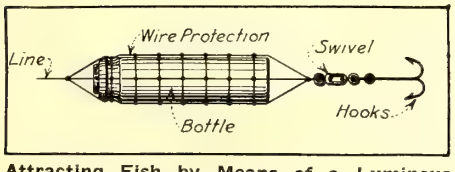
Small celluloid articles can be repaired with this simple cement. Dissolve one part of camphor in forty parts of alcohol and add an equal quantity of shellac.

The cement is applied hot to the parts to be mended and the parts are held together until cooled.

Contributed by
THOMAS W. BENJAMIN.

LUMINOUS FISH BAIT.

All fishermen know that a light will attract fish. The present device comprises a small bottle or vial wound with wire spaced one-eighth of any inch apart. Two hooks are swiveled to the end of the bottle with fish line, tying it to the main line above the bottle. A luminous mixture is then made. Heat some olive oil on the stove for about fifteen minutes, just sizzling and not boiling; then mix in phosphorus



Attracting Fish by Means of a Luminous Bait and Hook.

the size of a small pea. Put in the bottle and cork. This is a fine bait for bass and can be used to an advantage at night. It can be used in winter fishing when the lines are placed thru holes in the ice.

Contributed by RICHARD ANDRESS.

FOR FIREPROOFING ANY KIND OF FABRIC.

A very good formula for this purpose is as follows:

Boric acid, 50 grams.
Borax, 60 grams.
Water, 1,000 cu cms.

Paint or soak fabrics in the solution; then either hang up to dry or press fabric with a hot iron.

Contributed by ALBERT W. PUTLAND.

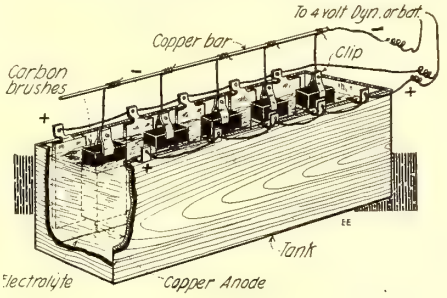
COPPER-PLATING CARBON MOTOR BRUSHES.

It is usual to thoroly copper plate the better class of motor and dynamo brushes made of carbon to improve their surface conductivity, and this may be accomplisht in the following manner:

The carbon brushes are usually cut from flat carbon plates of the desired thickness and measuring 12 by 12 inches. They are cut out in strips, which are then separated into the proper lengths by means of a high speed carborundum or corundum wheel about ¼ inch thick and 12 inches in diameter, rotating at high speed.

The brushes are first washed thoroly and after drying they are dipt in pure paraffin, when they are placed in a bake oven and heated at 110 to 115° F. temperature for 20 to 30 minutes.

They are copper plated by immersing in an electrolyte bath. For small tanks the bath is prepared by mixing two pounds of copper sulfate with one gallon of water and adding ammonia until the precipitate first formed is just redissolved. This colors the solution blue. Potassium cya-



Copper Plating Carbon Brushes in Electrolytic Bath.

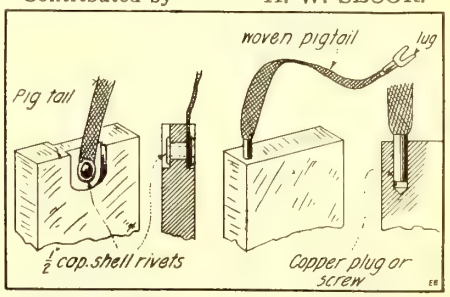
nid is then added until the blue color disappears. This bath should be used at a temperature of 122° F. to 131° F. Another bath, which may be used cold, is composed of a copper sulfate solution with 1/10 of its volume of sulfuric acid. Its density should register 1.197. This bath cannot be used for metal objects attacked by the above chemicals.

Pure copper anodes are placed in the bath, and these may be cut from pure copper sheets about ⅛ inch thick. The carbon brushes are held by spring clips, resulting in about ½ inch of the brush remaining unplated, but this is all right, as the unplated edge is the one ground down to fit the commutator curvature, and the copper plated surface need not necessarily reach the commutator.

The electric current required for a small plating tank is 15 to 20 amperes at 3½ to 4 volts, and a regular electro-plating generator is best employed. The brushes are plated from 4 to 6 minutes generally, but this will vary with the temperature of the electrolyte and the amount of current used.

A little experimenting will soon tell as to how long the brushes should be plated and as to the proper strength of current. It should be possible to regulate the latter by means of a rheostat. If the plating is done too rapidly by using too strong a current then the metal deposit on the brushes will tend to peel or turn black. Hints are given in the illustration for attaching the "pigtail" connectors.

Contributed by H. W. SECOR.



Details of Method Used in Firmly Securing Pig-tail Connections to Carbon Brushes.

HAND GRENADES.

It often happens in a laboratory that some inflammable acid is accidently spilled or some chemicals which do not agree be mixed. A very bad explosion or fire is usually the outcome of such mistakes.

A sanitary and safe device can be made by the experimenter at the cost of a few cents which will end chemical fires as quick as they begin.

It consists of a mixture of chloride of calcium, twenty parts; sodium chloride (common salt), five parts, and water, eighty-five parts. Several small thin bottles are purchased, filled with this mixture and corked.

When a fire occurs, one of these grenades should be thrown in such a way that it will break in or near the fire which will quickly be extinguished. Contributed by
EDWARD G. WILSON.

RADIO-ACTIVITY FROM GAS MANTLES.

Here is an interesting experiment on Radio-activity. I obtained some Welsbach gas mantles and powdering them and placed the same in a cardboard box. I then put a key in the powder and covered it with a piece of cardboard, on top of which I laid a piece of sensitized photographic paper with the sensitized surface down. The above operations were all done in a dark room lighted only by a ruby lamp. The box was then covered and left in a dark room for one week. At the end of this period I found that upon developing the photographic paper that there was an indistinct impression of the key on the same. The radio-active rays which are a property of the rare metal, Thorium, a small quantity of which is contained in these mantels, had past thru the cardboard and affected the sensitized paper.

Contributed by R. E. RAPP.

HOW TO CUT THE TOP OFF A BOTTLE.

Cut a piece of filter or blotting paper in two narrow strips, moisten same and paste around the bottle, each piece of paper parallel to the other, leaving between them a narrow space, marking the place where you want to cut the bottle. Now hold the bottle over the flame of a spirit lamp and turn slowly so that the bare space is heated evenly; after about a minute the glass will break quite clean and will only need to be filed smoothly to take off the sharp edges.

Contributed by G. M. BLUM.

POLE INDICATING SOLUTION FOR BATTERIES.

Formula.—Water, 1 teaspoonful; Phenolphthalein, 3 drops; Potassium Nitrate, 1 teaspoonful.

Directions for Use.—Dip wires into solution, and the one which is negative will color the solution about it red.

Contributed by
BENSON FREEMAN, JR.

Experimental Chemistry

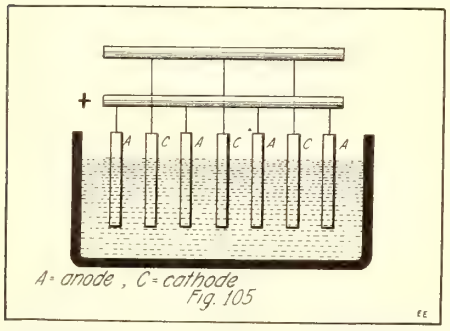
By ALBERT W. WILSDON

Twenty-Second Lesson

APPLICATIONS OF ELECTRO-CHEMISTRY.

ELECTRIC REFINING OF METALS.

THE process of electrolytic refining of metals, altho wide in application, has as yet been chiefly restricted to the refinement of copper. The metal has been obtained as "blister" copper from its ores, sulfids, oxids, etc., containing



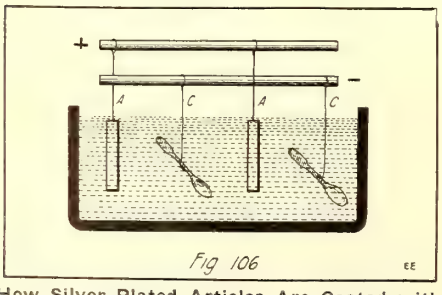
Arrangement of Apparatus for Electrolysis of Copper, Etc. A-Anode, C-Cathode, Both Immersed in Solution of Copper Sulfate with Sulfuric Acid.

many impurities which it is necessary to remove. A solution of copper sulfate with some sulfuric acid is put into a vat or tank, which is connected with the source of electricity, and a bar of thick plates of the crude impure copper is then suspended in the solution, and made the *anode*. The *cathodes* consist of very thin plates of the pure copper. (See Fig. 105).

The curent causes the copper ions from the copper sulfate in solution to deposit on the copper cathode, while the sulfate ions at the anode form a complex reaction, the result of which is to dissolve off more copper from the anode, thus tending to keep equilibrium in the solution. The *impurities* from the copper anode gradually settle in the bottom of the tank, and only pure copper collects on the cathode. Millions of pounds of copper are refined by this process each year in the United States, and since the beginning of the European War the output has increased to a very marked degree, having changed from a purity of 95 or 98% to practically 100%. This is called *electrolytic*, or refined copper. Native copper from Lake Superior does not need this refining, and usually sells for a fraction of a cent a pound higher than the electrolytic variety.

Theory.

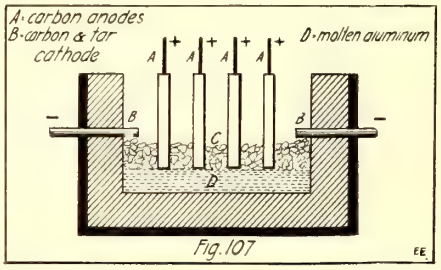
The theory of this action is that the copper sulfate molecules break up into copper and sulfate ions by solution. When the current passes, copper ions deposit as copper atoms on the cathode, (C in Fig. 105); sulfate ions at the anode (A in Fig. 105) become sulfate radicals, and at once break down into SO_3 and O, represented by the equation $SO_4 = SO_3 + O$, the oxygen being liberated and set free, while the former, SO_3, having a strong affinity for water, combines with it to form sulfuric acid, which at once dissolves from the anode to form copper sulfate, which is ionized to Cu^{++} and SO_4^{--}, and the operation is rendered continuous. No new supply of sulfuric acid or of copper sulfate is needed. The bar of impure copper becomes reduced as the refined metal increases at the cathode.



How Silver-Plated Articles Are Coated with Precious Metals by Electrolysis. The Spoons, Etc., Form the Cathode, a Bar of Silver Serving as the Anode.

The tank house of one modern electrolytic plant for refining copper is 600 by 200 feet, contains 1,600 depositing tanks, each having 22 copper anodes, each of which weighs about 400 pounds. These are put in place by means of cranes, and after being allowed to remain in the tank for about 43 days the remnant is taken out as scrap and resmelted. The cathodes (refined copper) are taken out every 7 days with the employment of cranes, a tankful at a time. Slimes are removed once in three months. The liquid contains from 12 to 20% copper sulfate, and from 4 to 10% of sulfuric acid.

The electrolytic refining of zinc and nickel have also been tried on a large scale but have not been as yet entirely successful. The zinc deposit has a tendency to be spongy and readily oxidizable and the nickel ores require previous smelting and contain many impurities.



Modern Method of Obtaining Pure Aluminum by Electrolysis. A Set of Multiple Electrodes (Carbon Anodes-A) Are Inserted in the Ore to Be Reduced as Shown, the Molten Aluminum Accumulating at "D."

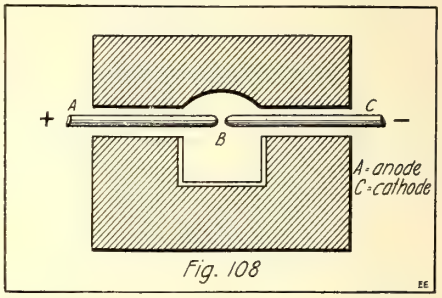
The recovery of metallic tin from scrap tin plate is another application of electrolytic refining that has been developed quite extensively in recent years. It takes place in alkaline solution and the tin goes into solution as an alkaline stannat.

The electrolytic refining of silver and its separation from gold and platinum contained in the silver bullion is also extensively practised and is gradually superseding the method of "parting" by nitric acid.

Electrotyping.

The process of electrotyping is almost the same as that described in refining copper. Most books are now printed from electrotypes, as are the entire pages of this journal, and they are also employed for printing maps, illustrations and numerous periodicals, etc.

The type is first set up, making pages of the size desired. An impression is made of the type or wood cut in a mineral wax, which is composed of a mixture of beeswax, turpentine and grafite, so as to have an exact opposite of the face type; that is, the projections of the type form indentations in the wax. The plate is called a *case*, and is impregnated with a fine coating of powdered grafite which affords the *conducting surface*. These impressions are hung from copper hooks, and form the cathode, in a vat containing a strong solution of copper sulfate acidulated with sulfuric acid, and a bar of copper forms the anode, as was the case in the refining process. Copper is deposited on the grafite cathode of wax to any desired thickness, and it reproduces faithfully every projection, indentation and line of the original. It is permitted to remain in the bath from



Moissan's Electric Furnace. Space Is Provided at "B" for Substance to Be Electrically Melted. In Such a Device Small Diamonds Have Been Made from Carbon.

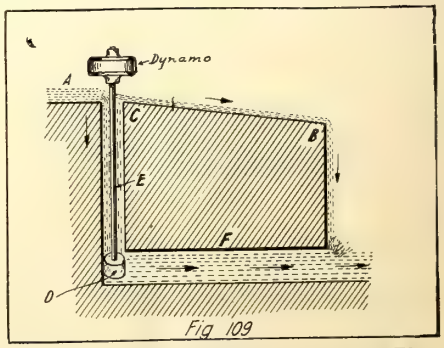
three to eight hours, depending upon the thickness desired. The film of copper does not adhere to the wax or grafite, and can be easily removed by hot hydrochloric acid. After removal from the moulds, the back is cleaned, a thing layer of tin foil is melted on it, and finally it is filled with molten type metal to render it rigid. The face is then of rigid copper, which is mounted on a suitable wooden support, called a block. This copper electrotype is harder and more lasting and durable than type metal. Copper is practically the only metal used for electrotyping. Recently a process was invented for electrotyping by steel, which is much harder and more lasting than copper, but its drawback lies in the fact that it rusts, and it probably will never entirely supersede copper.

Electroplating.

Electroplating is the *electrolytic deposition* of one metal upon another. It differs from electrotyping in that the deposit of copper or other metal is fixt permanently on the surface of the base metal, which forms the cathode, and is not removed, as was the case of the former process. The chief metals employed for electroplating are; gold, examples of which work are gold-plated watches and cigarette cases, etc., silver, used to plate knives and forks, etc., nickel, copper and platinum, and such alloys as brass and German-silver.

The cathode, which may be iron, copper, brass, bell metal, or other base metal or alloy, is first very thoroly cleaned with sulfuric acid to rid the surface of all traces

(*Continued on page* 801)



Sectional View of the Gigantic Hydro-Electric Plant at Niagara Falls. A Case of Utilizing the Chemical Action of the Sun's Rays Indirectly.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

"Electrical Laboratory" Contest

As announced in this department in the February issue, we are desirous of publishing each month a special article describing an exceptional Amateur Electrician's experimental laboratory. Such a laboratory will be found illustrated and described with several excellent photos on another page of the present issue. For prizes and instructions in preparing the articles and photos see the February issue. We now wish to say a few words with regard to the present laboratory contest. We are pleased to bring to the attention of all Radio and Electrical "bugs" two ex-radio amateur enthusiasts, who are shown in the photos at the upper right and left corners of the group. At the left we have a photo of the wireless set used prior to the war by Miss Edith Charmont of Cleveland, Ohio, and who has now joined the American Red Cross. She will probably go across the ocean and join in the "big game" before long. We are pleased to introduce a well-known ex-radio amateur—9 TL—known to his friends as Forest Longbrake, of Sheffield, Mo., but more recently of the 313th Field Signal Battalion at Camp Dodge, Iowa, and who expects soon to "go across" to France. Mr. Longbrake mentions that he has done lots of long distance work in the good old amateur days, with the set illustrated in his laboratory below. Once more—don't forget to read the important announcement in the February issue. Address all photos and manuscripts to the Editor "With the Amateurs Prize Contest."



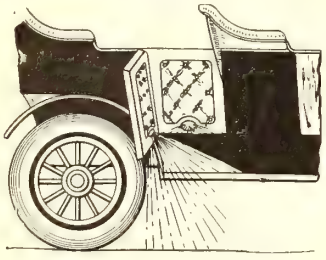
A GROUP OF REPRESENTATIVE AMERICAN AMATEUR LABORATORIES.
Radio Stations of, 1—Miss Edith Charmont, Cleveland, Ohio; 2—Forest Longbrake, Sheffield, Mo. Electrical Laboratories of, 3—Chas. P. McLaughlin, Cadiz, Ohio (First Prize); 4—Ralph P. Anderson, Selma, Calif.; 5—Vernon Clements, Elmwood, Nebraska; 6—Carroll Whitney, Waterloo, Iowa; 7—Frank Henninger, Pawnee, Ill.; 8—Scott E. Vance, Hillsboro, Ohio.

LATEST PATENTS

Door-Light for Autos

(No. 1,248,930; issued to Albert C. Schulz.)

An idea capable of wide application and providing electric light on the step of an auto whenever the door is opened, while the light on the closed door lights up simultaneously, and thus illuminates the

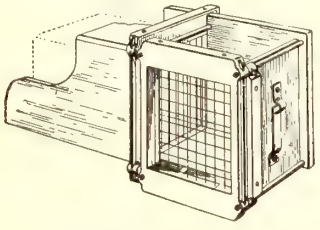


floor of the car. The lights are supplied with current from the car's storage battery or from dry cells, and are controlled by automatic switches mounted behind the doors. The circuits are inter-wired so that the lamps light in the manner above described. A glass window is placed in front of the lamp as well as underneath the lamp, so that the light shines in a horizontal plane as well as a vertical one.

Electric Ice Cutter

(No. 1,250,010; issued to Germain Pouchan.)

A clever invention intended for use in hotels, restaurants, etc., for the purpose of cutting ice into small blocks or cubes for table use. The inventor provides in this device one or more sets of wires which are heated by electricity and to be kept in contact momentarily, and thus the hot wires melt their way thru the ice. By using a suitable number

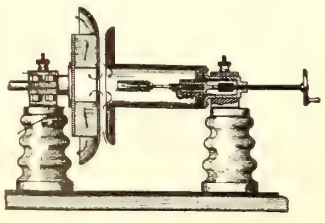


of sets of such wires, the ice may be cut in as many planes as is desirable. In cutting it into cubes, it must be cut in three planes at right angles to each other, and in this case the inventor provides three sets of parallel wires, the wires of each set to be so positioned as to cut the ice in the manner above described.

High Tension Rectifier

(No. 1,251,269; issued to A. Mulvany and E. Kennedy.)

The high tension rectifier here shown is intended particularly for use with X-ray tube circuits, for the purpose of converting high tension A.C. from the secondary of a step-up transformer into a high potential uni-directional current.

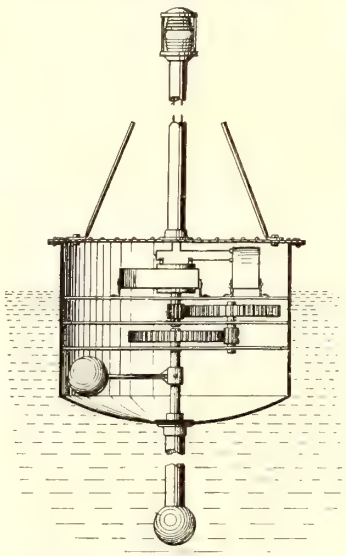


This rectifier takes advantage of the electrostatic field intensities surrounding electrodes of different areas. Means are provided, such as by an electric blower, for removing the ionized air and metal gases from between the edectrodes and simultaneously cooling one electrode, while means are provided for retaining the heat of the other electrode, to permit the generation of cathode rays.

Automatic Electric-Light Buoy

(No. 1,248,850; issued to H. Hartman.)

The main object of this device is to provide an independent and automatic electric light buoy of simple construction, which can generate its own electricity for lighting a lamp at its mast head without batteries or other apparatus requiring constant or periodical maintenance. The device comprises certain mechanical features whereby motive power for driving a high tension magneto is

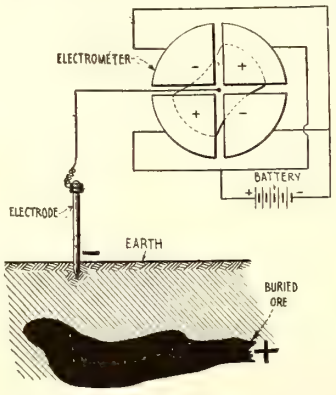


derived from the constant wave action of the sea. A heavy weight is mounted on the main shaft of the mechanism so that as the buoy pitches about on the waves, this weight follows the law of gravity and swings back and forth. The magneto is connected in series with a lamp of the Geissler tube type, and a suitable condenser.

Electric Ore Detector

(No. 1,248,380; issued to Rupert Nelson.)

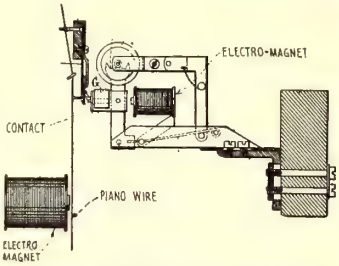
Different metals can be substituted for the electrode that is inserted



into the earth, so as to determine whether the ore is positively or negatively electrified with relation to the electrode, thus ascertaining into what class the ore belongs. The apparatus employed for the purpose includes a source of current such as a battery and a quadrant type electrometer, connected up in the manner shown. The diametrically opposite quadrants are connected to opposite sides of the battery so as to be electrified, negatively and positively respectively.

Electric Piano Player

(No. 1,249,157; issued to Alcide H. Maitre and Victor H. Gaston Martin.)

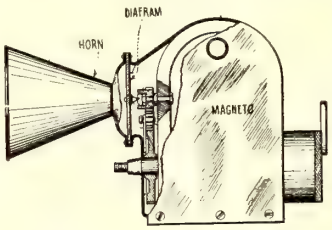


This patent deals principally with a unique electromagnetic interrupter for producing musical sounds such as by vibrating the strings of a piano or other instrument. The device is claimed to damp out false vibrations, and to suppress extraneous noises, so as to give a pure sound. The electrical interrupter contacts are subjected to the vibrations of the spring. There is also provided an independent spring pressing one of the contact members into engagement with the vibrating musical spring, so as to cause the sonorous vibrations of this string to faithfully react on the interrupter contact spring.

Combination Magneto and Horn

(No. 1,249,255; issued to H. R. Van Deventer.)

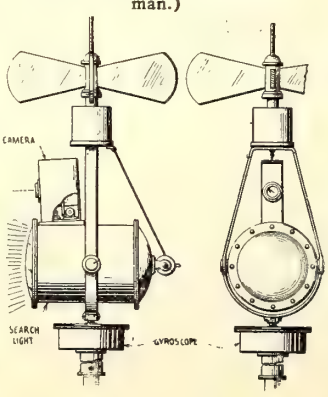
A combination dynamo or magneto and auto horn of simple design. The magneto is driven constantly as in the regular auto equipment, and the horn is mounted at one end of the magneto frame as



shown. By means of a sliding gear and a lever connected with a control rod and handle, leading up to the driver's seat, it becomes possible to bring a pinion into contact with a stud on the diafram of the horn and thus cause it to operate.

Submarine Movie Camera

(No. 1,250,582; issued to H. Hartman.)

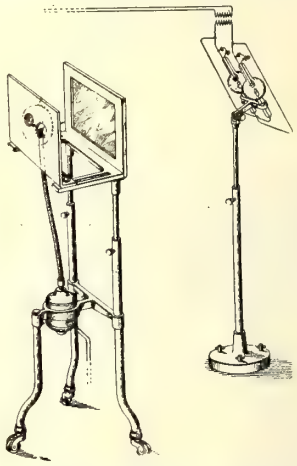


This apparatus provides for the taking of submarine motion pictures at various depths of the sea. The device is provided with electric motor stabilizer, and the various electrical features involved in the operation and orientation are controlled from the surface of the water by means of electrical conductors leading downward thru a well insulated cable. The outfit is provided with a shock absorbing member at its lower extremity in the event that the device might be lowered too rapidly in some instances.

Stereoscopic X-Ray Apparatus

(No. 1,250,093; issued to William D. Coolidge.)

The invention requires the use of two X-ray tubes, connected in a certain manner to a high tension transformer, while the successive images produced by these two X-ray tubes on a fluorescent screen are viewed in proper relation, first by

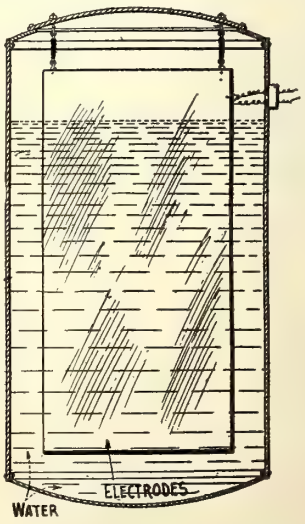


one eye of the observer and then by the other, in perfect synchronism with the current impulses so as to produce the effect of an image seen in stereoscopic relief.

Electric Boiler

(No. 1,251,116; issued to Ora E. Sarr.)

This invention appertains generally to electric boilers, and aims to provide an improved form of electrically heated steam generator, wherein steam for operating an engine or other device is produced



by the passage of an electrical current thru water, circulating around and between a series of oppositely charged electrodes in the form of metal plates, these plates being suspended in the water within the boiler. The patent covers special means for suspending the electrode plates within the boiler.

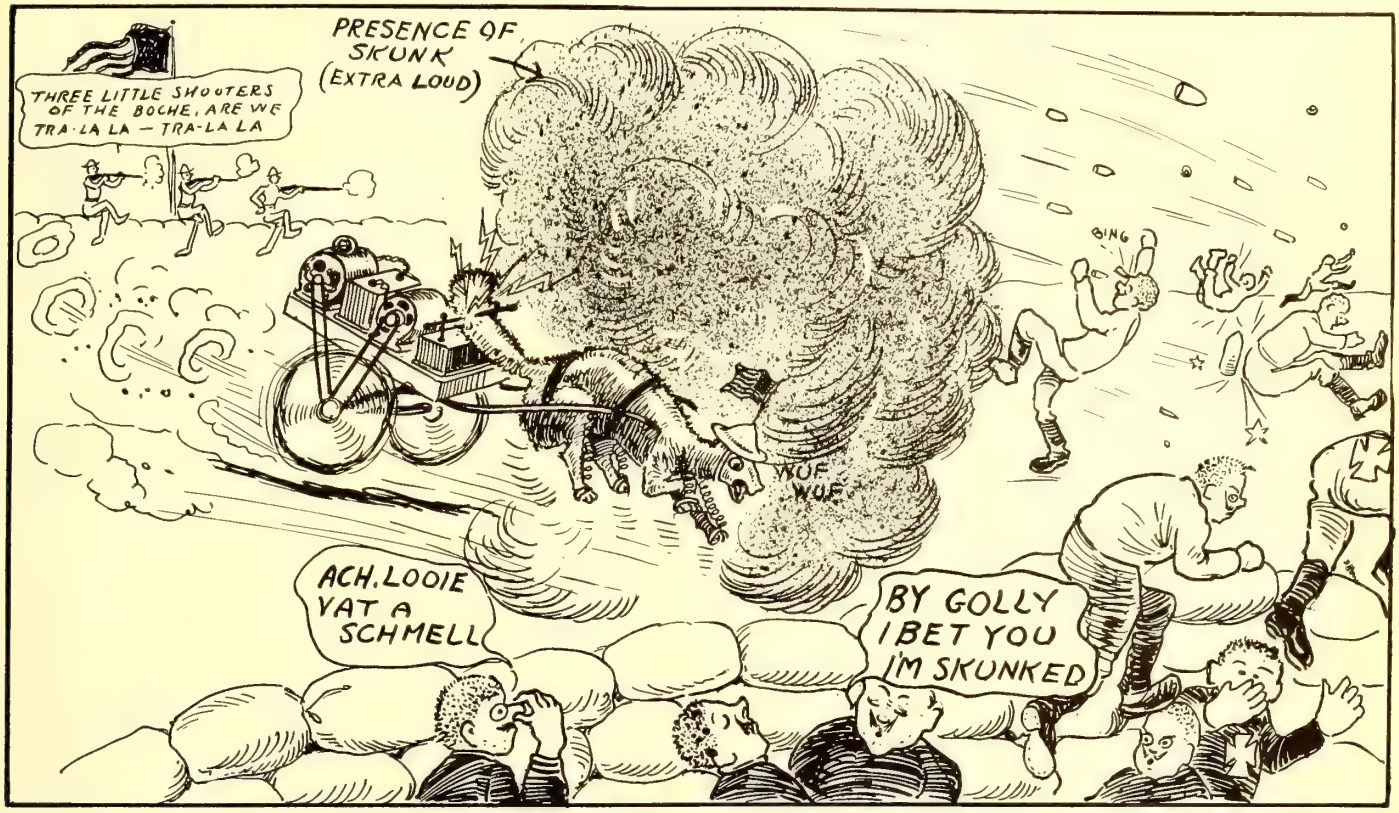
COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c EACH.

Phoney Patents

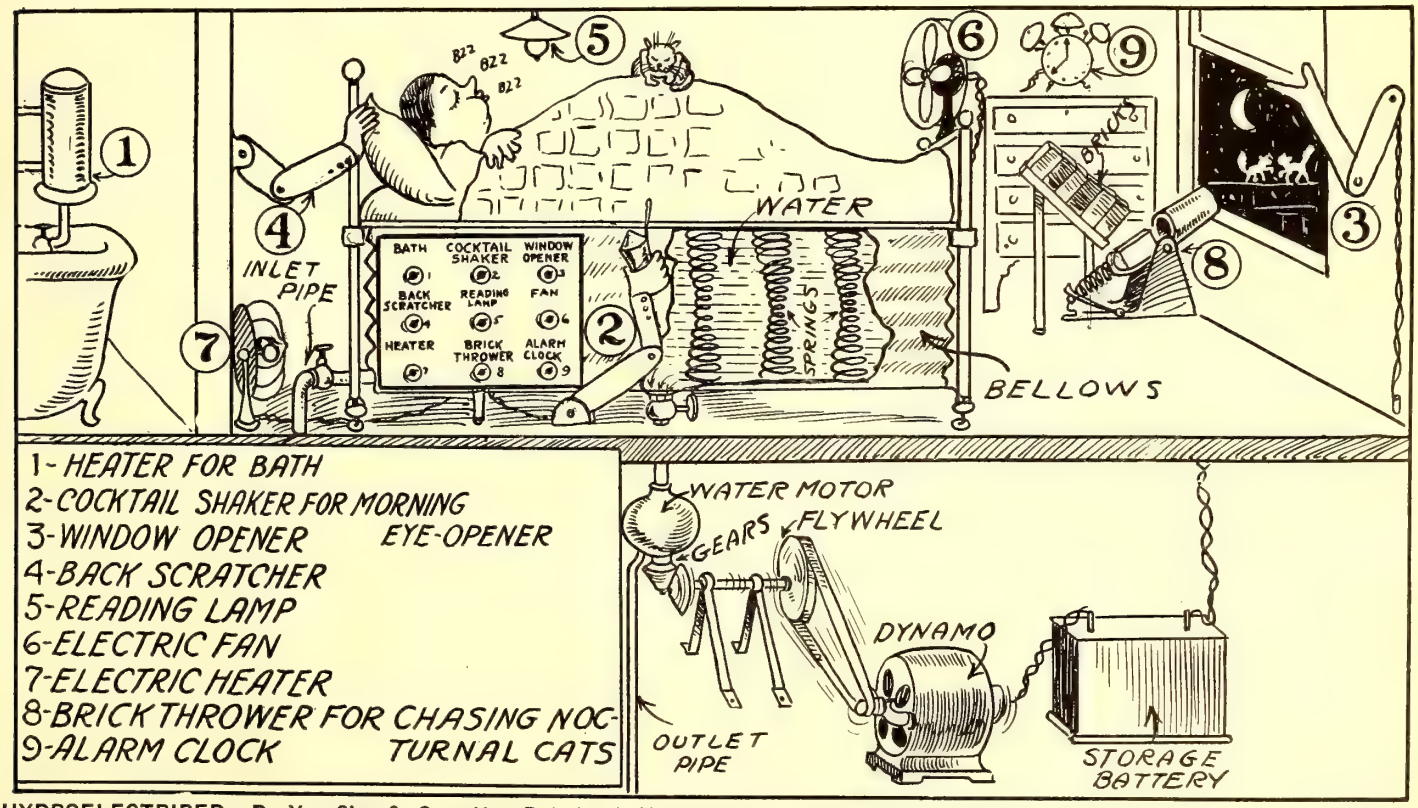
Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for the entire universe.

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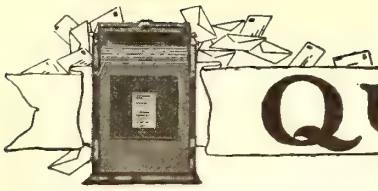
PHONEY PATENT OFFIZZ



Prize Winner. SKUNK GASSER. "Well, I've Been Skunked," Will Soon Be Heard Among the European Trench Inhabitants—at Least Just as Soon as I Can Get Official Washington to Consider the Merits of My Sure-fire Hun Destroyer. Several Hundred Battalions of Tame Skunks Are Hitched to Small Two-wheeled Carts, Each Containing a Dynamo, Motor, Storage Battery, and Spark Coil. Dynamo Charges Battery, Which Runs Motor. Motor Drives Cart. Skunk Can't Stop Once Spark Tickles Him. The Limburger-lovers Are Soon "Skunked" and the Sammies Do the Rest. Inventor, Rex Purcell, Mo. Valley, Iowa.



HYDROELECTRIBED. Do You Sleep? Sure You Do! Well, Here's the Latest Convenience for All Those Who Hit the Hay, either Periodically or Regularly. Just Before Retiring, Turn on the Water-valve Suppying the "Mattress Bellows." You Rise as You Snore, and While Sleeping Produce a High Pressure in the Bellows. This Water Pressure Runs a Turbine Connected to a Dynamo. The Dynamo Charges a Storage Battery. The Latter Furnishes Electric Current Free of Charge for Electric Light, Heater, Cock-tail Mixer, Fan, Alarm Clock, Ad Lib—Ad Infinitum. What More Could Mortal Want? Inventor, John Renault, Angers, France.



QUESTION BOX

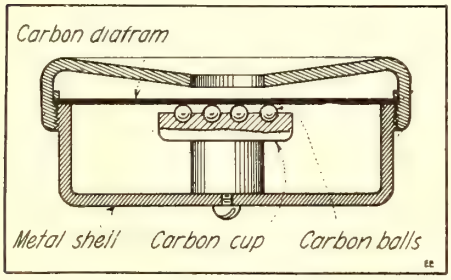
This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

SUPERSENSITIVE MICROPHONE.

(894) A. E. Glazier, of Oakland, Cal., requests:

Q. 1. Will you please publish a diagram of the interior parts of the *Super-Sensitive Microphone* such as is used for detective work and explain parts of the same; how



Sectional View of Super-Sensitive Microphone as Used in Loud-Speaking Telephones For Detective Work, Interior Telephone Systems, Etc.

does it differ from the telephone transmitter?

A. 1. The diagram herewith gives the schematic arrangement of a super-sensitive microphone as used in detective work. The essential parts of such a microphone are the container, usually made out of metal, the carbon diafram and a carbon cup. A very high grade of polished carbon balls are used in this carbon container, and the carbon diafram of which is so adjusted that they touch this diafram very lightly.

The main difference between an ordinary telephone transmitter and that of a super-sensitive type is the way in which the carbon grains are utilized. In the super-sensitive microphones, carbon balls and a carbon diafram are used, together with a fairly heavy current and a low resistance telephone receiver, having a resistance of about 5 ohms.

ELECTRO-MAGNET.

(895) W. C. Mace, Marshfield, Ore., writes:

Q. 1. Please give in detail specifications for an electro-magnet necessary to pull an iron lever thru 90 degrees into a horizontal position. There is very little resistance on this lever; approximately an equivalent of three pounds' pull. I would like to know the amount of wire, size of wire, size of soft iron core and amount of current necessary. I have unlimited current.

A. 1. A suitable electro-magnet for obtaining results such as you desire is specified below: The soft iron core should consist of a soft iron bar ½ inch in diameter and 3 inches long. Fiber bobbin ends 2 inches in diameter are placed at each end of this iron core, and then fully winding the intermediate space of said bobbins with No. 22 B. & S. D. C. C. copper magnet wire, and the ends of this winding should be brought out thru two holes protruding thru the end bobbin. The winding should be carefully protected by covering it with tape. Voltage used 12 volts and current about .75 ampere.

SQUIRE'S WIRED WIRELESS.

(896) Cyril Thorn, of St. Louis, Mo., asks:

Q. 1. In number 9 of Hawkin's Electrical Guides, on page 2337, a method is explained whereby you can telephone or telegraph over a single wire, without using a return wire. It is called Squire's *Wired Wireless*. As it does not describe fully how this is done, I do not understand it, and would like to know how it works.

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As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 *to* 150 *words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.*

Address photos to—Editor "Odd Photos," ELECTRICAL EXPERIMENTER, *233 Fulton Street, New York City.*

A. 1. The operation of Squire's *Wired Wireless* is dependent upon the transmission of alternating currents of different (above audibility) frequencies over a single line.

Let us suppose that the equipment is to be utilized for the transmission of telegraph and telephone messages. Several telephone and telegraph stations are linked electrically to a single wire, and each of these stations are *tuned* to a separate or individual frequency. The transmitters of each of these stations are equipt with alternating current generators supplying currents of frequencies corresponding to those used in the receiving stations, so that by means of a switch one can control the frequencies very easily. When the party desires to obtain a certain station, he merely throws over the switch controlling the frequencies to the particular frequency of the desired station, and thereby he is able to communicate with said station. No two different frequency currents can interfere with each other; thus the selectivity of the system. The first station might have a frequency of 30,000 cycles per second; the second station a frequency of 33,000 cycles per second, etc., etc.

WAVE METER QUERY.

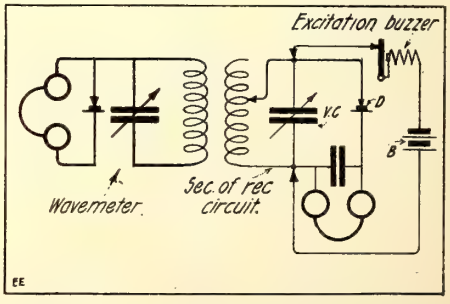
(897) John Halson, of Baltimore, Md., wishes to know:

Q. 1. How to utilize the wave meter for obtaining the wave length of a distant station.

A. 1. The manner in which you can apply the wave meter for measuring the wave length of a distant station is by arranging the apparatus as indicated in diagram. The received signal is first tuned to the required wave length of the distant station by varying the various inductances and capacities in the receiving circuit. Then by introducing a buzzer excitation circuit in the secondary circuit as indicated, and receiving this excitation current in the wave meter, resonance between the secondary and the wave meter will indicate the wave length which was originally received by the receiving set. By referring to the original calibrated curves of the wave meter the wave length of the distant station is thus obtained.

Q. 2. What causes a double humped resonance curve in an oscillatory circuit in a transmitter?

A. 2. Too close coupling between the secondary and primary circuit results in a double humped curve.



Circuits Used in Determining the Wave Length of a Received Signal By Means of the Wave-Meter.

ILLUMINATION QUERY.

(898) Paul Johnson, of Detroit, Mich., desires to know:

Q. 1. What disadvantage has a frosted glass upon an incandescent tungsten lamp?

A. 1. There are several disadvantages from using frosted glass on tungsten lamps; namely, the increase of temperature within the bulb due to multiple reflections of the irregular surfaces produced by the frosted glass, which naturally decreases the life of the filament due to the operation of the filament at higher temperatures. Secondly, the decrease of surface illumination produced by such a lamp, due to a gathering of dust in the fine irregular sections of the frosted glass.

Q. 2. What are *getters* in incandescent lamps?

A. 2. *Getters* are chemical compounds which are used to absorb the vaporized tungsten produced by the heated filament and retransferred back to the filament in order that the filament will be kept at the some thickness as it was originally. This retransformation is a chemical process, and very little is known about it, as the commercial companies are keeping it secret. However, it may be said that originally, when the incandescent lamp was begun, that halogen members of the chemical group were utilized, viz.: bromin and iodin.

Q. 3. What is a micron?

A. 3. A *micron* is the unit of intensity of illumination and is numerically equal to one one-thousandth of a millimeter.

ELECTRIC OIL AND WATER FINDER.

(899.) Mr. Phil Buracker, 828 Downing St., Denver, Colo., asks for data on:

Q. 1. A special form of "Hughes' balance" for locating underground ore, etc.

A. 1. Concerning special form of the Hughes' Induction Balance for locating metallic masses buried in the ground, etc., we would suggest that you read the article appearing in the August, 1916, issue of THE ELECTRICAL EXPERIMENTER, copy of which we can supply at 20c.

This article contains the basic principle upon which all such apparatus, of no matter what size, should be designed. With regard to the size of the inductance coil, these can be of any dimension desired, but, of course, the size of the wire and the number of turns on each coil will have to be judged by experiment to a large extent. Considering that the coils are made with a fairly large number of turns in proportion to their size, then the problem of exciting these coils properly is mostly a matter of experiment, and one which can be solved quickly.

If a buzzer fitted with an auxiliary battery contact is used as described in the article above mentioned, to excite the two primary coils of such an apparatus, then it is but necessary to increase the battery current or number of batteries in this exciting circuit thru the primary coils, and the sensitivity of the entire outfit checked up by approaching the coils with a metal mass such as an iron tank or any other metal object of fair size which may be at hand.

The diameter of the two coil bobbins or forms used on the French "shell locating" balance measure about 2½ feet in diameter, and one primary and one secondary coil are wound on each of the two bobbins, these bobbins being supported from a transverse bar carried on a light two-wheeled truck so as to be readily pushed along the ground when in use.

Q. 2. What is meant by the term "layer on layer?"

A. 2. With reference to the term "layer on layer," this simply means to follow the usual construction in winding electro-magnets or other coils and when one layer has been wound on, the second layer is wound



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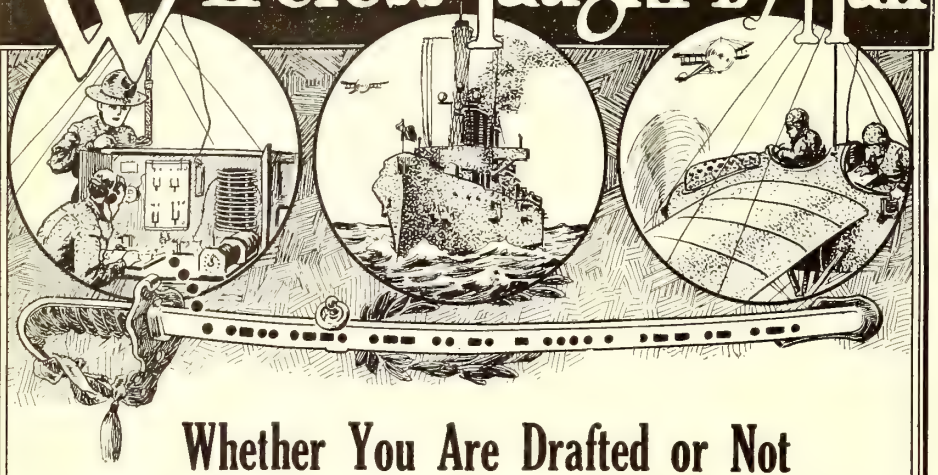
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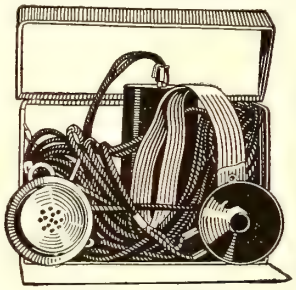
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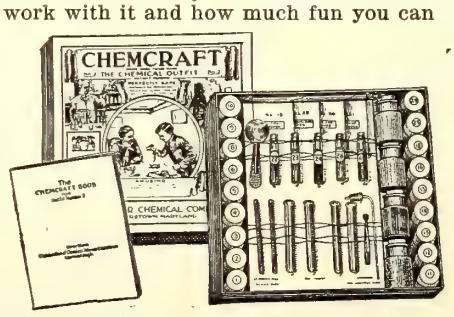
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over this in the usual manner, back and forth until the required number of turns have been placed on the coil.

Q. 3. Is there any form of electrical oil and water locater?

A. 3. Yes, an English concern has evolved a very successful electrical apparatus for this particular purpose, which has been approved and used with success by the engineers of the British government both in England and in foreign countries; particularly in India, where it has heretofore been extremely difficult to successfully locate flowing water in order to bore the necessary wells, of which a very large number exist in that country.

The principle on which the instrument works is the indicating of the presence of currents which flow between earth and atmosphere, and which, seeking the path of greatest conductivity are always strongest in the vicinity of subterranean water courses, the waters of which are charged with electricity to a certain degree.

In taking observations, wooden pegs are placed at intervals of twenty paces in a direction usually S. E. to N. W. The instrument is tried over each of these pegs in turn, and should the needle move on any one of them, tests are made all round it, and the spot where the greatest movement of the needle is obtained is where the boring should be made. If the needle does not move, subterranean water does not exist under the spot where the instrument is fixt.

The instrument indicates water courses flowing underground in a natural state, and not water pipes or sources that have sprung up to daylight. Observations should always be taken on a fine, calm, clear day between 8 and 12 in the morning and 2 and 5 in the afternoon, these being the hours of greatest activity of the vertical earth-air currents. Send us stamped and self-addrest envelope and we will gladly give you the name of the concern making this apparatus.

MISCELLANEOUS QUESTIONS.

SPECTRUM OF THE AURORA.

(900) A. D., San Francisco, Cal., writes the "Question Box":

Q. 1. Is anything positive known about the nature of heat lighting?

A. 1. With reference to the exact nature of heat lightning, nothing specific is known concerning this phenomena, but it is generally conceded that heat lightning is nothing more nor less than the reflection of powerful lightning discharges at a considerable distance.

Q. 2. (*a*) Has the spectrum of the Aurora ever been determined exactly or is it variable? (*b*) Can a gas be rendered luminous under the influence of heat alone, and if so is its spectrum identical with that of the same gas illuminated by an electric discharge in a vacuum tube? (*c*) In the event of gases not being known to be luminous under the influence of heat alone how can we explain the explosions of incandescent hydrogen witnessed during total solar eclipses, and how can we explain the illumination of gases in neubulae? (*d*) Are there such things as phosphorescent gases?

A. 2. (*a*) The spectrum of the Aurora has been measured by different investigators, but owing to the rapid and sudden changes in the coloring as well as the extent of the Aurora the spectrum varies likewise. However, several interesting points have been discovered in this direction, particularly in regard to the presence of certain rare gases in the upper region of the Aurora.

(*b*) It is possible to make a gas luminous under the influence of heat alone,

and the degree of luminosity depends upon the pressure of the gas due to its expansion, etc. The spectrum of this illuminated gas is the same as when excited by any other means, such as by the application of electric current.

(*c*) The explosions of incandescent hydrogen witnessed during total solar eclipses, and also the illumination of gases in nebulae are undoubtedly due to the presence of nascent hydrogen and also oxygen, which by the electrical disturbances occuring in these gases cause sudden molecular explosions. This is most probably due to the electrical bombardments of the gaseous ions, this causing the gas to become luminous.

(*d*) So far as we know there is no such thing as a phosphorescent gas.

Q. 3. (*a*) Where can I buy a book treating such subjects as unipolar lamps illuminated by High Frequency Currents; Fleming valves, Cooper-Hewitt lamps used as valves and vacuum tubes containing three electrodes used as detectors for Hertzian waves. (*b*) In the study of selective reflection there is a point I fail to grasp. We are informed that certain substances possess systems which vibrate with well defined periods. These systems reflect light falling on the substance only when the incident light is of the same frequency and in this case reflect it totally, producing the phenomenon of *selective reflection*. We further know that when these natural periods of vibration reside in the infra-red the vibrating system is no longer an electron but a *molecule*. Now a molecule is generally neutral as opposed to an electron, which is negative electricity.

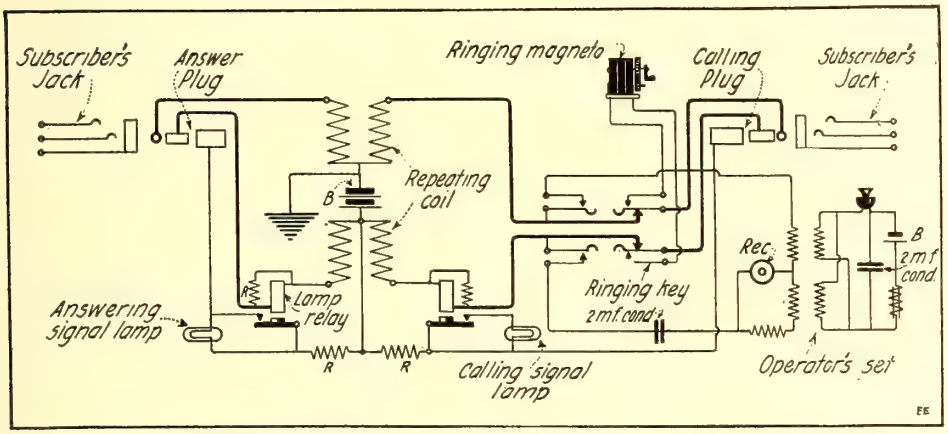
How then can the vibration of a neutral molecule reflect light since reflection is due to the radiation produced by vibrating electrons? Are we to suppose that neutral molecules can radiate energy when in vibratory motion, or are we to suppose the molecules cease to be neutral when vibrating?

A. 3. (*a*) We would recommend Dr. Nikola Tesla's book entitled "Experiments with Currents of High Frequency and Potential" which contains much valuable information on unipolar lamps lighted by high frequency currents, etc. For information concerning the Fleming valve and other valves of similar type, we would recommend that you consult any of the modern hand-books on Radio-telegraphy, including the excellent work of Dr. J. A. Fleming, which we can supply at $10 net. An exhaustive article describing the exact mode of operation of the Audion appeared in the August, 1916, issue of THE ELECTRICAL EXPERIMENTER, page 251, and which is one of the most authoritative that has appeared on the subject, the article having been past upon by Dr. de Forest and several other leading experts on this class of device.

(*b*) This is a somewhat complex subject and we would suggest if you have not already consulted back issues of the General Electric Review that you would do well to look up some very interesting articles on the subject of selective reflection which appeared therein about one year ago.

In general, it would seem reasonable to suppose that the molecules in a certain structure cease to be neutral when they are set into vibration by the application of some external means, such as by the rays from an X-ray tube or by ultra-violet light from a spark gap, arc light, etc.

You will find it worth your while to consult several of the newer books treating on molecular structure, and we take pleasure in suggesting one of the very latest works in this direction entitled "The Electron—Its Isolation and Measurement and the Determination of Some of Its Properties," by Prof. Robert A. Millikan, one of the foremost scientists in this branch of philosophical research. Our "Book Department" can supply a copy of this book at $1.60 prepaid.



Typical Circuits of Bell Telephone Exchange, Showing Position of Repeating and Retardation Coils, Lamp Call Signals, Et Cetera.

THE BELL TELEPHONE SYSTEM.

(901.) L. Slack, of Pittsburgh, Pa., asks:

Q. 1. Kindly give me some information as to the external and internal wiring of the Bell Telephone System.

A. 1. It would be impossible for us to give you full details, and especially a complete wiring diagram, of the Bell Telephone System in this column.

However, we are herewith giving you part of the circuit as used in the central exchange. It shows clearly how the various repeating and retardation coils are used.

TELEPHONE RELAYS.

(902.) J. H. Wood, Iowa, asks:

Q. 1. What is the state of the work now done by the telephone relay?

A. 1. The Bell Telephone Co. is now using a very successful form of telephone relay of the Audion type on their long distance lines, between the eastern and western coasts. If you talk from New York to San Francisco, your "voice" passes thru one of these Audion relays.

Also the "Brown" Microphonic Relay has been used quite successfully in England for several years in telephone and other work. There have been many patents taken out in the past few years on electro-magnetic forms of telephone relay, and if you are intending to carry out research work on this device, we would strongly suggest that you have a patent attorney make search of the patent office records, and furnish you with copies of all of these patents taken out in recent years.

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Electricity is a great and fascinating calling. It is one of the great professions of the future. What Edison has done shows its possibilities. Think of Dr. Steinmetz, once an immigrant without friends or money, now consulting engineer for General Electric Co. And Prof. Pupin who got $250,000 for one electrical invention. All cannot rise like these men, but any man who knows electricity thoroughly has no limit upon him. The field is so large that there is a demand for trained men as inventors, engineers and experts in a score of different branches. Good wages made in ordinary electrical work. Large salaries paid to expert electrical engineers—and the chance to go into the electrical contracting business. Get your training now. Here is the opportunity.

Partial List of Subjects

Fundamental Principles of Electricity and Magnetism, Dynamos, Motors, Lighting Circuits, Power Circuits, Bell Circuits and Wiring, Automobile Circuits, Wiring Buildings, Electrical Signs, Burglar Alarms, Ignition Systems, Meters, Storage Batteries, Lamps, Equalizers, Controllers, Switchboards, Telegraphs, Telephones, Telautographs, X-Rays, Transformers, Calculating Wire Sizes, Electrical Heating, Installation of Electrical Systems, Electrical Testing, Illuminating Engineering, Maintenance of Electrical Apparatus, etc., etc.

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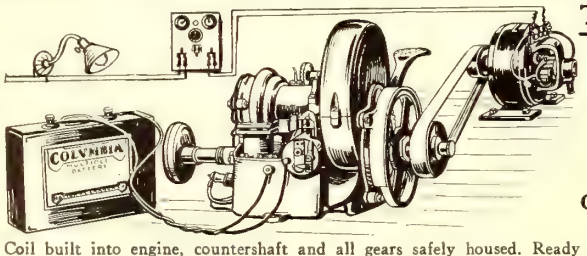
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COST OF RUNNING ELECTRIC LAMP.

(903.) G. H. B., New York, inquiries:

Q. 1. How many kilowatt-hours will a 25 watt, 110 volt, Mazda lamp consume, burning 31 days continuously and what will it cost to operate?

A. 1. A 25 watt, 110 volt Mazda tungsten lamp, burning continuously for 31 days will consume 18.6 K. W. hours of electrical energy and at 10c per K. W. H. your bill for this lamp would be $1.86. This is computed as follows: The 25 watt lamp would consume .025 K. W. H. per hour (25 ÷ 1,000, as there are 1,000 watts per hour to 1 K W. H.); then .025 × 24 × 31 = 18.6 K. W. H. in 31 days. At 10c per K. W. H. the bill figures out at $1.86 (18.6 × $0.10 = $1.86).

PROCEEDINGS OF AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

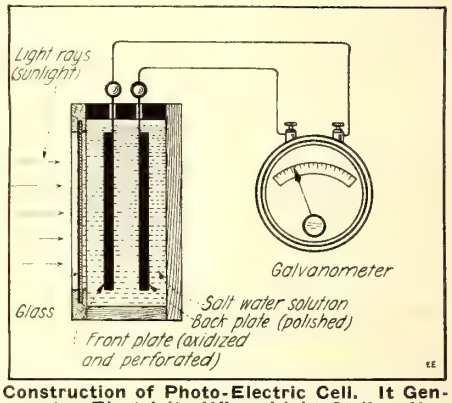
(904.) J. E. Cartinill, W. Va., wants to know:

Q. 1. Where he can procure the American Institute of Electrical Engineers' proceedings.

A. 1. You may procure copies of the proceedings of the American Institute of Electrical Engineers by writing to the Secretary, Mr. F. L. Hutchinson, c/o the Institute, 33 West 39th Street, New York City, and the monthly Proceedings are worth $1 a copy.

PHOTO-ELECTRIC CELLS.

(905.) T. T. Gentry, Lexington, Ky., asks:



Construction of Photo-Electric Cell. It Generates Electricity When Light Strikes It.

Q. 1. How to construct a photo-electric cell?

A. 1. Regarding the construction of light-sensitive copper oxid (photo-electric) cells, these are usually constructed of two thin copper plates immersed in a salt water solution, one of the plates (front one) being blackened by oxidation over a gas or other flame, and the other (back plate) remaining polished. A sensitive galvanometer can be connected across the two plates, and when light is thrown on the cell, the galvanometer will be deflected.

Refer to the September, 1916, issue of this journal, page 316, where extensive technical data is given on such cells. In one type tried out and there described in detail, the voltage produced in strong sunlight was 1/10 volt and the current about 1—2,000 ampere. This was with a small cell having plates but 3 by 4 inches.

It was found that if the cell was left short-circuited in the dark while not in use, the efficiency of the light reaction would then be greater upon exposure than when left open-circuited while not in use. Upon exposure of the front plate to light the electronic reaction is practically instantaneous. The electronic flow with light on is from the rear plate to the front plate; the current flow from the front to the rear plate.

ARC LIGHTS VS. SERIES INCANDESCENT LAMPS.

(907.) W. D——, inquires:

Q. 1. As to relative charges which should be made for series incandescent lamps in place of arc lamps for street lighting?

A. 1. In the first place, we cannot give you the exact data desired as we do not know the total watts consumed by the 600 C. P. 4.4 ampere series arc lamp mentioned.

Figuring, however, on 70 volts per series arc lamp and with a current of 4.4 amperes you would obtain a total consumption of 308 watts per arc.

The inverse ratio between the 100 watt series incandescent lamp and the 308-watt arc lamp is therefore 32.45 per cent, and this percentage of 87.50 (the rate per annum for the arc) gives $28.42 per annum as the equivalent rate which should be paid for the 100 watt series incandescent lamp, considering the same base price per k.w. hour.

Speaking in a general way and without knowing any of the details governing the operating conditions of your local electric light company, we would advise that the series incandescent will prove the least expensive with regard to maintenance as compared to the arc lights. It is our opinion that the method of computing the equivalent rate to be paid by the city for incandescent series lamps as above outlined is not fair in all cases, owing to the fact that the electric light company may be operating under much less favorable conditions in your city as compared to the operating conditions in the other city.

BAROMETER QUERY.

(908.) Guy B. Admire, Missouri, asks:

Q. 1. See first experiment at Fig. 1, right; a partial vacuum is produced at the top of the tube. Say the atmospheric pressure pressing down raises the water in this tube 15 inches. But in the second experiment there are 2 square inches instead of one; would it raise water 30 inches in this tube?

A. 1. In reply to your query concerning the height of a liquid in a barometer tube, would say that this is a function which depends upon the atmospheric pressure and upon the density of the liquid in the barometer tube, and has nothing to do whatsoever with the cross-sectional area of the tube itself.

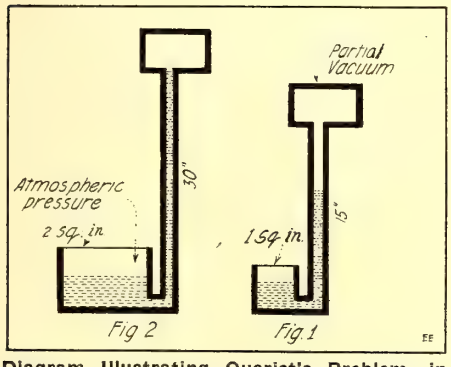


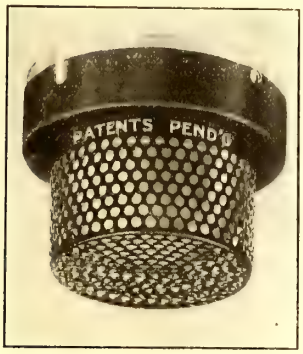
Diagram Illustrating Querist's Problem, in Which He Asks if Greater Area at Base of Barometer Does Not Cause Greater Height of Liquid to Be Supported as Shown.

At sea level the atmospheric pressure will support roughly about thirty inches of mercury or about 34 feet of water.

A new pocket lamp, which carries its own electric generating plant and requires no dry battery renewals, remains lighted as long as the dynamo is kept in motion by a lever operated by the thumb.

NEW AUTOMATIC FIRE DETECTOR.

This new electric fire detector is a compact little device to be used in either dwellings, factories or warehouses, piers, etc., to give warning, by means of any alarms or annunciator system to which it may be connected, of a fire in its early stages so that a fire extinguishing equipment can be brought into use before the fire passes beyond the first critical few minutes. It gives an alarm in ten to thirty seconds; automatically adjusting itself to the usual changes of temperature occurring within the enclosure in which it is located. One detector will take care of 300 to 500 square feet. The device is thoroly protected against injury by a guard, which is placed over the sensitive portions.



Simple Form of Electric Fire Detector Operating Upon the Principle That Air, When Heated, Rapidly Expands. This Causes the Device to Close an Alarm Circuit.

These detectors may be put in with one or more on a circuit on their own independent system or they may be connected to the present call-bell system, or they may be connected, by use of an auxiliary fire-alarm box, to the present fire alarm service in the building. In private installations, the wiring is not influenced by regulations or unusual requirements; the ordinary bell wiring properly protected against injury is sufficient, as only battery current is used, or it may be installed with a complete system of annunciators and fire alarm bells, either with or without the wiring under constant supervision. This system may be connected to any manual fire alarm system by an auxiliary transmitting fire box, thus making the present system automatic.

The detector consist of a hemispherical air reservoir, the flat side or top of which is formed by a flexible diafram. This reservoir contains air at atmospheric pressure and when the surrounding atmosphere rises in temperature quickly, the dome, which is a rapid conductor, becomes heated and expands the air in it, causing the diafram to project outwardly and close an electrical contact, which acts as a switch closing the circuit of whatever fire alarm system it is connected with. To prevent false alarms being turned in by the natural changes of temperature within the enclosure in which the detector is located, a compensator is made part of the device.

NEW RADIO RECORD.

It is reported that just recently the Marconi wireless plant at New Brunswick, N. J., "picked up" a message from the Cavite naval base, on the Philippine Islands, adjoining the city of Manila, a distance of 10,000 miles. But Tuckerton comes to the front with a longer reach than that, the report being that several times this fall and winter, messages have been grasped out of the air that were sent from New Zealand, just about the antipodes from us.

YOU MIND WANDERER!

CONCENTRATION of mind, of effort, is a great factor in your endeavor and no one can successfully concentrate and apply himself if his body is not in perfect health. The mind would reflect the ailing condition of his body and impair his ability.

If you are only 50% of the man you ought to be; if you have let your vitality ebb away without cultivating the resources within you; if you have let yourself run down physically until it affects you mentally; you have been neglectful of your bodily needs. You well know that a weak debilitated system affects the memory, destroys your ambition, makes you unequal to any task and compels you to drag along in a listless fashion.

I will put your efficiency up to the notch where it ought to be; no matter what your condition now is or your position; I will make you once more gain a keen, vivid relish for work and pleasure and enable you to have such control of your mind that every good thought, instead of going to waste, you can cash in on.

I will make you vital, vigorous, snappy, energetic, enthusiastic—ambitious; I will make you do more with less effort; I will make you feel the tingle of rich, red blood flowing in your veins; I will make you feel the thrill of your nature and increase your life; I will make you splendidly healthy, strong, virile, physically able, mentally capable, better in body, better in mind—all distressing results of youthful folly will be nullified and will vanish.

I Will Revitalize, Rebuild You Through a Course of



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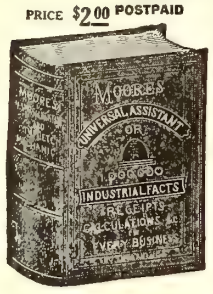
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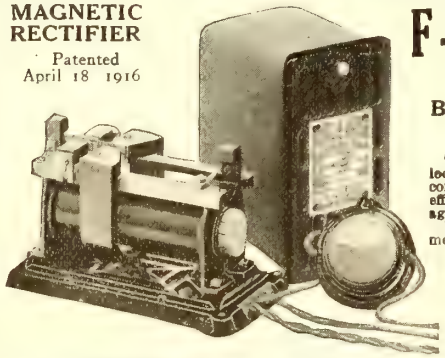
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TELEPHONING TELEGRAMS.

Conservation is the watchword of the hour. Telegraph as well as telephone companies are losing experts by the thousands to the United States Government, which has urgent need of their services. This has resulted in many branch telegraph offices being placed in the hands of persons who are not expert telegraph operators. In many cases the business handled is transmitted to main telegraph offices by telephone, and it is important that the method of transmitting uncommon words, unusual names, code words, cipher words, unpronounceable words and words in foreign languages, when passing initials or when spelling in the customary manner, should be standardized; that is to say, the same method of transmitting an unpronounceable word over a telephone circuit should be the same in all sections of the country.

The traffic department of the Western Union Telegraph Company has authorized the use of the following method for telephoning difficult words and names, which ought to be made standard thruout the entire service:

First, pronounce each letter; then, follow with the corresponding identifying word given in the list below, and as illustrated in the example:

A for Adams	N for New York
B for Boston	O for Ocean
C for Chicago	P for Peter
D for Denver	Q for Queen
E for Edward	R for Robert
F for Frank	S for Sugar
G for George	T for Thomas
H for Henry	U for Union
I for Ida	V for Victor
J for John	W for William
K for King	X for X Ray
L for Lincoln	Y for Young
M for Mary	Z for Zero

EXAMPLE: If the name "B. C. Dvorak" is to be transmitted, telephone employes shall pronounce the name and then say "B for Boston" and pause, "C for Chicago" and pause, "D for Denver," "V for Victor," "O for Ocean," "R for Robert," "A for Adams," "K for King."

MARCONI PRAISES AMERICA.

Senator Guglielmo Marconi, who has been appointed head of the Italian permanent mission in America, made the following remarks recently in addressing the Italian senate on Italo-American relations:

"The Italian mission to the United States again realized during its journey the great friendship and sympathy existing there for us and the great assistance the United States is ready to give us.

"The friendly feeling and concrete measures adopted by the American people in favor of Italy deserve our entire gratitude. We must consider the spontaneous American intervention in the war with special satisfaction."

CALIF. ELECTRIC PLANTS TO COMBINE.

Representatives of electric light, heat and power plants serving 38 counties in northern and central California have agreed to allow their electric generating plants, both hydro-electric and steam, to be operated under one head, it was announced recently.

P. M. Downing, chief engineer of the electrical department of the Pacific Gas and Electric company, it was announced, has been selected to have full charge of all of the plants with authority to carry out their efficient operation with rigid economy of fuel oil, and to cease the operation of as many of the steam plants as may be found compatible with proper service.

This plan is to be carried into force and effect at once, and to continue for the duration of the war and during such further time as would be deemed in the best interests of the public.

SUBSTITUTE FOR THE LECLANCHE CELL.

According to the *Bulletin de la Société d' Encouragement pour l'Industrie Nationale,* Prof. Féry describes a new type of wet primary cell that he has elaborated. The Leclanché cell, depolarized by manganese dioxid, is the most common type at the present day. Prof. Féry conceived the idea of doing without manganese dioxid and depolarizing the cell with the oxygen of the air. Hitherto, attempts in this direction had not met with much success owing to the zinc electrode being vertical in position, giving rise to certain disadvantages.

To overcome these defects, and use the air as the depolarizer, Prof Féry has given the zinc electrode the form of a horizontal plate placed at the bottom of the cell. The carbon electrode is vertical, being separated from the zinc by a thin sheet of felt or an ebonite cross piece.

Local action in a cell of this type is practically eliminated, and the quantity of zinc dissolved is 1.24 grammes per ampere-hour. The voltage on open circuit is 1.18.

SUNDAYS AND THURSDAYS SET ASIDE AS "LIGHTLESS NIGHTS."

To further conserve coal and other fuels, the United States Fuel Administration, amending its former orders permitting the restricted nightly operation of electric signs and displays, has now put into effect a schedule of "lightless nights" on Sunday and Thursday of each week.

Under the new order, it is forbidden to consume coal, oil, gas or other fuel for illuminating or displaying advertisements, notices, announcements or signs designating the location of an office or place of business, or the nature of any business, for electric searchlights, or for external illumination for ornamentation of any building, or lights in the interior of stores, offices or other places of business when such stores are not open for business, excepting such lights as are necessary for the public safety or as are required by law; nor for excessive street lighting intended for display or advertising purposes, whether such lights are maintained by the municipality or others.

Dr. Garfield, Fuel Administrator, has also requested that, in compliance with the patriotic spirit of the order, householders shall observe the "lightless nights" by burning as few lights in homes as it is possible to get along with conveniently.

WIRES TO RUSSIA ARE SEVERED.

Cable and telegraph lines to Russia have been cut, American Minister Morris, at Stockholm, reported on January 29th, and the only remaining routes of communication with Petrograd now are thru Persia and Vladivostok. The land telegraph lines were severed, Mr. Morris reported, at Haparanda and the cables at Viborg. He gave no indication of the significance.

BIG POWER PLANT AT NIAGARA IS PROPOSED.

Three bills designed to provide for the construction by the State of a hydro-electric plant on Goat Island, Niagara Falls, were introduced in the Legislature at Albany, on January 16th, by Senator Gibbs of Buffalo. Provision would be made for a bond issue of $3,000,000 if the measure should be approved by the voters at the Fall election. As proposed by the bill, the plant would be operated either under State management or by lease, and would be capable of generating 500,000 horse power.



ELECTRICAL MACHINERY, by Terrell Croft. First Edition, cloth bound, 318 pages; numerous illustrations; 5½ x 8½ inches. Price $2.00. Publisht by McGraw-Hill Book Co., New York, 1917.

Another work from this author of practical electrical books and one that will be thoroly appreciated by the practical man. The many chapters and sub-divisions cover all phases of electrical machinery that one constantly comes in contact with. Practical applications and theories have been arranged side by side so that the student, as well as the advanced worker, is able by means of the diagrams and explanations to grasp the essentials of modern electrical practise. A comprehensive idea of its scope may be gained from the following list of chapters:

Principles, Construction and Characteristics of Direct-Current Generators and Motors; Management of Direct Current Generators, Starting and Controlling Devices for D. C. Motors; Troubles and Testing of D. C. Generators and Motors; Principles, Construction and Characteristics of Alternating-Current Generators; Management of Generators; Induction and Repulsion Motors; Synchronous Motors and Condensers; Management of and Starting and Controlling Devices for A. C. Motors; Troubles and Testing of A. C. Generators and Motors.

A truly motor and generator book, and one which will find a ready welcome by all electrical men.

PERPETUAL MOTION, by Percy Verance. Cloth bound; 360 pages; illustrated; 5½ x 8 inches. Price $2.00. Publisht by Enlightment Specialty Co., St. Louis, Mo.

A very excellent work on a much discust subject. For centuries the struggle for the means of self-motive power has progrest and yet today in the Twentieth Century we are as far as ever away from the solution.

The numerous chapters cover a wide range, giving data on most of the known attempts at perpetual motion. The vast history of the subject has been boiled down and a comprehensive digest given, on the different methods by which various scholars sought the solution to the problem. Also chapters on why the various devices failed Among some of the more important chapters may be noted the following:

Devices intended to operate by means of Wheels and Weights; Devices employing Rolling Weights and Inclined Planes; Hydraulic and Hydro-Mechanical Devices; Magnetic Devices; Liquid Air as a Means of Perpetual Motion; Radio and Radio-Active Substances; List of Numerous Inventors and Their Devices and a final chapter on whether the question will ever be answered, besides discussions and opinions of eminent scientists on the subject.

A book for all interested in Mechanics, and those who have a strong mechanical bent. This book does not contain any new matter, but aims rather to provide a fairly broad digest of the principal perpetual motion schemes proposed from time to time in the world's history. It will prove interesting reading for all those interested in the subject from the layman's viewpoint, the treatment being non-mathematical.

RADIOTELEGRAPHY—War Department, Office of the Chief Signal Officer, Paper Covered, 6 x 9 inches, 135 pages, price 30 cents. Publisht by Government Printing Office, Washington, D. C., 1917.

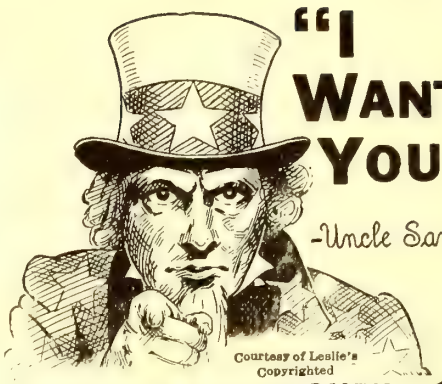
A very handy book which should find a great many friends among radio men. Into this small volume has been compiled all the chief points of radio equipment, formulas and calculations such as one expects to find only in a more expensive book.

The work starts with the fundamental principles of electric charges, static fields, currents, magnetic fields, etc., and then branches out into power circuits, calculations and the functions of the various instruments, with many curves and illustrations which are of great help in mastering the art.

Considerable space is devoted to hook-ups of all standards sets as used by the U. S. Signal Corps, with notes on gasoline motor sets and complete operating instructions.

Several chapters dealing with wave meters, tuning, damping and decrement are very thoro, enabling the uninitiated to grasp the calculations of radio quantities very readily.

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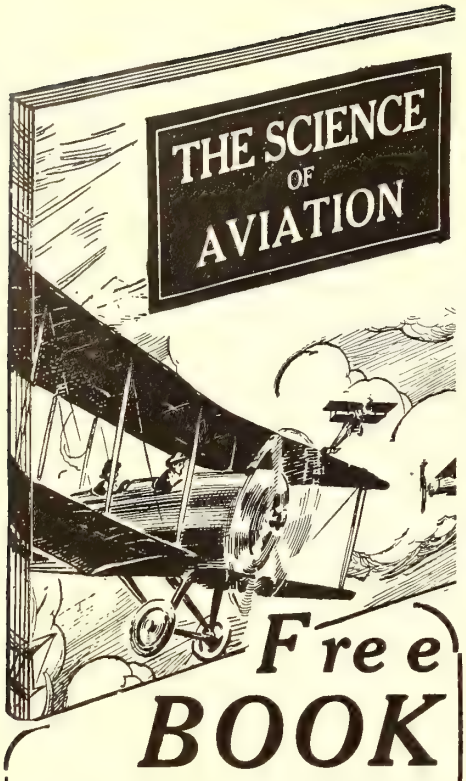
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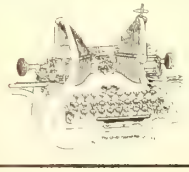
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EXAMPLES IN BATTERY ENGINEERING, by Prof. F. E. Austin. Cloth bound, 5 x 7¾"; pocket size; 90 pages. Price $1.25. Publisht by the author at Hanover, N. H., 1917.

Another very good book by Prof. Austin is this latest pocket manual on Battery Engineering. Usually very little space is devoted to this important subject in electrical text-books and it is only touched on lightly.

The increasing application of primary and storage cells and the greatly extended adaptations possible in the near future form valid reasons why battery students and engineers should have an adequate knowledge of the principles of "battery engineering."

The work covers all the working theories and practical applications in a series of lessons covering the same in easy and gradual steps. The importance of chemistry is treated on, as it has much to do with the final success of the materials involved, etc.

Many practical formulas and examples are given for calculating internal resistance, heat losses, electro-motive-force, amperage, efficiency, etc Various arrangements of battery circuits are also given.

It is a good book for all electrical and radio students and is of particular interest now, especially as storage batteries are being adopted more widely every day to automobiles, aeroplanes, submarines and radio equipments.

NOVEL ELECTRIC TARGET.

To enable a rifleman to see where his bullets go an Ohio inventor has designed a target which, when hit, extinguishes lights in front of it and shows a light from the back thru the bullet hole.

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(*Continued from page* 753)

a large user of sulfuric acid, increased its demand fifteen times normal since the beginning of the war.

"Where will this important industry obtain the power necessary to meet this vast demand? Electric power enters into the cost of these products varying from two per cent to 60 per cent. The cost of ferro silicon, for example, is about 50 per cent power. Hence its cost must be kept at a minimum. It must be kept at a minimum because we are in direct competition with foreign countries where the governments insist on a *complete development of the water power resources* and where real constructive legislation is used to aid the cause of conservation. Conservation by the way that is conservation, and not a plank in a political platform.

"There are but two sources of power: First, coal; second, water. Daily we read headlines complaining of 'shortage of fuel.' The most optimistic prognosticators tell us the mines will disgorge but little over their usual amount this year. Decreased labor supply is not the only cause of the shortage. It is well known that every ton of steel requires a ton of coal in its manufacture. The production of steel is without precedent, and so its consumption of coal. Our mighty effort should be to prevent additional uses of coal and in fact diminish the domestic consumption in favor of the steel industry. Even if it were possible to obtain coal at prices permitting steam-electric developments, the apparatus for this purpose could not be obtained in less than three to four years. The war program of this country is such that the total capacity of the manufacturers building this class of apparatus has been requisitioned for that length of time which may even be extended. The shortage of power menace is with us now and its solution must be obtained in far less time than that to save us from a desperate serious embarrassment of our war program. Therefore, we cannot look to steam to solve the power problem. Evidently our only lasting salvation is in water power.

"Water power can be divided into two zones: western and eastern. The bulk of the eastern power is located at Niagara Falls, a potential possibility of perhaps 6,000,000 horse-power, 3,000,000 available without affecting its scenic grandeur. We have heard the great exponents of western power proclaim that if there is a shortage of power in the east, come to the west, where there are some 13,000,000 horse-power undeveloped at the present time. This power could be developed at a cost to permit a selling price equivalent to Niagara power some five or ten years ago. But is power located so far from the industry's center of gravity cheap at any price?

"The electrochemical industries at Niagara Falls consumed practically all of the power developed on the American side (approximately 250,000 horsepower) plus approximately 150,000 horsepower imported from Canada before the outbreak of the war. Owing to the increased activities on the Canadian side, the Canadian government has found it necessary to exercise certain rights which it retained, and a great percentage of the power coming to this country from Canada has been cut off. The industries, therefore, at the falls find themselves in the predicament of having installed equipment, but no power to operate it. It is doubtful if at the present time 70 per cent of the installed equipment at Niagara Falls is under power. In other words, the plants are not turning out as much today as they were previous to the war. It was found necessary in Buffalo, but 20 miles away, to build a steam plant of 120,000 horsepower. This being a public service corporation, it was necessary to produce power regardless of the cost, but when a mobile industry is affected, there is nothing for it to do but move and this is happening.

"The best hydraulic talent in America advises us, that it is possible to develop at Niagara Falls 3,000,000 *horsepower* without in the least affecting the scenic grandeur of the most wonderful cataract in the world. By the proper location of submerged dams, the rapid deterioration of the Horseshoe Falls would be eliminated and the certain suicide of this wonderful cataract stopt.

"The crest of the Horseshoe Falls is moving back at the rate of seven feet a year. The length of the crest in 1842 was 2,030 feet and now has increased to 3,020 feet. The farther back the erosion goes the more rapid it becomes. At the present rate, the Horseshoe Falls will be completely eliminated in the next two or three generations and we will have nothing but a *rapids* to replace the same. The installation of the above mentioned dams would then, therefore, accomplish a double benefit; that is, preserve the beauty of the falls together with developing half of this potential power. Some have asked for the use of water as limited by the Burton treaty, i. e., 36,000 cubic feet per second on the Canadian side and 20,000 cubic feet per second on the American side, but this is simply a drop in the bucket and would in no way affect the serious power shortage that now tends to ruin one of our most promising industries to say nothing of embarrassing our entire manufacturing position.

"Engineers have calculated that to develop 3,000,000 horsepower at Niagara Falls would save for posterity 100 tons of coal per minute or 52,000,000 tons of coal per year, sufficient to change the situation from a *shortage* to a *surplus* in the coal industry. Furthermore, it would assist in the freight car shortage, releasing 62,000 cars for use elsewhere, thereby changing the situation again from a shortage to a surplus."

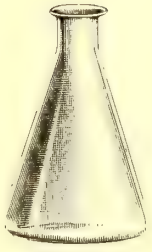
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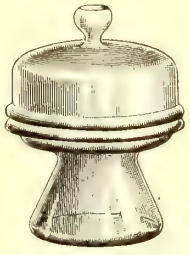
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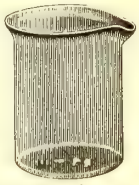
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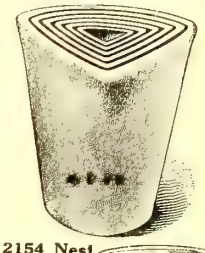
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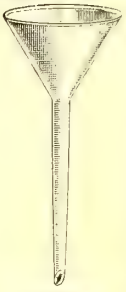
Acid Acetic U.S.P.	lb.	$0.45	Cupric Sulphate, tech	lb.	$0.40
Acid Hydrochloric (Muriatic)	lb.	0.45	Ether	lb.	0.90
Acid Nitric ch. pure	lb.	0.45	Formaldehyde, tech. (Formalin)	lb.	0.80
Acid Oxalic, tech.	½ lb.	0.80	Glycerine ch. pure	½ lb.	0.90
Acid Sulphuric ch. pure	lb.	0.45	Hydrogen Peroxide, tech	lb.	0.45
Alcohol denatured	lb.	0.55	Iodine, Resublimed	oz.	0.75
Alcohol, Wood, refined 95% (Methyl)	lb.	0.50	Iron Chloride (Ferric)	lb.	0.45
Ammonia, concentr. (Hydroxide)	lb.	0.50	Iron Sulphate, tech	lb.	0.40
Ammonium Carbonate, tech	lb.	0.45	Lead Acetate, tech.	lb.	0.80
Ammonium Chloride (Sal) tech.	lb.	0.50	Lead Nitrate, tech.	lb.	0.95
Barium Chloride, tech	lb.	0.70	Litmus Paper, blue	book @	0.10
Calcium Chloride	lb.	0.25	Litmus Paper, red	book @	0.10
Calcium Sulphate	lb.	0.25	Manganese Dioxide, tech	lb.	0.85
Chloroform U.S.P.	½ lb.	0.90	Mercuric Chloride	½ lb.	0.65



No. 2154 Nest of six Crucibles $0.50



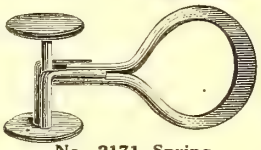
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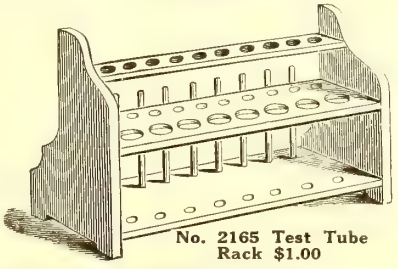
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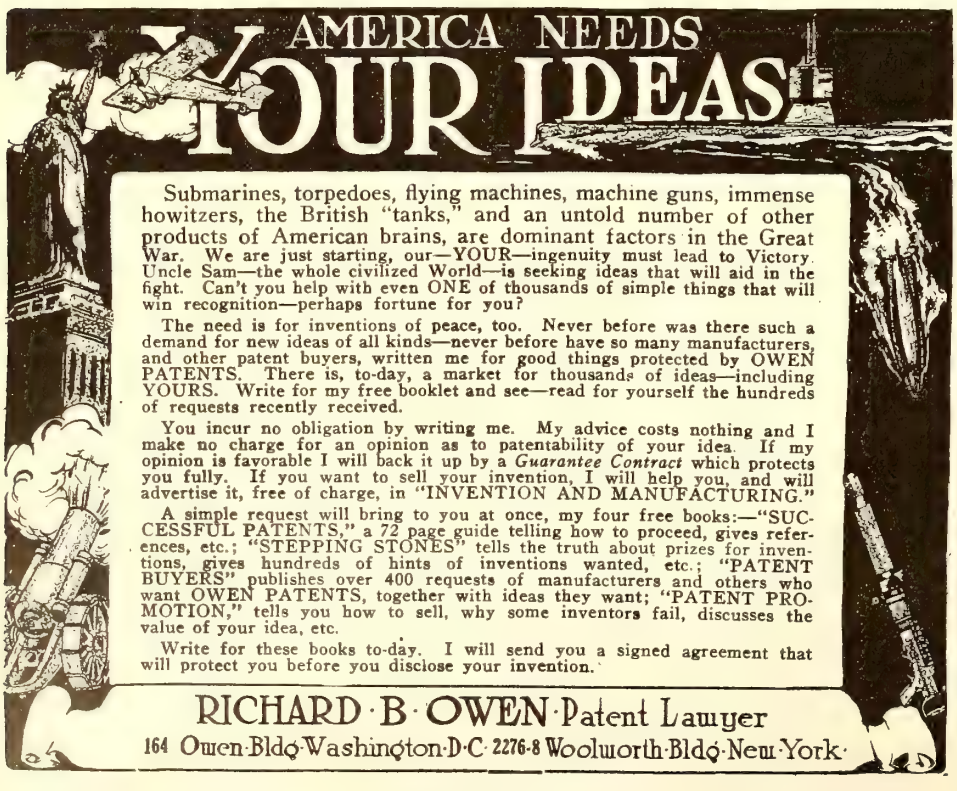


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Should advice be desired by mail a nominal Sketches and descriptions must be clear and ex ten on.

STARCHED CLOTHES SPRINKLER.

(203) Mrs. Leslie McNeill, Corpus Christi, Texas, has submitted an idea of a water sprinkler to be used in sprinkling starched clothes. The idea in brief is a sort of portable tank with a spring attachment which when pulled, will sprinkle water from the bottom of the tank.

A. While the idea is feasible, we think it is far too complicated for a household utensil of this kind. It seems to us that the average housewife would not wish to invest any money in a device of this kind when an ordinary cup or sprinkling-can can be had for much less money. Anything that runs to simplicity and low price is sure to win out over more complicated ideas nowadays.

COMBINATION ELECTRIC LOCK.

(204) Henry O. Wuelfing, Bloomfield, Conn., has submitted to us a very interesting idea on a combination electric lock, particularly for use in preventing automobile thefts. The lock from the outside appears the same as an ordinary safe-lock, but in place of the usual steel tumblers, fiber gears are substituted which must be turned in a certain position in order to close the circuit, the correct locating being done by turning the dial back and forth to certain numbers.

A. This is a very good idea, and we are almost certain that nothing like this exists at the present time; we are convinced that a patent can be procured on this invention. As a precautionary measure, however, we would advise our correspondent to get in touch with a patent attorney in order to have a search made in the patent office.

GAS STOVE.

(205) Joseph F. Tucci, New York, N. Y., has sent in a sketch of a gas stove, the principle of which seems to lie in so-called forced draft, also making use of the principle of a Bunsen burner. This stove throws the heat out by means of a hood-shaped top, which also serves the purpose to throw the heat forward instead of upward. The inventor claims that he thus corrects the faults of present gas stoves.

A. This device appears quite plausible on paper, but without having it tried out, we are at a loss to know whether it will actually work as described. We would advise our correspondent to have a model made and if it works satisfactorily, to have a search made for patentability.

DOUBLE ENVELOPE.

(206) Williams E. King, Monesson, Pa., submits a very ingenious and what he calls a double envelope, made from a single piece of paper. The double envelope is supposed to be used for contributions in churches and elsewhere without confusion as to the donation. Our correspondent wants to

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know if such a device is of any value, and if it could be patented.

A. The idea is very clever and seems quite feasible. We have seen a double envelope before, but not made as described by our correspondent. We would for this and other reasons recommend a search in the patent office; any patent attorney will be glad to conduct such a search at very low cost.

DYNAMO.

(207) Julius Gernot, Maurer, N. J., has sent us sketches as well as description of a dynamo armature, which he thinks will save not alone an enormous amount of energy, but will *almost* run free, thereby producing free energy! His contention seems to lie in the assumption that bringing the windings to a certain position on the outside of the armature, no power will be used in so transposing the windings. Our advice is asked.

A. Our correspondent labors under a delusion, and his machine will certainly not work as he states. It doesn't matter if the winding of the armature is outside or inside, if current is produced he must have just so much energy to do it, and this energy cannot possibly be cut down. Our correspondent also seems to think that it is the field coils which absorb the energy, and for that reason, he suggests some changes in the field coils as well. This, however, is not correct either, for the simple reason that if you take a magneto which has no field coils it does not work any different from a dynamo with field windings. If the magnetic flux is cut by the windings of the armature, so much energy must be supplied to the driving pulley in order to get so many watts. It doesn't matter how the windings are arranged, and no matter how efficiently they are disposed, the difference in the power factor saved is very small.

ELECTRIC NON-FREEZING DEVICE.

(208) J. D. Browder, Jr., Canadian, Okla., has submitted an electric non-freezing arrangement, whereby he uses a certain number of thermostats which control a heating element of an automobile radiator. The idea being that as soon as the temperature goes below 32 degrees Fahrenheit, the heating element keeps the radiator from freezing.

A. A very clever idea and seemingly cheap enough as a commercial article to be placed upon the market, where we think it would find a ready sale; we believe there is a distinct advantage of having a device of this kind. Nothing like this seems to exist at the present time. We think an idea of this kind is patentable.


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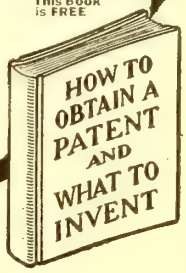
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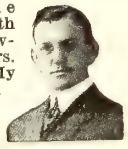
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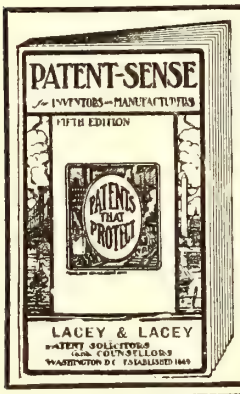
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(*Continued from page* 751)

turned into military or naval appliances almost over night The Army and Navy booths helped to tell the story of how electricity was mobilized for the defense of the nation.

With thousands of men and women, formerly employed in one form or another of electrical occupation in civil life, transferring their activities to the Government service, it is hardly necessary to point out the patriotism that has actuated this class of workers. As the war plans of the United States are developed and as more and more places for electricians are made in the Army and the Navy, the men at home are hearing the call.

For those who are unable to offer their services to the country as electricians or electrical inventors or engineers, there still remains an opportunity to be patriotic. The man who is not in service may act as an auxiliary to the man who is in the Navy or the Army. How can he do this? Simply by becoming a member of that great army of "Liberty Loan" subscribers which has been growing steadily since last June.

The Third Liberty Loan affords a chance for the electrician at home to stand by his associate under arms. The loan not only will buy clothing and food for the man in service, but will help to equip the submarine chasers, the aero plants and the communication systems in which that associate of his is rendering expert help to the Government.

Do the readers of THE ELECTRICAL EXPERIMENTER realize that the Third Liberty Loan will pay for the Radio that binds together the hundreds of units in the American fleet? Do they understand that the aviator who flies over the Boche trenches and communicates his discoveries to his comrades by wireless is supplied with his outfit out of the Liberty Loan? His equip-

(*Continued on page* 798)

THE HOW AND WHY OF RADIO APPARATUS.

(*Continued from page* 766)

Several other forms of condenser are illustrated in Fig. 4-A, B and C. That at A is the familiar rolled type of condenser. These are formed of one or more dielectric layers, made long with respect to their width, and which are suitably interleaved with two or more metal charging leaves; the whole is then rolled up and tightly comprest after having been soaked in hot paraffin wax. This gives a high capacity in a small space, and enables a large capacity condenser to be quickly constructed. Substantial terminals for such a condenser are formed of small copper strips about ¼ of an inch wide, which are wrapt in several turns of the tin-foil leaf at the end as Fig. 4-A indicates; this junction may be riveted. Where a fixt tin-foil and waxed paper condenser is used, and there are a large number of tin-foil tabs to be joined together, a very efficient and substantial connection is afforded by simply punching or drilling a hole thru the tabs and passing a battery terminal screw thru the opening formed and placing on either side of the tin-foil tabs a piece of copper or brass about ½ inch square. When the nut on the screw is tightened up, the tin-foil connections will be clamped firmly, and the connecting wire from the circuit may be fastened between two nuts on the screw or else soldered to the screw as desired.

An interesting *roller type* of variable condenser was invented some years ago by Mr. H. Gernsback, and this is shown schematically at Fig. 4-B. Three porcelain rolls are used in this scheme A, B and C. The three rolls are geared to each other by means of gears secured to the shafts of each roll, but which are not shown for the sake of clearness. A thin as well as flexible sheet of copper or aluminum foil as also a strip of flexible insulation, such as oiled linen or oiled silk is secured to roller A at the left. These are also secured to roller B as shown, and a second strip of flexible metal foil makes connection to rollers B and C. When the adjustment knob secured to the central roller B is turned, it unrolls the dielectric and one copper electrode from A, and also the second copper electrode from C, while a gradual increasing condenser capacity is produced about the perifery of roller B. The arrows in the drawing indicate how the rollers turn when the central knob attached to B is rotated either to the right or to the left. increasing or decreasing the capacity in consequence.

The diagram at Fig. 4-C shows how a variable air dielectric condenser may have its capacity increased several fold by filling its container with oil. One of the best oils to use for the purpose is castor oil, which has a "K" value of approximately 5. Thus, if the variable condenser with air dielectric has a capacity of .001 m.f., when it has its container filled with castor oil, its capacity will be increased to about .005 m.f. This property is made use of considerably in the laboratory, either for the purpose of increasing the capacity of the condenser or for increasing the resistance between the plates, and thus cutting down brush discharges and other leakage, where it is desired to use such a condenser in experimental *Poulsen Arc* circuits, etc.

A special form of high capacity, small size rotary variable condenser used by one of the leading commercial radio companies in their receiving sets and measuring instruments, as well as wave meters, is shown in section at Fig. 5-A. This variable condenser has about five times the capacity of an equal size air dielectric condenser, for the reason that it employs hard rubber as a dielectric instead of air.

The stationary semi-circular plates are covered with thin discs of hard rubber as illustrated, and the moving semi-circular plates slide in between the hard rubber leaves in the usual manner. The reason for the greatly increased capacity of this type of condenser is due to the high specific inductivity of hard rubber, which is about 5. Another interesting form of condenser which has been used both in this country and abroad to some extent, but which must be built very accurately to be reliable and free from accidental short-circuits, is the vertical, cylindrical plate condenser illustrated in plan view at Figure 5-B. As becomes evident the central rotary knob and shaft carries a suitable rigid member to which is fastened at either end a set of properly spaced, cylindrically curved plates which, as the knob is turned, intermesh with the similarly curved stationary plates, and thus increase the capacity of the condenser until they are moved thru 90 degrees. The capacity is reduced by turning the knob so that the moving plates slide out from within the fixt plates.

It is often desirable in building wave meters and in certain forms of receiving sets to obtain an extra high variable capacity. A common method of accomplishing this result is indicated at Fig. 5-C. A small or medium size variable condenser VC, is connected in series with the circuit, and in shunt with this variable capacity there is placed a group of small fixt condensers of the desired capacities, arranged with a multiple-contact switch similar to that shown in Fig. 3-C or one comprising

a metal sector as shown at Fig. 5—C with a series of spring contact fingers. Thus suppose the variable condenser VC has a capacity of .001 m.f., and that each one of the five fixt capacities shown has a similar m.f. value. It is thus clear that we may now obtain any capacity from practically zero up to and including .006 m.f. by intermediate stages.

The standard connections for both fixt and variable condensers are given at Fig. 6-A and B. A fixt condenser is usually connected in series with a detector as shown at Fig. 6-A, and is sometimes called the "stopping" condenser. The high resistance telephone receivers used with this circuit in connection with a crystal detector D, are frequently shunted across the fixt capacity as at Fig. 6-B. Either connection of the telephone receivers serves equally well in a majority of cases, but if the capacity across the 'phones is adjustable or variable, it is considered best practise to connect the 'phones across it instead of the detector, as considerable tuning can be done in this way and maximum strength of signal obtained.

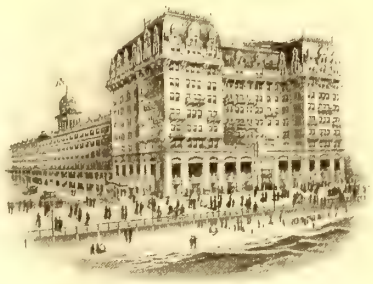
Referring to Fig. 6-B, a standard connection of the variable condenser is across the secondary of the loose coupler LC. The variable capacity thus shunted across the secondary not only permits the closed oscillatory circuit to be adjusted to resonance with the open aerial circuit, but also permits a closeness of adjustment or tuning which the usual secondary inductance switch does not give. In any case the oscillations set up in the secondary circuit by adjusting it to resonance with the aerial oscillatory circuit, overflow to the shunt detector circuit, where part of the current is rectified by the crystal detector D, indicated in the diagram, and is stored up in the fixt condenser. The charge which this fixt condenser accumulates during the time of a single train or *group* of oscillations, discharges thru the high resistance telephone receivers T, thus causing the diaframs of the 'phones to vibrate at a rate which corresponds to the spark frequency of the transmitting station.

A new use for variable condensers is shown at Fig. 6-C. There are here used in the rôle of a *capacity coupling* between the aerial and closed oscillatory circuits. The diagram shown is that described and illustrated in the latest edition of the "Naval Electrician's Text-Book" by Captain Bullard, Volume 1. This arrangement of capacity coupling in the place of *electromagnetic coupling,* which is used in practically all other receiving sets, is strongly commended by the U. S. Navy experts, and is claimed to be equally efficient to any form of electro-magnetic coupling for short wave lengths, and to be very much higher in efficiency for long wave lengths. In this hook-up, devised by Dr. Louis Cohen, formerly of the Bureau of Standards Radio Laboratory, the primary circuit is tuned to the incoming wave length in the usual manner. The secondary coil L-2 and condenser C-2 are made resonant to the same wave length. The aerial circuit energy is transferred from the one circuit to the other by means of the two *coupling condensers* shown and which are secured to a common shaft, so that they are simultaneously adjusted. These condensers are in no sense of the word tuning condensers, and do not vary the adjustments of either primary or secondary oscillatory circuits. They are used for no other purpose than that of transferring electro-statically the energy in the aerial circuit and circulating thru inductance L-1, thence to the closed circuit comprising inductance L-2 and variable capacity C-2, across which is placed an adjustable *stopping* condenser BC, crystal detector D. and high resistance telephones, T.

(To be continued)

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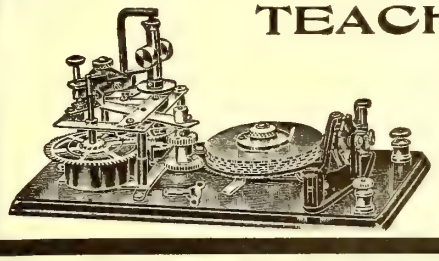
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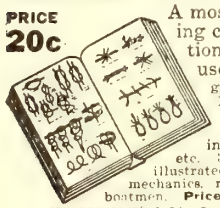
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THE THIRD LIBERTY LOAN AND YOU!

(*Continued from page* 796)

ment must be of the best. He must have instruments and dynamos that are better than those of the German who is up in the air on the same kind of assignment. All this requires money. That is where the American at home can co-operate with the man who used to work alongside him, and who now takes his life in his hands to search out the secrets of the enemy.

The German scientists who turned their thoughts toward war many years ago, devised weapons of destruction which they were quick to bring into action in 1914. British and French intellect, which had not been working in the same barbarous channels as that of Germany, was forced to imitate the enemy. It did not take many months for our Allies to catch on to this new and appalling game. By this time they have shown Germany how well they have learned the lesson she taught them in 1914. The United States has been forced to go to the same school. Here it was only a question of turning the unrivalled American genius for industrial invention in the direction of war. The nation has adjusted itself to battle conditions and will fight Germany, bomb for bomb, gun for gun, mine for mine, 'plane for 'plane, until the enemy lays down his arms and admits that he cannot finish what he started out to do.

The best intellects of the nation, hitherto employed in the diverse industries of the country, have been called into consultation by the Government. The Army and the Navy are getting the advantage of this "conscription of brains," as the assemblage of inventors at the call of patriotism may be called. The greatest minds may be diverted from private business in the laboratory and directed toward the mobilization of the mechanical forces of the nation; the most skilled workers in all the electrical trades may enlist in the Ordnance or the Signal Corps; every energy may be bent toward war; but unless the Third Liberty Loan is supported by the people as heartily as were the first two, all these efforts will be in vain. Men cannot fight without supplies and equipment. The Third Liberty Loan provides these essentials.

Thus the loan becomes the immediate concern of every man and boy in the electrical industries and in the experimental laboratories. It is no question of finance which has to do solely with the bankers or with the rich investors. Primarily it is a banking matter; yes, and it concerns the mobilization of billions in credit. But it also is the personal affair of every one in the United States.

The First Liberty Loan was over-subscribed fifty per cent., so that three billions were offered where two were asked for by the Government. The Second Liberty Loan was for a minimum of three billions, but more than four and a half billions were subscribed. When the Third Liberty Loan is opened, what will the answer of the Nation be?

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EXPERIMENTAL PHYSICS.

(*Continued from page 760*)

On comparing (a) and (b) in safe "red light" no difference will be apparent. One might hastily come to the wrong conclusion that light has no chemical effect on silver bromid, but if now a few drops of a weak solution of amidol, eikonogen, pyrogallic acid, ortol, or of any other well known developer are added to each of the test tubes (a) and (b) we find that (b), the one which has been exposed to the light, rapidly precipitates out fine black particles which gradually sink to the bottom. (See figure 56 (b).) Evidently the light has done something to it. Actually the light caused the silver bromid to give off a slight amount of bromin and percipitate out a minute quanity of silver. "Nascent silver" (silver just formed) causes the hydrogen in the "developer" to unite with the bromin of the silver bromid and thus leave the insoluble black silver particles. In the case of the ordinary "dry plate" or "film," silver bromid is mixed with gelatine (forming a more sensitive combination than the silver bromid alone, since the gelatine absorbs the bromin given off) hence aiding the liberation of bromin and the deposition of silver. The plates or films after being exposed show no change to the eye but when placed in the developer, wherever there was most light there will be most action, hence most silver and hence the darkest part of the "negative." Black objects, giving off no light do not affect the negative and the negative stays transparent (white).

This is illustrated by figure 57. If I is photographed the negative will appear as in II. Naturally one must remove the negative from the developer as soon as a clear image is obtained otherwise the entire amount of silver bromid would be decomposed and a black plate would be obtained. Practise enables one to know just when the "critical point" is reached. The process of "retaining the image" is not yet complete since if we were now to allow light to strike the negative the entire amount of silver would be deposited giving a black negative. This is eliminated by "fixing" *i.e.,* dissolving out the silver bromid by "hypo" (sodium thiosulfate) and washing, thus leaving the negative with no more silver bromid to be acted upon by the light. Now our image is fixt *permanently* on the plate or film and can be used for making prints, enlargements, lantern slides, etc.

The process of making *prints* or *positives* is essentially the same as that of making negatives. The negative is placed flat against the sensitized paper (paper with silver bromid and gelatine or albumen) and exposed. Thus light will pass thru the light part of the negative and not thru the black part of the negative in varying degrees, so that after developing the result is really a negative of the negative film or plate. Referring to figure 57 we see that the negative of II (which is the negative of I) is I (which is the original) so that our prints are exact copies of the original.

Experiment 64:—Different colors affect silver bromid in unequal degree. Blue and violet have a very pronounced affect while red and orange have almost none. It is because of this fact that the process of loading and unloading the camera and the process of developing are carried out in red light. To verify this, photograph various colored objects or better still a spectrum (see lesson 10, figure 52). It will be noticed that red appears black and blue white and the intermediates hues shade gradually from white to light gray, then darker gray, etc., up to black. If now a print is made of this negative the red end of the spectrum will be white and the blue end black with intermediate gray. The power of a light to affect the plate or film is called the *actinic* power. Since all colors do not have the same actinic power, ordinary photographs do not have *true* color values. This effect can be remedied by interposing *color screens* between the object photographed and the plate, thus reducing the sensitivity of the more actinic colors. A still better way is to use *orthochromatic* plates. These are treated with baths of certain dyes which increase the sensitivity of silver bromid for light of their own color. These plates, however, have the disadavantage of being slower than ordinary plates.

Experiment 65:—The process of making photographs in Nature's own colors has been a problem of Physics rather than Chemistry. There are several processes now in use for *colored photography* both for "still" and "moving" pictures, all of which depend upon the same physical principles of color. In lesson 10 we found that ordinary white light is composed of violet, indigo, blue, green, yellow, orange and red, and that if we mix these colors *white* light results. As a matter of fact if blue-violet red, and green (three primary colors) are mixed white light results.

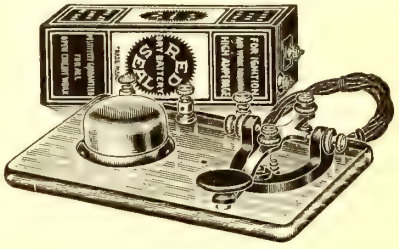
One may satisfy himself of this fact by dividing a circular piece of cardboard into three equal parts, painting the segments with these three colors (see figure 58) and revolving the circular disk rapidly by attaching to a small motor. Because of persistence of vision the three colors will strike the eye at apparently the same time and the disk will appear white. In the most successful of color photograph processes, the glass plate is covered with an extremely fine layer of starch grains (almost microscopic in size) some colored red, others green, and still others blue-violet, *i.e.,* the primary colors (see figure 59). The mixture appears to the eye as *white*. Upon this mixture a layer of gelatine and silver bromid is spread. Since each colored starch grain can transmit only its own color of light it is evident that the silver bromid behind each red grain will be affected only by red light and a similar result is true for the other two colors. In order to form a positive immediately, the silver is dissolved out and the silver bromid decomposed into silver. Therefore where light from a red particle struck the plate the silver bromid was changed to silver, and then the silver dissolved out, so that the plate is transparent and on looking thru it one sees the little starch grain, *i.e.,* the same color as the object. The same holds true for the other two colors. On looking at the whole plate after development and fixing processes similar to those of black and white photography, the transmitted light will fuse the almost microscopic spots of color, and one sees the image of the object in Nature's own colors.

In *motion picture* work the same principle (primary colors) is used. The negatives are taken alternately (on black and white film) thru *red, green and blue-violet screens,* thus getting pictures of the red, green and blue-violet parts of the objects on separate films. On projecting the films, a screen similar to the disk of figure 58 is revolved in front of the film synchronous with the placing of the three films in position, so that the film of the red parts of the objects is projected thru the red screen and similarly for the others. By the *persistence of vision* these are blended, thus giving the natural colors. This phase of motion pictures is still in the experimental stage and a fortune awaits the one who develops a good commercial method, especially a method making it possible to take motion pictures in artificial light. May success reward the efforts of the conscientious workers in this field.

(*To be continued*)

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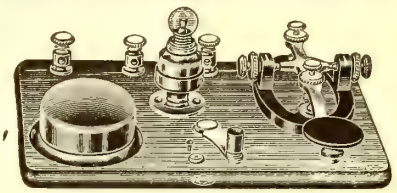


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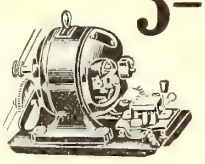
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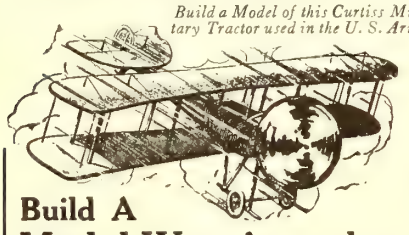
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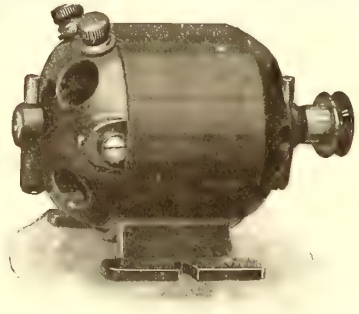
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VISITING ARLINGTON VIA THE TALO CLUB.

(*Continued from page* 763)

into the receiving room, and while watching the outfit work we saw the chap outside cut the other fellow off and start to operate the relay by hand. Afterwards we found out that the chap in question had the day before been on duty receiving and had taken his message from a boat, to be relayed later on, and that the fellow who did the sending at the time, made a mistake, so that was the reason for breaking into the transmitting. Some stunt, say we.

Along about this time "noon" began to pay us a visit and, of course, great interest was taken in watching how the 100 K.W. set was started up. One operator throws in a switch and the ammeter climbs to 300, and nothing happens; then somebody else grabs hold and at last the outfit gets into working order, but it took five minutes to speed up and say, 42 cm. gun-fire has nothing on the noise from the spark when the key is prest. One needs cotton in the ears, and then some, for when you stand ten feet away and attempt to talk, it's a case of yelling your head off, and ten to one the other chap don't get you. It is claimed that the spark can be heard two miles away on a quiet night, and one of the operators told us that when he goes to see his girl he never needs his watch to let him know when it is ten o'clock.

"Woody" wanted to get a picture of the back of the small switchboard, and as he owns a Graflex camera, we were afraid that the noise of its going off would inform the operator who would, no doubt, demand the film, for at that time some publishing company had bought the rights to take pictures, so there was nothing doing in the line of amateur photography, but he told me about his desire, and while he beats it back of the board I motion "Mac" and "Dickey" to come over and talk to the operator on duty *real loud,* thereby hoping to drown out the sound of Woody's "gun," for by the time the glass plate drops out of the way and the shutter film moves over the negative and three or four other things happen, bystanders know it because of the various clicks and groans. Everything worked fine except that when developed the picture was *no good,* as the light was bad, altho to use the words of another member, "Look at all the fun we had."

Going outside to watch the antenna "spark," which it *didn't,* we found the famous aerial switch mounted on two short poles with a ship's bell attached (see photo herewith). 'Guess they ring the bell when signals come down the lead-in. The switch consists of a carriage moving on two rails and controlled by wires passing thru holes in the receiving room wall. This gives three positions, namely, *grounded, transmission* and *reception,* and is really a very clever stunt. I almost forgot to say that before coming outside we inquired if it were possible to go up one of the towers, and the answer we got was to the effect that if we could get one of the men to go with us, why go ahead. So far, so good; but when we glimpsed the small stair-way with hand-rails only six inches high and nothing but air surrounding, Oh! Boy! we thought of Home and Mother and mutually dropt the subject.

Two of the towers are four hundred feet high, and the other six hundred, so you see it would have been some climb, and besides we all wanted to get back again the same day, for I guess that it would have taken at least an hour to climb and do it without dropping on the way up.

There was a small aerial running from midway the highest pole down to the station and this was used for six hundred meter work, as the large antenna has a natural period of about *two thousand meters.* In some way or other we started to argue about the number of wires in the aerial, and I nearly bent double trying to count them while "Woody" snapt a picture of me. 'Bet the fellows thought I would topple over, but luckily my stabilizer was working and I regained normal position again. The large aerials were pulled up by means of a steam roller and it was done by pulling up about two hundred feet, and then coming back for another hunk. Pieces of wire lay around and we all brought back a souvenir.

The wires from the telegraph companies and Washington Observatory were connected in the receiving room, for it is, no doubt, known that the time clock that closes the circuit for both Arlington and Key West, Florida, is in the Observatory and operates both stations simultaneously. Beyond this was a large room where there were going to be kept various styles of receiving sets and form a sort of museum while in one corner was a box full of Audions; afterward I told "Dickey" that while neither one of us would steal money the temptation to walk off with a couple of those bulbs was very strong and he certainly agreed to the fact. It's a funny thing tho when you look right into it and I suppose it is born of the training that an Amateur receives, namely, that radio sets need good detectors and also that every scrap of material must be saved in order to make new sets.

Our time was now getting short, so taking a last look we beat it for the car which could be seen coming some distance away, and upon arriving at the Monument, the motion on the floor was carried and we started skyward. "Woody" and "Mac" walked up while "Dickey" and "yours truly" rode, but as it takes five minutes to travel the five hundred feet we had a nice rest and would have gone to sleep only at the start the cables that held the car being so long, the car oscillated up and down a few inches and we thought something was going to happen. We could hear "Woody" and "Mac" yelling as they climbed round and round on their journey upward and we mutually thought that we for once possest the brains.

The top was reached, but Ye Gods! when you look down it almost makes you forget the Continental Code and "Woody" almost lost his hat, hauling his head back in again for the windows are small, but I grabbed it and very near lost my own. Postal cards were written and mailed at the top, but say, getting back to Arlington, one only appreciates the size of the towers when seen from the Monument, for it looked just like a gigantic spider about to use the Monument for a toothpick. The view from the top is great and well worth seeing, because it gives a clear idea of how Washington is laid out and with a little imagination it is easy to think how it feels to be an aviator.

Upon coming down we started back for the station and on the way "Woody" and "Mac" took in the Museum while "Dickey" hunted up the White House and I kept on till I hit Bryant's "eats dispensary" and satisfied my 5 m.f. condenser, afterward going to the station and waiting for the rest of the bunch to follow.

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EXPERIMENTAL CHEMISTRY.

(*Continued from page 780*)

of oxid, and then hung in a solution of a salt of the metal to be deposited; a strip of the metal—gold, silver, or nickel—is suspended in the solution as anode, to keep the bath from deteriorating. (See Fig. 106). For gold or silver the bath usually contains potassium cyanid (KCN) together with a little of the salt of silver or gold (AgCN), etc., forming a double cyanid (KCN. AgCN). The current employed is furnished either from a dynamo or battery, and varies in voltage according to the metal deposited.

By way of illustration: In nickel plating we begin with 5 volts, gradually decreasing the current to 1 volt; for silver plating 3 volts potential is employed with a strength of 50 amperes per square meter of cathodic surface; in gold plating the E. M. F. should not exceed 1 volt and the current strength 10 amperes per square meter of cathodic surface. The time of immersion varies according to the metal to be plated, the metal deposited, and the thickness of the desired deposit. For nickel plating with a battery current, the time is from two to six hours; for silver, from eight to twelve hours; while gold requires but a few minutes immersion.

Due to the tendency to peel, heavy plating should be guarded against. Before such base metals as zinc, pewter, etc., can be plated with nickel or silver, they are given a light coating of copper, the object of which is to secure firm adhesion of the plating metal.

Electrolysis.

Most electrochemical processes involve *electrolysis,* the simplest illustration of which is the separation of water into its elements. Water was stated to be a non-electrolyte; it can, however, be electrolyzed indirectly for an experiment as follows: a small amount of sulfuric acid—which is an electrolyte—is first mixed with the water, which is then poured into the electrolytic apparatus and connected with the source of electricity, which may be two or three Daniell cells, these being the best for this purpose; or it may be connected, using a motor-generator, with a street current. A motor generator giving a maximum voltage of 15 and an amperage of 15 is of sufficient size. The electrolytic tubes should preferably be graduated. When the current is turned on it will be noticed that the gases collect unequally, about twice as much at the cathode as at the anode. A slight variation is due to the greater solubility of oxygen than of hydrogen in water. After running the current for a while, with a lighted splint test the gases which escape. Hydrogen collects at the cathode and oxygen at the anode.

Primarily it is the acid that is electrolyzed. The solution first contains $\overset{++}{H}\overset{--}{H}$ ions and $\overset{--}{SO_4}$ ions. When the current passes, $\overset{++}{H}\overset{--}{H}$ ions become H_2 molecules at the cathode and rise thru the liquid. The SO_4 ions at the anode become SO_4 radicals and break down into SO_3 and O. The oxygen rises as a gas thru the water, the SO_3 (being the anhydrid of sulfuric acid) unites with H_2O and forms H_2SO_4, which is again ionized into $\overset{++}{H}\overset{--}{H}$ and $\overset{--}{SO_4}$ ions, to again go thru the same process. Thus the end products are hydrogen and oxygen, and the water indirectly has been electrolyzed. The acid remains unchanged in quantity but it is really the acid that carries the current. In the electroylsis of all salts in solution water plays an important part.

Reduction of Metals.

Perhaps the most striking illustration of the reduction of metals by electrolysis is the preparation of aluminum as it is now carried on at Niagara Falls, where nearly 5,000,000 kilos (1 kilo equals 2.2 lbs. approx.) are annually produced by the famous Hall process. The principle involved is not dissimilar to those described above, the greatest difference being in the solvent and the kind of electrodes. A large iron box is lined on the sides and bottom with a mixture of carbon and coal tar, which forms the cathode (See Fig. 107). Large carbon terminals suspended from rods connected with the electric supply form the anode. The "bath" consists at first of solid cryolit (Na_3AlF_6), or a mixture of cryolit and fluorit (CaF_2), which is put in at the bottom and around the terminals. When the current is turned on the resistance to its passage by the cryolit fuses the latter, after which the aluminum oxid (Al_2O_3), specially prepared from the mineral bauxit, impure $Al(OH)_3$, is fed in. It is first dissolved by the molten cryolit, and then electrolyzed into oxygen and the metal aluminum. The latter seeks the cathode at the bottom of the bath where, at intervals, it is drawn off; while the oxygen passes to the anode, some of it consuming, at the intense heat, part of the carbon and burning it to carbon monoxid and dioxid, which escape.

Many other metals are now reduced by electric processes, as calcium, arsenic, phosphorus, and even iron. Calcium was a cabinet curiosity a few years ago, listed at $10.00 a gram; but now, owing to electrolysis, sells at *cents* per kilo. It is quite possible that, some time in the future, iron ores may be wholly reduced by electricity.

Many of these processes are electrothermic, involving heat to a far greater degree than usual, electric furnaces being substituted for the bath described above. The heat in these furnaces runs as high as 3,500 to 4,500 degrees. Moissan was the first, or at least one of the first, to utilize the process and invent a furnace, about 1890. This first attempt is illustrated in Fig. 108, and is a general type of most electric furnaces. It is about the same thing as an electric arc light placed horizontally and inclosed. Intense heat generated between the carbon terminals or electrodes by the passage of a current is made use of to melt, to vaporize, to reduce or to combine substances. Refractory elements like platinum, gold, copper, silicon and carbon are fused and even vaporized. In this furnace Moissan made minute diamonds from ordinary black carbon, the diamond being an allotropic form of carbon (see lesson on Carbon). The substance to be acted on, usually in the form of a powder, is put into the central open space between the terminals, the space closed, and the current introduced.

Carborundum.

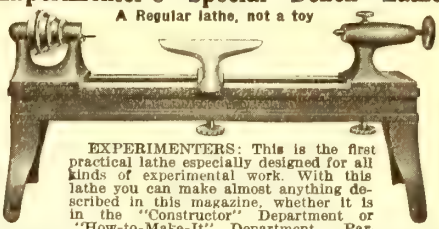
This product, next to the diamond, is the hardest substance known, and was prepared by Acheson, but its chemical properties were investigated by Mülhauser in 1892. It is now made by million of kilos (1 kilo equals 2.2 pounds, approx.) annually. Its manufacture involved a very simple process, a reaction of silica (SiO_2) and carbon, the latter combining with both silicon and oxygen.

$$SiO_2 + 3C = Sic + 2\ CO$$

Carbon monoxid (CO) escapes thru the loose openings and burns, with the characteristic blue flame, to carbon dioxid (CO_2) on reaching the air. The carborundum (SiC) is left around the core of the terminals as a beautiful, crystalin, iridescent lustrous, metallic looking substance.

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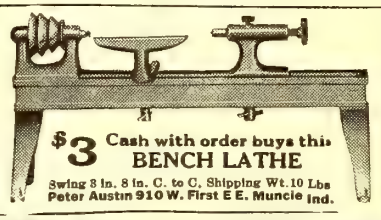
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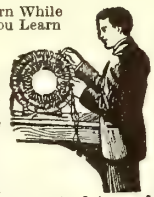
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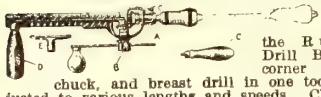
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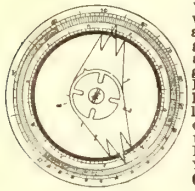
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The furnace is about 5 meters long, 2 meters wide, and 1½ meters high, built loosely of uncemented fire brick, and is dismantled at the end of each run. The carbons are 8 cm. in diameter and 60 cm. long, arranged in two bundles of about 60 carbons each. The charge contains 34.2% coke, 54.2% sand, and 9.9% sawdust, and 1.7% sodium chlorid (common salt), the total weight amounting to 10 metric tons. The conversion takes about 36 hours and produces about 2 tons. The core consists mainly of grafite around which is a layer of the crystallin carborundum, some 45 cm. thick.

Carborundum is used in all sorts of abrasive work from the polishing of granite to dentistry, taking the place formerly occupied by emery and corundum. Acids have no effect on it.

Calcium Carbid.—(CaC_2)

A substance which seems liable to revolutionize gas lighting is one of the largest furnace products. Slaked lime (CaO) and coke (C) are mixed and put into an electric furnace, the terminals in which are, as usual, carbon. A temperature of 3,300 degrees is obtained, at which the lime melts and the carbon reacts with it, combining with both calcium and oxygen, the latter forming carbon monoxid and carbon dioxid escaping. The calcium carbid is at first liquid at the high temperature, then is obtained in lumps of gray, earthy appearance.

$$CaO + 3C = CaC_2 + CO$$

The process was invented by Moissan and also Willson, the carbid having been accidently discovered in 1894 by Moissan.

When calcium carbid is thrown into water it reacts violently with it, liberating the gas acetylene, which burns with a brilliant white flame familiar to most readers, uniform thruout, entirely devoid of the non-luminous parts of the ordinary gas flame.

$$CaC_2 + 2H_2O = Ca(OH)_2 + C_2H_2$$
$$H_2C_2 + 5\,O = H_2O + 2\,CO$$

Acetylene is much in use for lighting headlights on automobiles, but is being gradually superseded by the electric lights to a very marked degree. It is also used in many places for lighting streets and houses, the gas being liberated in small definite quantities by water trickling on the carbid. It burns with a very smoky flame unless used in a special burner. Being an endothermic compound, acetylene easily explodes when under great pressure, dissociating into its two elements. It is non-poisonous.

The preparation of caustic soda by electrolysis was taken up in the Lesson on Sodium and Potassium Hydroxid, and little more need be said here about this process.

CHEMICAL UTILIZATION OF SUN'S RAYS.

That these electrochemical industries, and many others that might have been mentioned, have centered near Niagara Falls is due to the drop of 150 feet or more of the vast body of water of the Niagara River. For ages all the tremendous energy of this gigantic falls was wasted. A few years ago the idea was conceived of turning a small portion of the water into a canal, a mile or so back from the main falls, making an artificial drop, by excavation in the earth by the side of the river. Machinery was installed, the water conducted vertically downward thru penstocks, and turbines placed at the bottom, which the 25 meters of falling water with its enormous energy set in motion. This energy is communicated to the surface by revolving shafts and there used to drive powerful electric dynamos. The water is discharged by a subterranean passage below the Falls (See Fig. 109). It was a magnificent scheme, the immediate success of which was so great that new companies were formed—so many as to threaten the very existence of the Falls, and Congress has now past a law limiting the use of the water. The electric current is carried for great distances, even running street cars 100 miles away.

Utilizing the energy of falling water—indirectly the radiant energy of the sun—begun at Niagara, is now carried on at other places where cataracts have been provided by nature. The recent utilization of nature's forces has enormously stimulated chemical industries and led to many discoveries of new chemical processes; for of all agents, electricity best lends itself to the generation of other forms of energy. In Canada, Switzerland, Brazil and other countries, great waterfalls are utilized in this way. It is even proposed to carry the electric current from the falls of Zambesi in Africa to Witwatersrand, a distance of 600 miles.

(*To be continued*)

PRESIDENT'S SPEECH TO WORLD VIA CABLE AND RADIO.

(*Continued from page 742*)

and thence to India and the East Indies. Another cable route extends from Durban, on the east coast of Africa, to Mauritius Island, thence to Cocos Island, to Java and the west coast of Australia, landing at Perth. New Zealand received the message via the Vancouver cable route.

One of the longest straight, uninterrupted cable routes is that from San Francisco to the Philippine Islands, via Honolulu, T. H., Midway Island and Guam.

Alaska, too, read President Wilson's memorable speech, thanks to the cable running from Seattle to Valdez, via Sitka. Over snow-clad mountains and valleys the message leaped along telegraph wires to the farthermost telegraph city in this part of the world—St. Michael, on Norton Sound. It swept across Norton Sound with the speed of lightning, thanks to the wireless system operating between St. Michael and Nome. This wireless link, belonging to the U. S. Government, is of considerable historic interest, as it was first built by the well-known American radio pioneer, Dr. Lee de Forest, in the early days of Radio.

Another frigid clime territory that has cable connection with the world, but not shown on the ordinary map, is Iceland. A telegraph line runs across Iceland and its cable route is via Shetland Islands, southward to Scotland.

Coming back to the Atlantic Ocean we find that at present the direct German cables from New York have been cut. These used to land at Emden and ran via the Azores, which tiny spots of land, far out in the broad Atlantic, serve to join together many of the most important, long distance cables of the western hemisphere, as a glance at the map shows.

It has been said that, after the war, the United States and Canada will have an open sesame in establishing trade connections with the South American countries. This presumption has often been based on the mistaken belief that the European countries would have to send all cable messages via New York, and thence to South America, via the New York direct cable to Colon, etc. In this way it was thought that, perchance, the American merchants would get the tips on commercial deals and beat the Europeans to it—or at least give them a run for their money. This is where many people deceive themselves, for there is multiple cable service to Pernambuco, S. A., via Cape Verde Island, to Lisbon and Cadiz, thence to London, Marseilles, Aden, and the Far East; not to mention the other ambitious empires in northern Europe, all of which are plentifully supplied with cable and telegraph connections.

CAN ELECTRICITY DESTROY GRAVITATION?

(*Continued from page* 743)

(having practically no mass) rested upon insulators. They were separated from the protective screen by sheets of glass and were *grounded* to it by heavy copper wires. The metal boxes were then charged in every way that the solid lead spheres had been, but *not the slightest change in the position of the suspended balls could be detected.* This would seem to prove conclusively that the "repulsion" and "gravitational nullification" effects that he had produced when the *solid* large balls were electrically charged, were genuine and based undoubtedly on a true *interatomic electrical reaction,* and not upon any form of electro-static or electro-magnetic effects between the large and small masses. If they had been, the metal boxes, with no mass, would have served as well as the solid balls.

Another interesting experiment was conducted with low frequency alternating current applied to the large lead spheres. Spring contact brushes were fastened to the wooden blocks supporting the large spheres as shown in Fig. 4, one brush on either side of the ball. This permitted sending current thru the ball from one side to the other. First, a direct current of 20 amperes was sent thru the two large masses, but no effect upon the suspended masses could be detected. Next, an alternating current of 20 amperes was sent thru the large masses, see Fig. 4, with the result that the gravitational attraction was quickly reduced to zero, and not only that but in 15 to 20 minutes the small lead spheres *had moved away over one-half as much to the opposite direction* as the distance they had been attracted originally towards the large masses. Thus gravitation had not only been completely nullified, but it was *actually reversed.*

AT WAR WITH THE INVISIBLE.

(*Continued from page* 759)

I had the eerie feeling of one who beholds an awesome vision in a dream, aware that he is dreaming and unable to rouse himself. All sense of reality vanished before that appalling devastation. The tide was setting in from the bay and the sullen waters brought a small wave lapping at my feet. There was a splotch of rusty sediment on the wavelet which, to my disordered imagination, had the appearance of blood. It might be from some of the innocents beneath the sea, I thought, and drew back shudderingly.

The worst feature was that no one had survived to tell of the disaster. Camden, directly across the river, could give no coherent account of what it had seen. In fact, it had seen nothing that could explain the mystery. At ten o'clock in the morning—it was Sunday, and the neighboring cities were smiling peacefully up at the sky—a sudden explosion shook the Earth to its very heart. Stunned by the shock, the residents of Camden were further bewildered by the shattering glass and the rush of wind that sent chimneys and roofs crashing to the streets. Those who were first able to look about saw a black cloud rising to a great height above Philadelphia. It hung there for an hour or more, and meanwhile the surge of angry waters could be heard rushing in to fill the void. When the air finally cleared, the terror-stricken people rushed to the river front and their hearts sickened within them as they beheld a troubled ocean rolling over the region where once their sister city had been.

Ingals and I discust the problem for hours, but could come to no agreement. The National Geological Society had already declared the cause to be a volcanic crevasse of prehistoric origin, a layer above which had given way beneath the city and dropt it to a great depth. I accepted the Society's solution as the only reasonable one, but Ingals scoffed at it.

"The Mars fever has gone to your brain," I told him in one of our disputes. "Supposing they could have slipt thru the V-plane blockade—an obviously absurd proposition—why didn't someone see them coming or going? And why didn't the *selenoid towers* indicate their approach? I suppose you know that the plates in those towers will record anything coming towards the Earth as soon as the sol-ray interference begins—and that's 2,000 miles up. Professor Bergerov explained that very clearly in this morning's *Times.* Surely, you're not going to maintain that they've learned to reach us without disturbing the sol-rays."

"I'm maintaining only one thing," declared Ingals, "and that's the utter assininity of relying on the security of the past. What do I care for your damned sol-rays? The same minds that discovered them can find a way to circumvent them. Instead of wasting time trying to prove why the Martians couldn't have done it, those scientists had better be devising something to prevent their doing it again. And they'd better be preparing urgently quick, too, for it's my solemn belief those world-murdering devils are making ready for another descent."

Ingals was right. Barely eight days after the complete obliteration of America's third largest city, there came hurtling thru the air the gripping news of the destruction of Ramillon, the proud capital city of Mercury.

The need for theorizing was gone. The Martians had plainly broken thru the apparently impenetrable blockade and were again wantonly on the rampage. But how? we asked ourselves desperately. What unknown force had blood-reddened Mars unleashed, that could reach across the incalculable space, unseen and unheard, and, more omniscient than lightning, select its victims at will?

The days that followed Ramillon's destruction were like a gruesome nightmare. Every city on the allied planets lived on the edge of an unseen abyss, cringingly awaiting the next bolt to fall upon it.

On Friday morning, November 10th, as London was emerging from the fitful sleep of a terrorized city into the broad, full sunshine of a new day, a series of short, sharp, ominous explosions were heard in the air above the National Gallery. In sudden alarm, those in the vicinity gazed upward. From out of a clear sky, a shower of thin, red, metal discs zigzagged fantastically to the ground.

The entire district from Oxford Street to the Victoria Station became at once a frantic bedlam. Stampeded humanity rushed for shelter, and with palpitating expectancy awaited the direful catastrophe. With fascinated horror they watched the bewildering missiles bound and rebound from street to sidewalk and roll clinkingly to and fro.

Five—ten minutes past. The scarlet messengers had ceased falling, and lay gleaming in the bright autumn sun like splotches of blood. Here and there some, more bold than the others, stept out of their hiding places, compelled by curiosity to examine these strange visitants from out of the nowhere. Gradually London drew a sigh of relief. Traffic and life swung again into motion. Nothing fearful had happened. The metal hail phenomena would soon be explained, perhaps, by those whose business it was to solve such freakish events.

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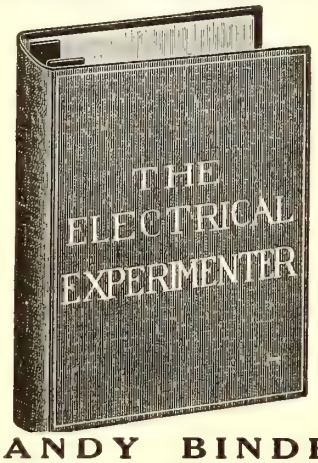
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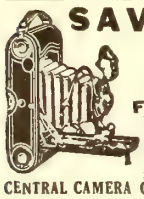
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Hardly an hour had past when London's feeling of reassurance was cruelly shattered. The discs, interpreted by university experts, were found to be messages from Mars. In one brief statement, the imprint on the red circle announced the complete destruction of the city by three o'clock that afternoon. A wail of deepest anguish rose from London's masses and spread like the blackened wings of doom over the whole city as the demoniac portent of the evil messengers penetrated the minds of the people.

In vain had the watchers in the Selonoid Towers sprung to their sensitive recording plates to seek for some indication of the enemy's presence. The plates were blank. A message, imploring help, was flashed over the Earth and at once our strongest forces were hurled to the spot. Huge V-planes, bearing tremendous batteries; grim little Heliolites (in one of which I was stationed) with their atomic detonators, and thousands of other craft thronged the air for a distance of five hundred miles around and above London.

But of what avail our formidable armament, when there was no visible enemy against whom to direct it? We circled about in close formation so that not even a sparrow could have escaped our reflectors, but the air was apparently innocent of any hostile ship.

Meanwhile, the city below was in the grip of a hellish panic. Those who could take to the air did so immediately, with never a thought for their treasures left behind. Others pushed and struggled like maddened beasts along the streets to escape from the doomed city. Bruised and crushed bodies lay thick along the highway, like worms after a spring rain, and their fellow beings trampled on them unheedingly in those awful moments.

Unfortunately, the greater part of those who cleared the city streamed out into Essex and Kent, overflowing such places as Welling, Grayford, Dagenhow, Grays Thurrock and Gravesend, where the Martians had evidently placed contact points for their detonators, in order to tear up the entire Thames bed and hasten the deluge from the North Sea.

A few minutes before the appointed hour we withdrew our army of planes with as many people as we could load on. I bent over the glass in the floor of my Heliolite for a last glimpse of London.

An immense throng had gathered on the Embankment, evidently resigned to the dreadful fate, and were listening to the soothing words of an old man who had assumed leadership of the mass and like some inspired prophet was evidently directing their thoughts away from the approaching terror. Down Cheapside way, other groups, crazed by fear, were tearing and rending each other in insane fury. My last impression—one that I still see vividly whenever I close my eyes—is of a large number of women and children kneeling on the ground in Regents Park, their arms outstretched piteously to us as we flew by.

So long had we stayed, loath to depart while there remained the faintest hope of discovering the Martians, that we had only reached Oxford when the explosion came. Again the dark cloud of destruction spread above the Earth, again the swirling waters rushed into the chasm, and London with its ten million lives was gone.

This was the culminating tragedy. Secure in her untrammeled power, Mars now issued an insolent manifesto. Peace was offered us on terms that would make the allied planets mere vassals to her will. If we accepted, the destruction of our cities would cease, otherwise—. Five days' grace were allotted us to make our decision. Unless we agreed to her demands by noon on Thursday, that hour would mark the doom of New York, and our other cities were to be similarly damned to extinction.

On the Saturday evening following London's destruction, I sat in the study of my apartment overlooking Van Cortlandt Park. My mind was spent from a whole day's heart-wearying discussion and argument in the Council. Many of the older men had advised submission, but several members of the Board of Strategy, including myself, pleaded for delay. At any moment the keen minds working tirelessly on the problem might discover the means used by the Martians to reach our Earth undetected. Without such knowledge, we all admitted, our cause was hopeless.

Alone in my room the mystery tugged at my mind again and again. It was baffling. In despair I looked about for something to relieve the unbearable strain. The *reflecto-screen* on the east wall caught my eye. It was connected with the leading theaters, and I remember thinking cynically how the people could go on playing even tho the end of the world was in sight.

Theresa Carmine was singing at the Metropolitan, I noticed by the *auto-indicator*. Switching off the lights, I connected the screen transmitter with the Opera House, opened the *audophone,* and stretched myself comfortably in an arm chair before the screen.

The second act of *Madame Butterfly,* that imperishable story of hopeless love, was nearing its end and Carmine stood looking towards the bay, waiting patiently for the lover who would never return. The wonderful colors of the screen brought out vividly the pathetic droop of the slim figure and the room echoed softly to the sobbing violins and 'cellos of the orchestra.

Unstrung as I was by the events of these anguished two weeks, the pitiful little tragedy touched me deeply. Tears came to my eyes and I thought of Ava. I had been unable to see her since the night of the reception in Paris. Probably the next cataclysm would destroy one of us, I thought, and the other would be left alone. like the little Butterfly, waiting, waiting—

The curtain dropt and the sound of ringing applause came over the audophone. The operator at the Metropolitan now turned his *visu-flector* upon the audience. Row upon row of exquisitely drest women and men flashed on the screen. The sight of the smiling, chattering, thoughtless throng jarred on my mood and I was half rising to disconnect the transmitter, when the view of a box directly in the center of the horseshoe brought me to my feet with a cry of surprise. There sat Ava beside her father, a pensive smile on her beautiful face, her eyes shining straight into mine!

The view past in a second and I was left gaping at the screen. I had been so engrost in the Martian atrocities that I had entirely lost track of the Venusian commission's program. Undoubtedly this was the day of their arrival in New York, and of course the committee had taken the members to the opera.

In another minute I was up on the plane roof and had pushed my little electric from the garage. The despondency of my mood had changed to joyous exhilaration, and I rose high in the air before turning towards the Metropolitan. A young moon was high in the heavens and New York lay beneath me, bathed in the enchanting glow. Never had the city looked so beautiful, so entrancing; never had it seemed so dear to me. I was conscious of a sudden strong faith that it would be saved from the despoilers.

The last act had already begun when I entered the box. Quietly I drew a chair from the rear of the box and seated my-

self near Ava. Under cover of the darkness I prest my lips to her hand. I felt a thrill go thru her as she recognized me, and my heart welled up in contentment. Again I raised her hand to my lips. The mystic bells chimed faintly and Ava prest my hand warningly. I leaned back, silently drinking in the radiance of her presence. Idly my mind played with the thought of the bells on her wrist. Mysterious bells, I thought dreamily, ringing like our love from heart to heart, invisible to the world—

With a sudden jerk I sat upright. "Ava!" I whispered. "Come outside with me."

She turned in surprise.

"At once!" I urged breathlessly.

Obediently she took my hand and followed me to the foyer. It was deserted and I led her to one of the gilded settees, my mind tingling with the idea that had entered it.

"The bells—" I spoke in a choked voice, unable to control the eagerness that was thrilling me. "Let me have them—I must see—"

"I cannot take them off. No one knows how the bracelet is fastened." My excitement had communicated itself to her and she breathed rapidly. "What is it?" she asked eagerly. "What have you discovered?"

"I'm not sure yet, but I think—I believe—" A surge of exultation overwhelmed me and I clasped her to me so tightly that it seemed as if our hearts must meet. "Ava!" I cried. "You and I have found the secret of the Martian raids!"

"Where!" she gasped.

"On your wrist!" I replied triumphantly. In the excitement of the moment, wrought up by the discovery and the closeness of her own dear self, I kist her.

"Can the bracelet be touched?" I asked when we had sobered down.

"Of course. Here, give me your hand."

With her left hand she directed my fingers to a place on her arm. To all appearances the soft, white skin was absolutely bare and there was nothing to prevent my touching it; but with my fingers barely a half inch away, a hard object interposed itself. I could feel it encircling her wrist. It was evidently of glass or some other crystalline substance, and, to my cautious, exploring fingers the surface appeared broken into innumerable tiny facets.

"*The bells are inside,*" Ava explained.

Blindly, as it were, I continued my investigations with finger tips alert.

"Where and how did you get the bell-bracelet?" I asked.

"A friend of my father gave it to me years ago. He was always experimenting with mirrors and stones. I remember his saying that some day he would be able to wear a coat that would make him invisible." A swift light of understanding illuminated her deep, opal eyes. "That is just what the Martians are doing!" she exclaimed.

I nodded. "Is that man still alive?"

"No. He was killed in an accident shortly after he placed the bracelet on my arm. That is why I have never been able to remove it. No one but he knew how."

(*To be Concluded.*)

A SPEEDOMETER FOR SMALL BATTERY MOTORS.

(*Continued from page 770*)

out when you pull the cord. Thread the other end under the staple, F, and up thru the small hole, g, in the arm, D. Connect the other arm up in the same manner. Tie the end of each cord to its appropriate arm, adjusting the length so that when the arms are up flush against their respective stops, e, Fig. 3, and the cord is taut, the slider will be about 1/16″ from the outer ends of the guides, H.

The part P is a wooden standard, ¾″ x ½″ x 1⅝″. To it are screwed the bearings, N, supporting the drum, M, by means of a small pin passing thru it and serving as a shaft, permitting the drum to revolve freely.

A good drum may be made by simply passing an ordinary pin thru the center of a cork. Be careful that the top of the drum is even with the center of the motor shaft.

Solder a short piece of No. 28 copper wire, L, to the end of the link, I. Pass it once around the drum and fasten the end to the pin, S, adjusting the length so that there will be no slack when the slider, J, is out as far as the cord, G, permits it to go.

The elastic band, Q (or better, a spiral spring if you can scare one up), is also fastened to the pin, S, and the other end fastened to the small screw-eye, R. The tension will have to be adjusted by experiment after the speedometer is completed.

O is a wooden standard, tapered at the top to about ⅛″ in width. See Fig. 3. In height it should be just sufficient to barely support the link, I.

A tack, K, similar to those used in making cigar boxes, is placed thru the slot in I and driven almost home, but permitting I to slide easily back and forth without the slightest trace of binding. This arrangement permits the lateral motion of J to be communicated to the drum, M, and thence to the end of the pointer, while preventing I from turning with the motor and twisting off the connecting wire, L.

An old hat pin, cut to the right length, makes an ideal pointer. It should be pushed thru the drum so that when the motor is at rest and the tension, Q, is properly adjusted, the end will be at "stop" on the dial, V, which is supported by the standard, U.

X, X^1 are two small angle irons used to firmly fix the standards, P and U, to the base board. The screws in X^1 should be long enough to pass entirely thru U and the wooden block, Y, into P, thus fastening the three pieces firmly together.

Pins should be driven into the dial at W, W to limit the swing of the pointer. The whole should then be screwed to the base board at the proper distance from the motor.

The principle of operation is similar to that of a governor on a steam engine. As the armature revolves the weights tend to overcome the tension, Q, and fly out, thus pulling the slider, J, toward the flange, B. This lateral motion is communicated to the drum, M, and pointer, T, by means of the link, I, and wire, L. The faster the armature revolves the farther will the weights fly out, causing the pointer to move across the dial toward the left.

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THE FIRST TROLLEY.

(*Continued from page 750*)

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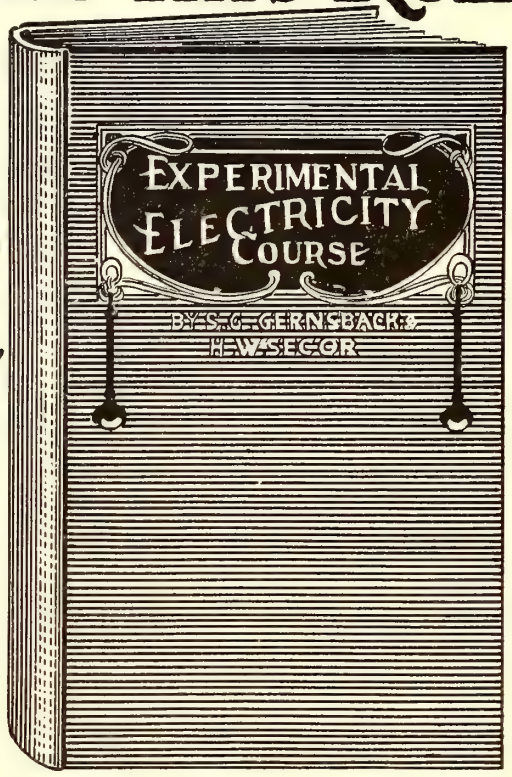
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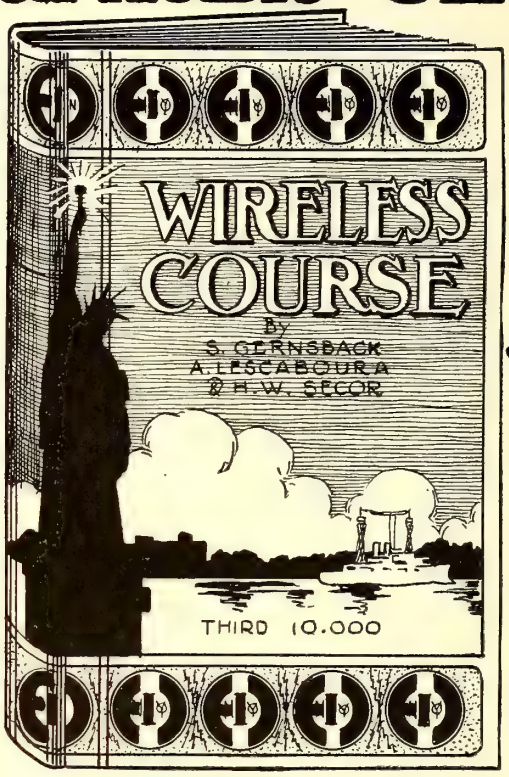


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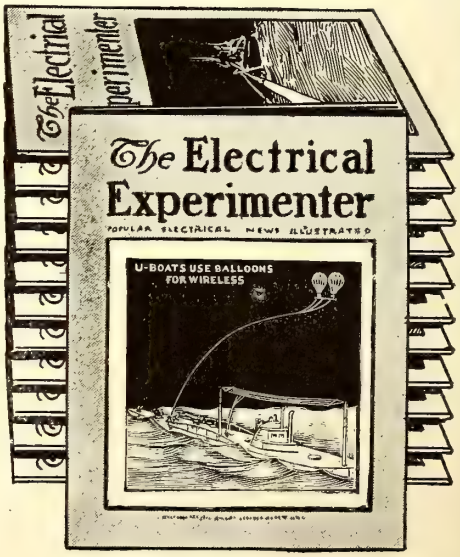
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WANTED—2 K.W. 60 Amp. dynamo 110 volt or less. Harry D. Morris, Quitman, Mo.

WRITE for list of small stuff for sale cheap. R. W. Chaffee, 67 Thurston St., Somerville, Mass.

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FOR SALE—Iver Johnson motorcycle first-class condition, 1913 twin cylinder; good running order, price $75.00. Howard B. Stossel, Front Royal, Va.

FOR SALE—¼ H.P. Emerson A. C. Motor. Will trade for good rectifier or water motor. All answered. A. Hampton, Box 263, Whitewright, Texas.

FOR SALE—15 dial Omnigraph (Morse code), key and sounder. Harry Baker, Box 48, Greenville, Ohio.

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BARGAINS FOR SALE—Erector, cost $15; No. 2A "Brownie" Camera; Bicycle Gas "Searchlight"; Hunting Lamp; Electric Lantern; Camp Ax; Bicycle Horn; "Boys' Book of Electricity"; Knapp Leader Motor; Striking Bag; Spring Exerciser. All practically new. Very cheap. Gordon Bennett, Darlington, Md.

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No. 4 Contains 270 pages, 379 illustrations. Alternating current principles—alternating current diagrams—the power factor—alternator principles—alternator construction—windings, etc.

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No. 6 Contains 298 pages, 472 illustrations. Alternating current systems—switching devices—circuit breakers—relays—lightning protector apparatus—regulating devices—synchronous condensers—indicating devices meters—power factor indicators—wave form measurement switch boards, etc.

No. 7 Contains 316 pages, 379 illustrations. Alternating current, wiring power stations—turbines; management, selection, location, erection, testing, running, care and repair—telephones, etc.

No. 8 Contains 332 pages, 436 illustrations. Telegraph — simultaneous telegraphy and telephony — wireless—electric bells electric lighting—photometry, etc.

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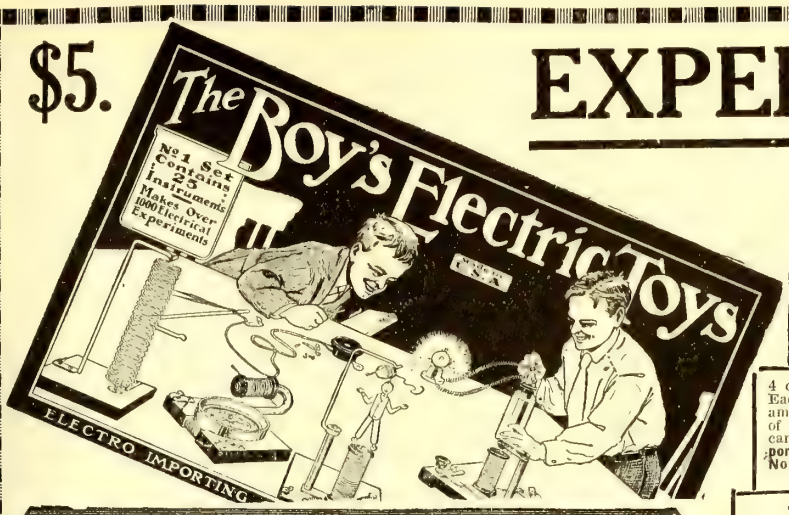
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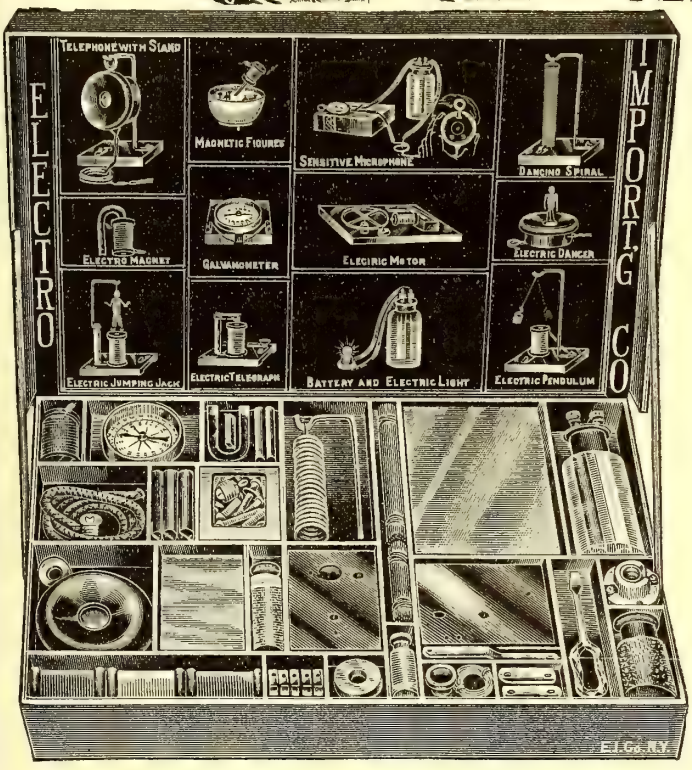
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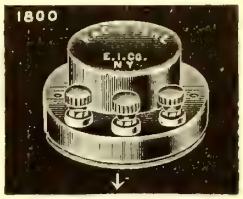
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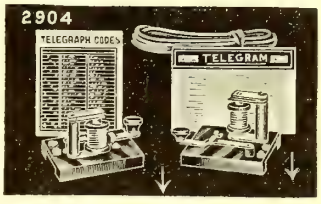
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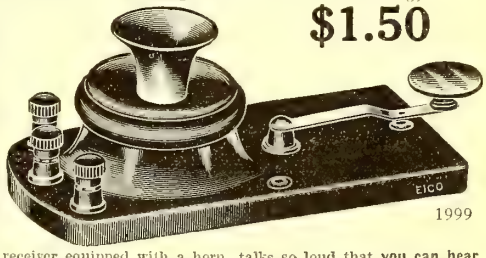
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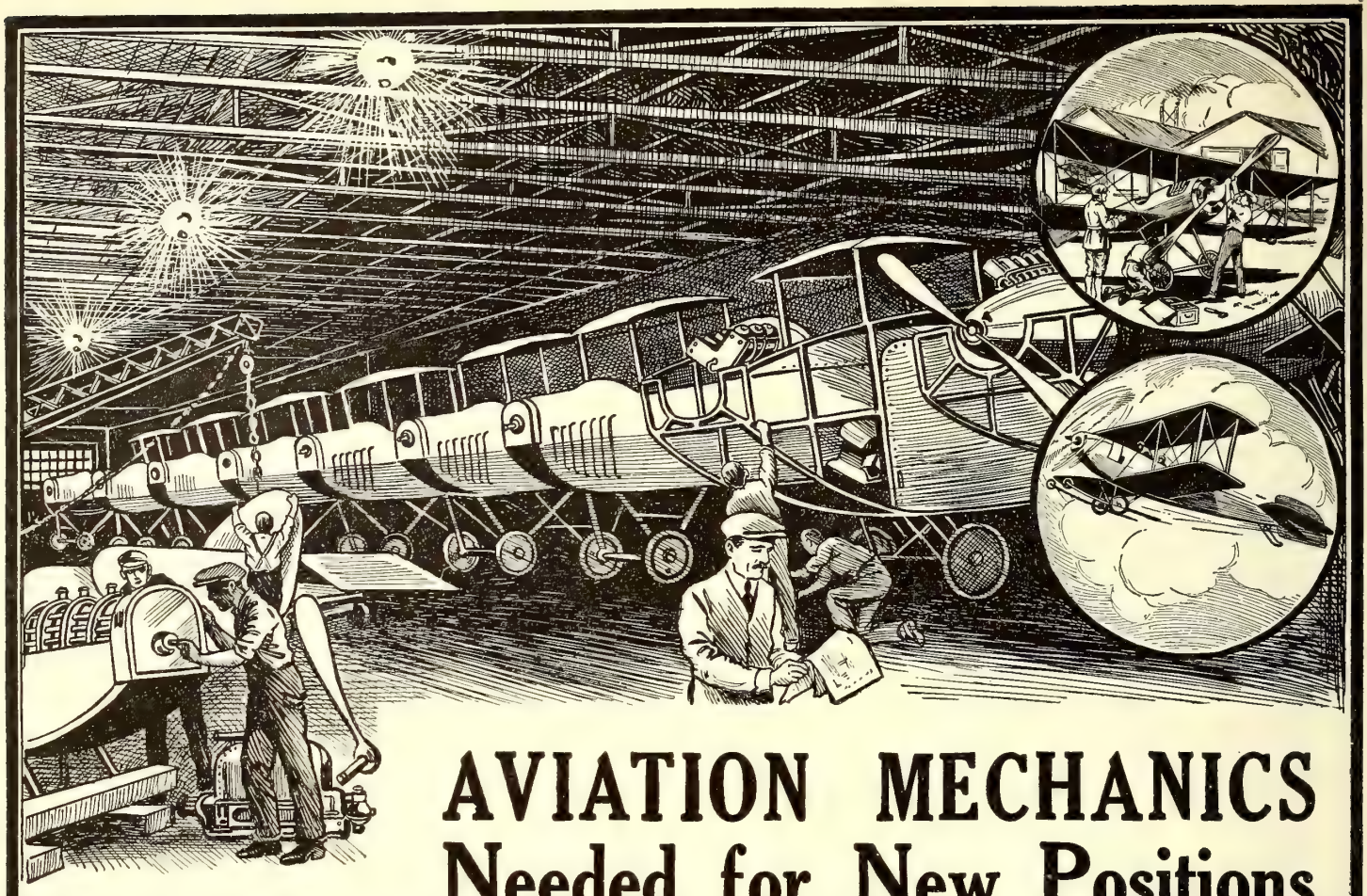
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"Twenty Years Ago"

THE following is an excerpt from a letter which reached me a short time ago. I quote one of the paragraphs verbatim:

"I am a widow with an only son. Jerome, who is an ardent reader of your splendid publication, which he has taken for over four years, is going into his twentieth year. For some time he has taken a correspondence course in electricity, and now he wants to enter an electrical school to learn the profession in a practical manner. While I know that he will make a success of it, I am somewhat troubled, as I, as well as his Uncle, think that the electrical field just now is very much overcrowded. The reason why I write to you is to have your honest opinion and what you think of the outlook in the electrical field. Is there much chance for the young man and is there a future for him? . . ."

Without knowing just what branch of electricity the young man is going to choose, our answer of necessity must be somewhat vague. Nevertheless, we have not the slightest hesitancy in stating that not only is the electrical field not overcrowded, but there exists now, and there will exist for years to come a great shortage of practical electrical men.

No field is as diversified as the electrical. Nowhere is there greater opportunity for the man who knows, for the man who specializes in *any* electrical line. As in every field of endeavor, it is primarily the knowledge of the man that counts. The field itself is secondary. But we earnestly believe that the man who has a general training in electricity has an open *Sesame* before him these days.

We are so busy and so engrost in our everyday work that we hardly ever stop to think how fast the world is growing and how tremendous the strides have been, all mainly due to the magic of the electric current.

Let us see just how the world looked twenty short years ago, before the young man in question was born. It will surprise us.

Twenty years ago, there were no electrical trains, no subways, which now whizz us daily to and from our work. Untold millions are invested in these enterprises and tens of thousands of people are engaged in the electrical end to operate these trains.

Twenty years ago, we were still burning our inefficient carbon lamps with their dull red light. Nobody thought of the brilliant tungsten lamps. Millions are invested in this industry alone, while thousands upon thousands of people are employed in it. What kind of light will we have twenty years hence? How many additional millions will be invested in a brand new lighting industry, and how many thousand workers will it employ?

Twenty years ago the X-Ray tube was just emerging from the laboratory to save untold human lives. Today the X-Ray industry is one of the most profitable ones, there being close to a thousand concerns manufacturing these wonderful tubes. And the X-Ray is still the great "X"—the unknown. We don't know to this day what these rays really are. What the next twenty years will bring to this field is impossible to forecast.

Twenty years ago there was no commercial nor amateur wireless telegraph, nor the wireless telephone. Can you imagine an ocean liner without its wireless today? And what of the countless millions invested in the wireless industry? And if the tens of thousands of wireless experts, near-experts and plain workers were quadrupled today, there would still be a dire shortage. And what impossible feats will "wireless" perform 20 years hence? Wireless *power transmission* alone will be an undreamt of huge industry. The mind staggers at the possibilities.

Twenty years ago there were no electric heating utensils. There were no electric flat-irons, no electric toasters, no electric ranges, no electric heating pads, no electric water heaters, etc. While today the electric heating industry is a very important one, and growing by leaps and bounds.

Twenty years ago there were no electric flashlights. Today it is a mammoth industry, with over 60 million dollars invested in it! Over 400,000 flashlights are turned out every working day in the U. S. alone!

Twenty years ago the ubiquitous electric dry battery—the common dry cell—was practically unknown. We still had our messy wet cells, which somehow or other never worked. Last year in the United States alone there were manufactured dry cells to the tune of over 40 million dollars! And every manufacturer is oversold for 1918! Aside from this the present dry cell is far from satisfactory.

Twenty years ago there were no electric baby incubators which now save thousands of lives every year. There were no vacuum cleaners, no radium, no transcontinental telephone, no slot telephone, no high-frequency machines, no spark plugs to make automobiles possible, no moving pictures, no automatic-electric block signals to save thousands of lives.

The list is as endless as are the prospects twenty years hence. Can anyone deny the wonderful future of electricity in view of such facts? H. GERNSBACK.

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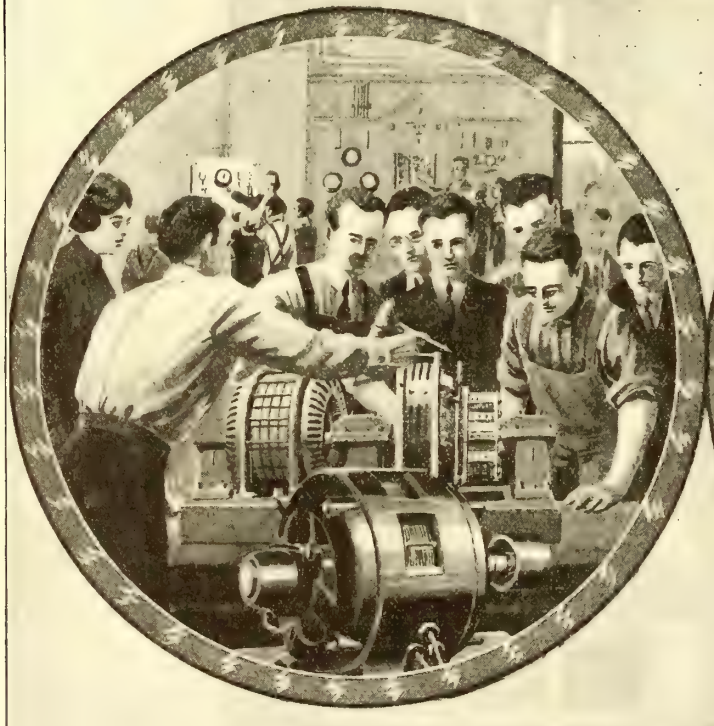
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H. GERNSBACK EDITOR
H. W. SECOR ASSOCIATE EDITOR

Vol. V. Whole No. 60 April, 1918 Number 12

Seaplane Radios Trawlers and Destroys U-Boat

ONE of the latest official stories from London describes the wonderful, almost uncanny, hawk-like qualities of the modern radio-equipt seaplane. In this instance the seaplane was flying along on patrol duty when suddenly it spotted a Teuton "unterseaboat" resting peacefully on the sea bed.

At once the seaplane officer sent out a radio call to a destroyer and her fleet of trawlers ten miles away. The aerial fighting craft never took its eagle eyes off the enemy submarine, but continued to circle around and around, making sure that it did not sneak away, as these sly craft are often wont to do. Shortly the destroyer and trawlers arrived on the scene ready for action under the direction of the seaplane. The trawlers got out their sweeps and began steaming toward each other. As they met their wires engaged the bow and stern of the submarine and began to pass under the submarine. Then the submarine released two mines which the crews of the trawlers ignored with the reflection: "Her eggs can wait a minute."

Then the trawlers crost and held the submarine by cables. The submarine attempted to free herself, but without success. The seaplane signaled "You've got him!" and the destroyer answered, "Thanks! We'll give him five minutes to come up to breathe, but no longer!"

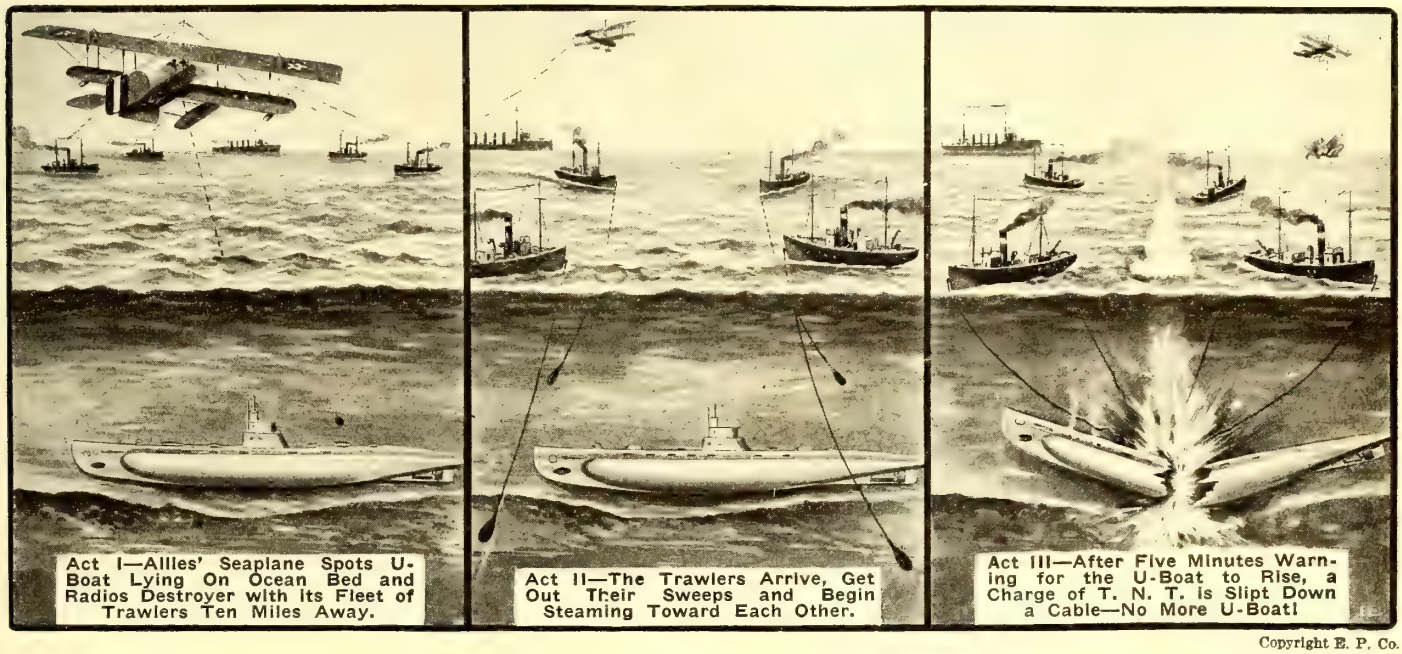
When the time had past "Fritz" had not moved a foot—upward at least. The destroyer flagged a signal and the trawlers slipt a small tin of T. N. T. to the taut wire and let it slide down to the submarine's hull. An ominous silence rested on the strange stage setting for a few moments—moments that seemed like hours. Then the distant-like deep boom and two gigantic, foaming gray mounds of water presently muffled the explosion. The wires about the submarine snapt in the middle and the crews coiled them up. Meanwhile the seaplane circled around a patch of oil that came to the surface and then notified the trawlers that the submarine was destroyed.

The aerial observer then slipt a band of cartridges into his gun and sped off after the mines floating in the tide to burst them with rapid firing. The first mine sank punctured and the second exploded as the bullets reached it.

The Germans are loath to divulge U-boat casualties to anyone, even their own people, and especially among their naval crews. The Allies are slowly but surely curtailing the activities of enemy submarines. This is so for several reasons, chief among which is the fact that the leading scientific minds among the Allied councils are at work on anti-submarine devices and schemes.

The Americans have brought to bear on this problem a vast array of scientific talent—more than the average man would possibly ever suspect. Secretary Daniels of the U. S. Navy Department has recently stated that a new anti-submarine device in the form of a "locater" is being tested out in practise and giving very favorable results.

One Yankee inventor has perfected a sound-wave "sub." locating scheme, which has proved of such a meritorious nature that the *Naval Consulting Board* has taken it up in earnest. Publicity cannot be given to this invention now, of course, but without mentioning harmful details it may be said that the idea is to send thru the water a powerful sound wave, as by means of a Fessenden sub-sea oscillator and then to intercept the reflected wave or echo. By



Act I—Allies' Seaplane Spots U-Boat Lying On Ocean Bed and Radios Destroyer with its Fleet of Trawlers Ten Miles Away.

Act II—The Trawlers Arrive, Get Out Their Sweeps and Begin Steaming Toward Each Other.

Act III—After Five Minutes Warning for the U-Boat to Rise, a Charge of T. N. T. is Slipt Down a Cable—No More U-Boat!

Copyright E. P. Co.

RAILROAD TRAINING GIRLS AS TRAIN DISPATCHERS.

One of the large eastern railroads has opened a building in Philadelphia, where a staff of competent teachers will instruct hundreds of girls in the art of train dispatching.

The picture shows one of the girl students seated at an electric switchboard in the school. On the table is a complete miniature railroad, operated by electricity with switches, signals, semaphores, etc., by means of which the students are taught the duties of a dispatcher.

The complete miniature electric railway would, in its completeness, tickle the boy Edison to his heart's content. It works just like the big railroads—only no one is killed or have their leg cut off, should the fair train dispatcher make a mistake and transpose a freight and a passenger train at the wrong moment. But she is reprimanded—never fear. That's what the school is for—to teach the profession and teach it right, for railroading is one of the most, if not the most exacting of vocations.

And so it happens that we see few errors, even with beginners as we watch the deft fingers of the beskirted railroad students, as they push the buttons that cause the miniature semaphore lamps to flash red, then green—stopping trains in certain blocks and starting them again when the block ahead shows "clear."

Hats off to the "Ladies of the Rail."

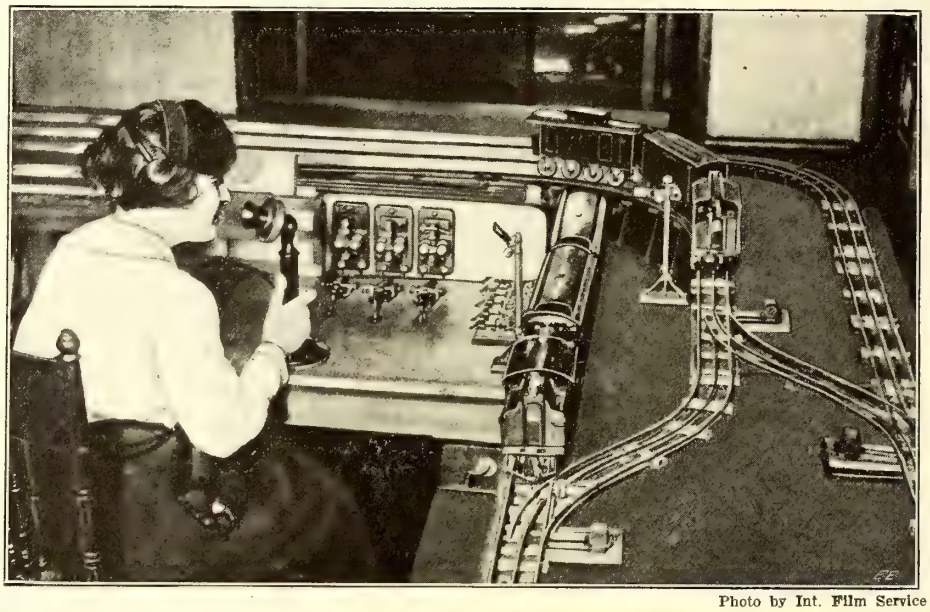


Photo by Int. Film Service

Here We Have a Glimpse of Miss America Learning to "Do Her Bit"—Students Are Taught Railroad Train Dispatching With a Complete Miniature Electric Railway Like That Shown.

"METERWOMAN" TO SEE YOU, SIR!

Women will be employed by the Rochester Railway and Light Company as meter readers, beginning next month. The step has been taken to relieve men for military service and for urgent work in other lines. The women will be given a preliminary course in meter reading.

Frederick W. Fisher, employment manager, stated that the women will wear an official badge of identification. Altho it will in many instances be necessary for the "meterwomen" to clamber into unpleasant positions, they will not be required to wear overalls.

WIRELESS PLANT IS SEIZED.

A wireless plant thought to have a radius of several hundred miles was seized recently by Sheriff Applegate at Timber, a small community about 20 miles from the Oregon coast. The plant, which was rather well concealed, was found at the home of J. E. Jacobson, who is ticket agent and operator for the Southern Pacific R. R.

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measuring the time required for the reception of the echo, and several other factors, the exact position distance of the "sub." can be ascertained on special, finely calibrated instruments.

The Germans are, according to one writer who resided in their country not so long ago, making use of a clever sound wave stunt for locating enemy ships without using the periscope. This scheme involves nothing more or less than applying the principles of triangulation, well known to every student of civil engineering and surveyors, to sound wave propagation, reflection and interception. One of the U-boats might, for instance, send out a powerful sound wave from an under-water oscillator; this wave, especially if concentrated, would be reflected upon striking the hull of a steamer and at an angle. By underwater sound wave telegraphy two or three U-boats could quickly check up the angles of reflection and determine the speed, as well as the location of the steamer or warship, and without once showing their periscopes. This may be the answer to the *Tuscania* riddle—it is said that no U-boat was sighted. Another way of firing torpedoes accurately without taking sightings thru the periscope was described in the July, 1917, issue of the ELECTRICAL EXPERIMENTER.

A Swiss electrical engineer, employed for the last ten months at the electrical works at Kiel and who has recently returned to Geneva, says that the Germans are making every effort to conceal their submarine losses, especially from the navy, because of increased difficulty in mustering crews. He estimates the Germans lost 30 per cent. of their submarines during the time that he was at Kiel.

"I saw a score of submarines lined up in the canal undergoing repairs," he said. "They had been hit by depth bombs, which the Germans seem to fear greatly."

The engineer added that there had been two serious mutinies at Kiel during 1917.

WHAT IS T. N. T?

Tri-nitro-toluol, or tri-nitro-toluene, or T. N. T. is a white solid which is easily made and which is safer to use than many other explosives. Chemically it is $CH_3 C_6 H_2 (NO_2)_3$. It is made from toluol and nitric acid. The toluol is obtained as a by-product in the coke industry. There is not enough toluol prepared in the United States to supply its present needs. The tar and illuminating gas of the city gas-works contain toluol. By making certain changes in equipment the toluol could be saved. Toluol in gas gives illuminating power, but if gas mantles are used its absence will not be mist. It is of no value in the gas used for heat. It has been estimated that enough toluol is burned in illuminating gas in the United States in *one day* to make T. N. T. for 150,000 3-inch shells. Three hundred pounds of T. N. T. are used in a single torpedo.

CHICAGO HAS FIRST ELECTRIC FIRE BOATS.

The first electrically propelled fire boats are in service in the City of Chicago. They are 125 feet long and can deliver 9,000 gallons of water per minute at a pressure of 150 pounds to the square inch.

ECUADOR AND PERU FAVOR AMERICAN ELECTRICAL GOODS.

America's opportunity of increasing its sales of electrical goods in Ecuador and Peru during the absence of German competition is pointed out in a report made public recently by the Bureau of Foreign and Domestic Commerce, of the Department of Commerce.

Before the war this trade was divided between Germany and the United States, the advantage being with the American manufacturer. The Government's report is concerned with the market as it exists today and the opportunities it offers for the future.

Copies of "Electrical Goods in Ecuador and Peru," Special Agents' Series No. 154, can be purchased at the nominal price of 10 cents from the Superintendent of Documents, Government Printing Office, Washington, D. C., or from any of the district or co-operative offices of the Bureau of Foreign and Domestic Commerce.

HIGHEST TELEPHONE LINE IN THE WORLD IN COLORADO.

Engineers of the Mountain States Telephone & Telegraph Co., have installed what they believe to be the highest telephone service line in the world. On the Denver-Leadville toll route the company has constructed the section of the line that crosses Argentine Pass at an altitude of 13,200 feet. The newly-built section is only one and three-tenths miles in length, and it is estimated that the cost of construction was more than $12,000.

BACK NUMBERS!—Many readers desire to obtain back numbers of this journal. We have a limited quantity of these back issues on hand and can supply them at the following rates:—Back numbers of the Electrical Experimenter not over three months old, 15 cents each; over three months old, 20 cents each; over one year old, 35 cents each.

Search-light "Sub" Destroyer for Ships

By H. Winfield Secor

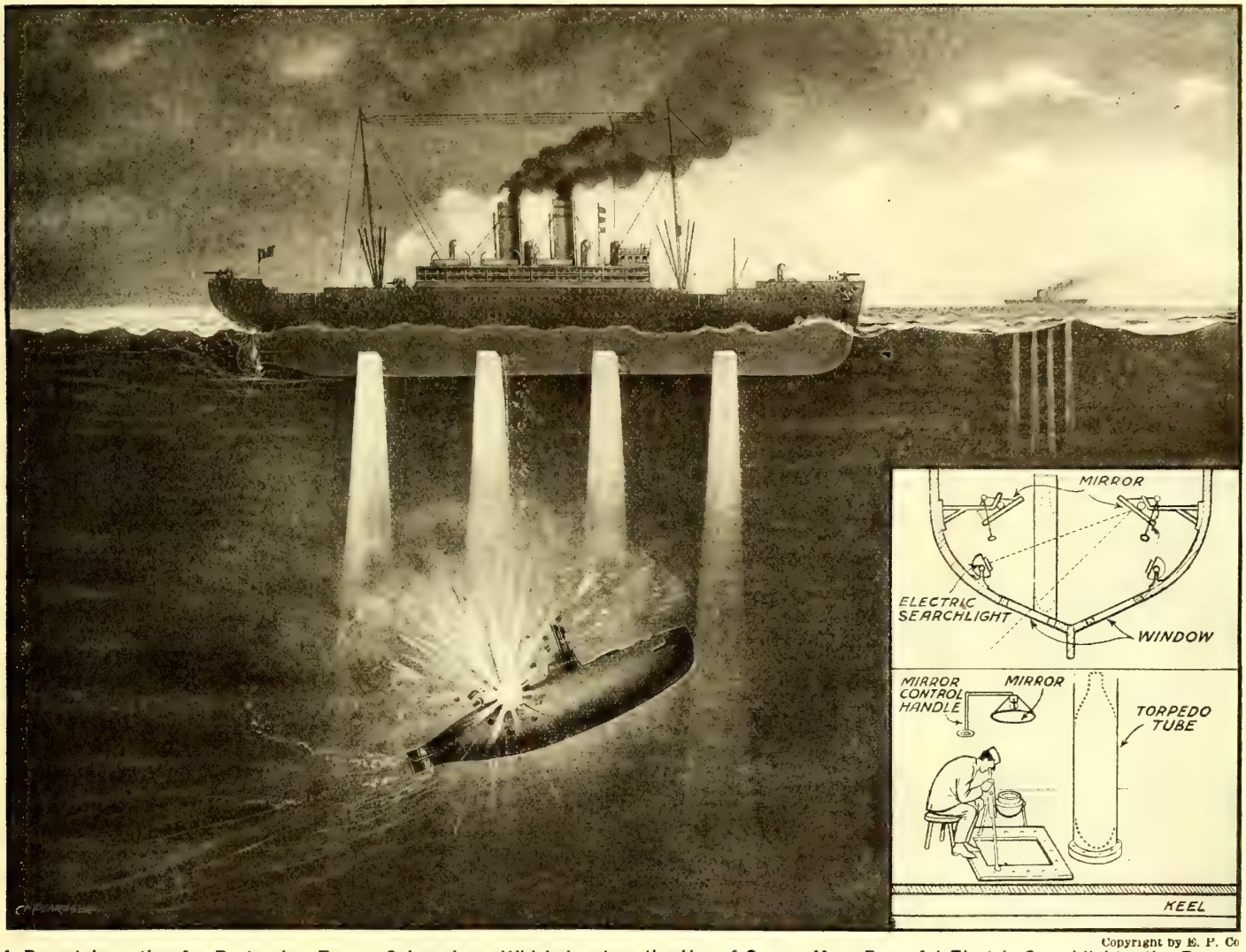
IT has happened now and then that a merchant vessel has past directly over an enemy submarine without knowing it. Likewise enemy submarines have dived under steamships for one reason or another—perhaps to escape being rammed, or again to get a better chance to torpedo the unsuspecting vessel. Now imagine what would happen if, just when the ship was over the sub-sea craft, it suddenly turned on a battery of powerful under-water search-light projectors, as shown in the illustration!

moved off the spot—a matter of a few seconds. Also, the lower part of the hull of ships so equipt could be strengthened and double-bottomed to stand the extra strain. Besides, why have the depth bombs detonate so quickly? Considering that the target is, under these conditons, fairly sure of being hit, why not use magnetic torpedoes—each torpedo to be provided with a powerful electro-magnet, so that when it reaches the "sub's" steel hull it will be attracted and held. Then, with suitable time fuses attached (or else by providing them

Sperry search-light, capable of developing over a billion candle-power in one concentrated beam.

This interesting scheme of combating submarines has been patented by an Illinois inventor, Mr. George W. Keister. In his patent specifications, among other things, he says:

"The present invention relates to a device for torpedoing and destroying submerged objects such as submarines, and has for its object to provide a device of this character which embodies novel features of construc-



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A Recent Invention for Destroying Enemy Submarines, Which Involves the Use of One or More Powerful Electric Searchlights, the Beams of Which Are Projected Thru the Glass Windows in the Bottom of the Vessel's Hull. When a Submarine Is Spotted, the Observer at Once Discharges a Depth Bomb, Which, if Fitted With a Strong Electro-Magnet, Will Attach Itself to the "Sub's" Hull, and Explode Later When the Time-Fuse Acts. This Allows the Vessel Time to Get Away from the Spot.

As soon as the observer stationed inside the ship's hull sees a black hulk, he discharged a torpedo or depth bomb with every chance of hitting its mark. Considering that the projectiles would come fairly close or right on the target, they would not have to be loaded as heavily as the depth bombs ordinarily used, with the consequence that the vessel discharging them would not be in such danger of self-destruction or injury, as are the present destroyers and other craft. By means of time fuses suitably applied the depth bombs need not detonate until the vessel had

with an electric diafram depth-gage detonator, as described in the January, 1918, isue of the ELECTRICAL EXPERIMENTER), the U-boat would continue on its way, suspecting nothing perhaps, unless it should have been the slight bump when the magnetic depth bomb "took hold," when suddenly—well, it would be all over for the Hun sub-sea sailors in less time than it takes to tell about it.

It is possible to see a distance of 75 to 100 feet with modern high power electric search-lights under water, especially with such intensely powerful projectors as the

tion, whereby a submarine, even tho it may be submerged to a considerable depth, can be located from a vessel directly above the same and a torpedo projected with accuracy in the direction of the submarine

"Further objects of the invention are to provide a device for destroying submarines which can be mounted without difficulty or great expense upon any small vessel of a sufficient size to carry a torpedo tube, which can be controlled by a single operator. (providing only one sub-sea searchlight is used), and which will make it easy to locate

(*Continued on page* 865)

The Dictograph in the Trenches

IN our November, 1917, issue Mr. H. Gernsback showed graphically how the microphone could be used for trench warfare, and we showed several applications how it was to be accomplished. While the article was not official in any way and only showed the application as it existed in our minds, we are now happy to show actual photographs of the same idea, showing that the idea is now in actual use on the front, the strange part being that the several applications are exactly as shown by us in our article, which like many similar ones was only imaginary, we having no official information of any kind that the microphone was being used for such purposes.

Our photographs show the dictograph at the front, and how our boys "over there" use the instrument to detect plans of the enemy.

Illustration No. 1 shows one of the boys crawling up towards the enemy trench to place a highly sensitive transmitter. It will be noted that the transmitter is placed upright in an old tomato can which easily camouflages the sensitive little instrument. As is well known these microphones are so sensitive that they detect a whisper at a distance of fifty feet. The sensitivity too is increased a great deal if the wind blows towards the microphone.



Photos Western Newspaper Union

How Our Boys "Over There" Listen in for Fritz's Secret Confabs. A Super-Sensitive Telephone—Known as a "Dictograph"—Is Used For This Purpose. Fig. 1, Shows a "Sammie" Crawling Up Near An Enemy Trench to "Place" a Camouflaged Microphone (in a Tomato Can); Fig. 2, How the Dictograph Transmitter is Placed in a Dug-Out Near an Enemy Trench; Fig. 3, A Trench "Listening Station."

Fig. 2 shows how one of the microphones is placed near the enemy trench in a sort of dug-out, but little ground separating the microphone from the trench. This is right under the enemy's parapet.

In Fig. 3 a trench receiving station is clearly shown. At this station the intelligence is received by one or more operators, usually one listening, the other writing down whatever talk is picked up.

It goes without saying that the successful placing of these detectaphones as well as the laying of the wire, which operations are always under direct fire of the enemy, is one of the most dangerous and difficult undertakings in modern warfare. It is a task allowed only to a man of iron nerve, and it takes much courage and good judgment not to blunder.

During the night very often the presence of a man is detected, and it then becomes necessary for him to lie perfectly still for perhaps hours at a time, as the slightest movement would draw machine gun or sharp rifle fire at once. When finally the man in "no man's land" retraces his course, he must do so very slowly and cautiously, going backwards at the rate of fractions of an inch at a time, irrespective of the fact that it may be freezing or that the rain may come down in torrents. However, this is only one of the disagreeable fortunes of war, and our boys do the work as cheerfully as they do it efficiently.

WHITE HOUSE ELECTRICITY.

The White House at Washington is said to have the most intricate and complete electrical system installed in any building in the United States. There are in the mansion nearly 170 miles of wires, providing for 3,000 incandescent lights, a bell system, and a private telephone system for the President and his family exclusively.

NEW METHOD OF MAKING LEYDEN JARS AND CONDENSERS.

Long ago the tinfoil type of Leyden jar and condenser for wireless telegraphy and other purposes passed into oblivion, and in its place settled the copper-plated type. A new method of producing metal-coated glass for such purposes is described in *Glashütte,* which, it appears, is a variation of the Schoop process. According to this method the surface of the glass is heated until it just begins to soften and the surface is then sprayed with finely divided metallic powders. The metallic particles are thus driven into the surface of the glass and a very durable metallic coating ensues. It is stated that when the under surface of the glass flask is treated with copper or aluminum in this way the water can be raised to boiling point in three-quarters of the time that would otherwise be necessary, and, in addition, the vessel is much less liable to crack. One would imagine that this process would have useful applications for treatment of glass reflectors for lighting purposes.

The instrument known as the dictograph employs a super-sensitive microphone connected with a telephone receiver and battery. The microphone converts the sound waves into corresponding electrical currents variations, which operate the receiver.

INVENTOR CALLED BY U. S. TO FINISH U-BOAT DEVICE.

Experimenting for a year with an invention aiming at the destruction of submarines, Prof. Harvey C. Hayes, head of the physics department of Swarthmore College, has been so successful that he has received a call from the United States Government to enter the national service. He refused to discuss particulars of his new venture adding that he has been forbidden to disclosed the location of the laboratory where he is to continue his research work.

Professor Hayes will be joined by five other physicists from the best universities and laboratories in the country in the Government research work. They commenced work on January 1. Professor Hayes expects to be engaged in this service for a year at least, and it is unlikely that he will return to Swarthmore at the opening of the next term in September. His family will accompany him to the site of the laboratory.

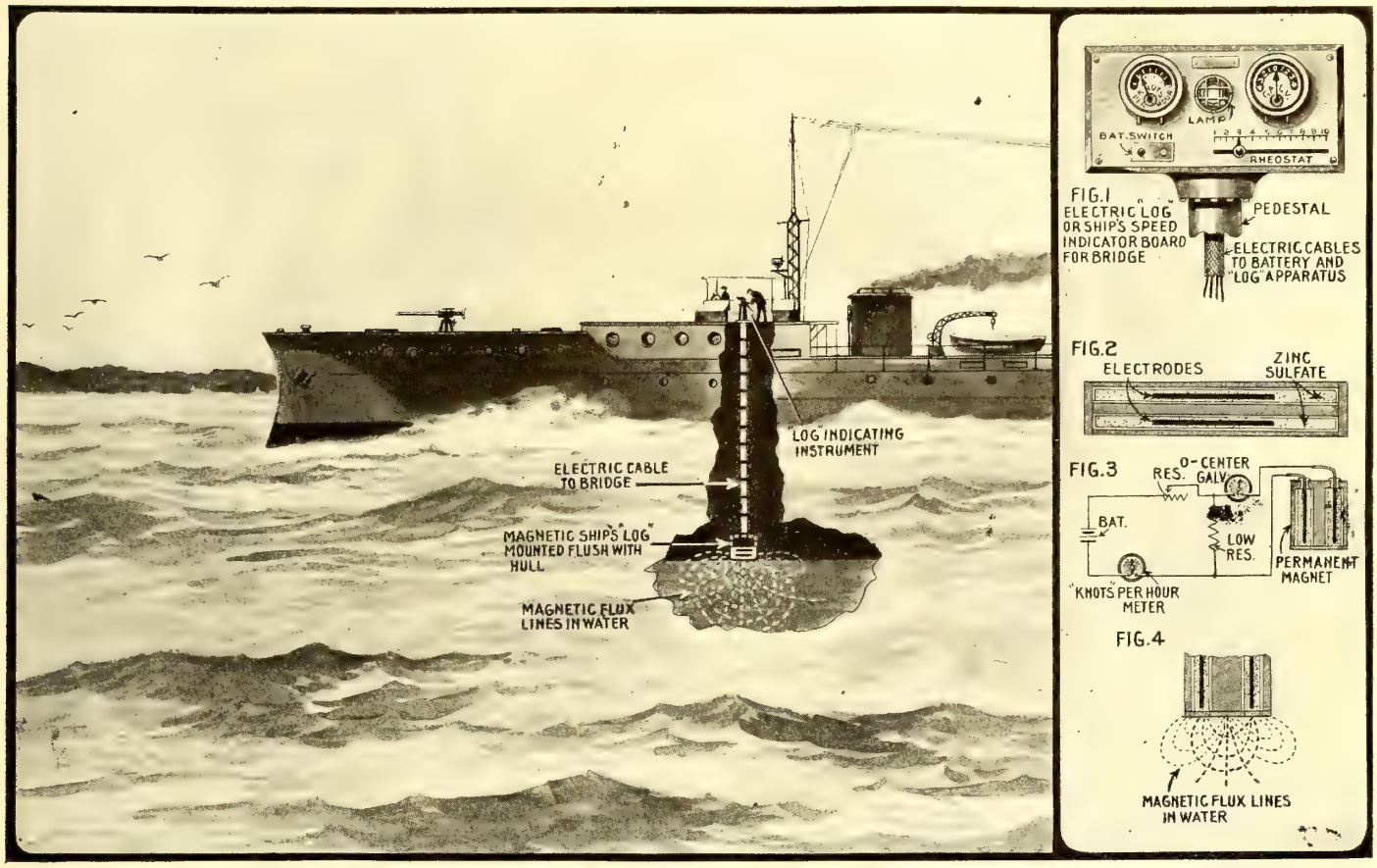
Professor Hayes was in his fourth year as a member of the faculty of Swarthmore College. Previous to his service in the physics department he was an instructor in research work at Harvard, where he took his doctor's degree. The vacancy caused by Professor Hayes' withdrawal will be filled by W. O. Sawtelle, of Harvard.

"Electro-Magnetic Log" that Measures Ship's Speed

TALK to any old-time jack tar or sailorman as to how they measure the velocity or speed of a ship when under way, and he will cut loose with a long tirade on the various merits and demerits of the immortal *taffrail log*—famed in song and story the world around. For the taffrail, be it known, gentle reader, is the hindermost deck rail on a ship, while the *log line* is the rope or cable which is heaved over said rail and into the briny billows below whenever the cocky commodore wishes to know how many knots the mechanisms used extensively on large and small vessels leave something to be desired. They are not as simple or as accurate as they should be.

Realizing these facts, two Boston inventors—Messrs. Smith and Slepian—have worked out a very ingenious and extremely simple electro-magnetic ship's log which is illustrated herewith, both in detail and applied to a ship. It's principal feature is that it does away with all dangling thingmabobs suspended from ropes or cables, and which devices, owing to this fact, are exposed to the water; Fig. 2 is a longitudinal section of the magnetic device, while Fig. 3 is a wiring diagram of the electrical connections to the meter calibrated to read *knots per hour*, and Fig. 4 shows the distribution of the magnetic flux and the direction of the induced E. M. F.

In the illustrated embodiment of the invention the magnetic flux is furnished by a permanent magnet, having a middle pole N and two side poles S. The magnet poles are long and narrow. *The magnet is arranged permanently in the ship's bottom*



Copyright by E. P. Co.

Every Yachtsman and Sailor Knows What the "Log Line" Is—It Measures the Speed of a Vessel Thru the Water by means of a Spinning Propeller Attached to Its Lower Extremity, Which Connects With a Dial Device at the Taffrail. Errors Are Liable at Any Time, Especially When the Observer Is Inexperienced. Here's the Latest—a pure "Electrical Log" Which Is as Rugged as It Is Simple. It has no moving Parts and Is Built Flush With the Hull.

good ship is making. And how does the faithful mate take the *log?* Well, it's this way, fellow land-lubbers:

As aforementioned, the *log line* is thrown over the taffrail and into the water. At the lower extremity of the line there is secured a propeller-like device which spins around at a speed proportional to the speed which the ship is making thru the water. The revolutions which the little propeller makes are transmitted to the deck rail by virtue of a flexible shaft, which connects with a dial and indicating arrangement, whereby it becomes readily possible, with the aid of a stop-watch, or by other means, to determine how many *revolutions per minute* the log propeller is revolving at. By referring to tables and other data provided for the purpose, it thus becomes possible to find out how many knots you are making. But this is a round-about way of doing it. Even the new electrical log always subject to more or less error. This new electro-magnetic log is a fixture, once installed on a vessel; there are no protruding parts to be knocked off or damaged, and the indicating instrument reads off the ship's speed directly and accurately in *knots or miles per hour.*

Here is the way in which the new electro-magnetic ship's log works: A magnet is placed on the ship's bottom so that the magnetic flux passes thru the sea water. The magnetic flux traveling with the ship thru the water generates a difference of electric potential in the water directly proportional to the velocity of the ship. These differences of electric potential are measured and from them the speed of the ship is determined.

In the drawings which illustrate the detailed construction of the invention, Fig. 1 is a perspective view of the inclosed magnet and electrodes, the lower face of which is so that the lower face of the magnet is next to the water. The magnet is insulated from the ship's bottom and the lower face of the magnet is insulated from the water by a plate of insulating material. The ends of the magnets are closed by plates of non-magnetic material. In the cavities and between the poles of the magnet are located two electrodes of amalgamated zinc. The cavities around the zinc electrodes are packed with zinc sulfat and the cavities are lined with insulated linings. In the insulating plate are plates or windows of porous earthenware thru which the water can seep, to form an electrical connection between the sea water and the zinc electrodes in the cavities.

While the porous earthenware windows allow an electrical connection thru them, they do prevent any considerable diffusion thru them of the zinc sulfat so that the

(*Continued on page* 863)

At War With the Invisible

By R. and G. WINTHROP

(CONCLUSION)

"WE must get hold of Professor Firman right away," I declared, finally. "He should understand this. Go tell your father, Ava, while I locate the professor."

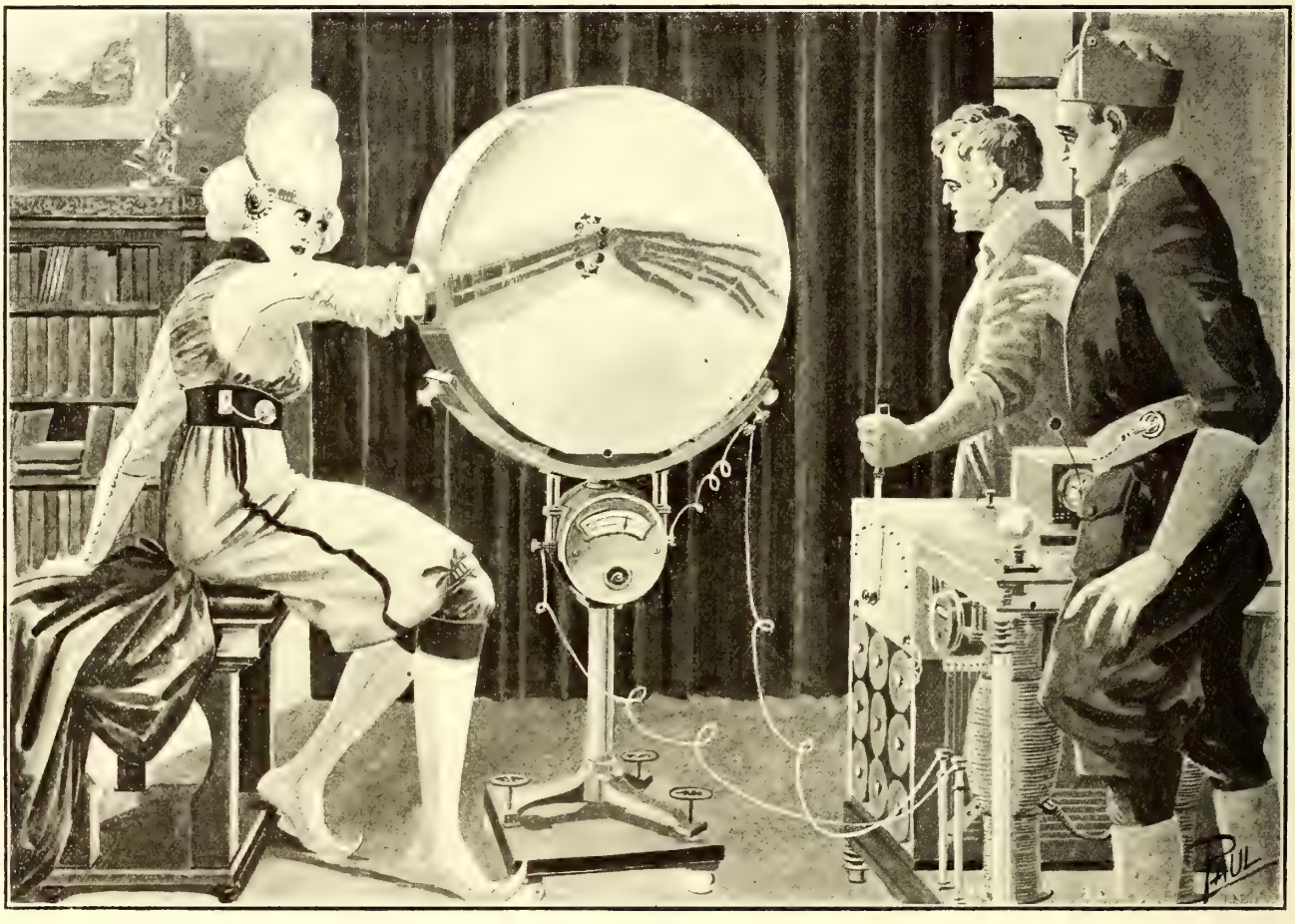
With the pocket 'phone I reached Firman in a few moments. Late as it was, his laboratory at Columbia University still claimed him, his energetic brain busy with the problem that held the universe. To my tremendous importance of what had occurred

Another obstacle presented itself when we reached Firman's laboratory. To secure the privacy he needed for his work he had double-barred all doors leading to his rooms, and, of course, had forgotten my promised visit as soon as the 'phone was out of his hand. But such trifles were not to stop me on this night.

in picturesque phrases how much longer the inefficient police were going to allow drunken aerists to go around smashing busy people's windows.

"It's all right, Firman," I assured him. "This isn't an accident. It's Elvan."

I was brimming over with suppressed excitement, hope and happiness. The sight of his strong face, its massive features outlined clearly in the moonlight, heightened



". . . Arranging His Apparatus, Professor Firman Placed Ava's Arm Before the Helium-Planoscope Screen and Directed a Powerful Helium Ray Upon It. . . . An Outline of the Flesh and Bones Greatly Enlarged Was Visible, and Around the Wrist Was a Circlet of Tiny and Heretofore Invisible Bells."

demand that he come at once he turned a deaf ear. Nothing could take him from his work. Fervently I cursed his stubbornness, but the difficulty was a minor one. If the mountain would not come to us we could readily go to the mountain. Telling him to expect me in a few minutes, I hastily replaced my 'phone and turned to greet President Venasarol, who was approaching, his mouth open in bewilderment at the excited account his daughter was giving him of my discovery. I added a few words, grasped Ava's arm and hastened off with her, leaving the Honorable Peros still dazed and only half comprehending the

Leaving Ava to await my return on the roof, I sank slowly to the upper story of Schermerhorn Hall, where several lighted windows showed the presence of workers. I selected the largest window on the supposition that it must be Firman's, and brought the nose of the plane against it with just enough force to send the glass crashing to the floor inside the room. A high-pitched voice, lifted in bitterly complaining profanity, satisfied me that I had struck the right one. No one could swear like Firman!

In another moment he appeared at the opening, peering out angrily and inquiring

the feeling of confidence that had possest me from the moment I saw Ava. Firman was the mental giant of this scientific age. With the help I could give him I knew we would solve the deadly riddle of invisible attack on our world and save it from destruction.

"Elvan!" his shrill voice—which always startled those who met him for the first time by its incongruity with his great bulk—rose still higher in surprise. "You! Well, what in hell do you want to smash my window for?"

"What in hell do you want to bar all your doors for?" I retorted. "I had to get

* This is a principle of physics not generally known. We cannot make a perfect mirror, but if we could, the mirror would be "invisible." Any object that is not primarily luminous in itself is seen by scattered reflection. If a surface was made so as to be perfectly reflecting, then all the light that fell upon it would be reflected, and this reflected light would reveal to the eye the source of the light before reflection. The reflecting surface itself would not be visible. This phenomenon is known technically as "specular reflection." The reason we see polished surfaces is because of the imperfect reflection from such objects, the light being reflected in various directions.

in somewhere. Don't waste time arguing, but hurry around and open the doors. I have something tremendously important to show you."

I could hear him muttering unfavorable comments on importunate friends in general and me in particular, as he left the window, while I hurried back to Ava. A few moments later the three of us were seated around a table piled high with instruments and jars of substances. Firman pushed them aside with an impatient gesture.

"All worthless," he replied, briefly, in answer to my inquiring glance. "Not a single clue."

I smiled at him with an encouragement hardly yet justified. "The clue is here," I said, and pointed to Ava's wrist.

SYNOPSIS—PART I. This gripping scientific story deals with a "War of the Worlds"—an inter-planetarian struggle for supremacy—the scenes of which are laid in the year 2011. The planet Mars, with all her super-intellectualism, has made war upon all the planets. The hero is a special war correspondent of a New York newspaper, who, while detailed to the reception in Paris of the War Commission from Venus, becomes enamored with the beautiful daughter of the president of the visiting commission—the Honorable Peros Venasarol. She possesses a most remarkable bracelet—which is not only invisible but contains a set of tiny bells. The hero notes this bracelet carefully, for it apparently is something beyond earthly understanding. Suddenly the correspondent is summoned back to New York by his editor—he flies across the Atlantic over night. Philadelphia and London had been wiped off the face of the earth—swallowed up. Did an earthquake do it? Were the Martian 'planes getting thru the earth's air patrol fleet—and, even so, why didn't the selenoid towers indicate their approach?

As quickly as I could I gave him all the facts that we knew. Before I had finished he was already bending over Ava's arm, his black eyes sparkling with eagerness, his lips pursed beneath the large, aquiline nose that marked his ancestry. Deftly his fingers past over and around the invisible bracelet. Murmurs of surprise, commendation and pleasure came from him as his penetrating mind grasped the properties of the strange ornament. Finally he sat back, a peculiar smile of satisfaction lighting up his expressive face.

"Extraordinarily clever," he declared approvingly, "but simple." He paused. "Yes, simple—quite simple."

I bent over the invisible wonder with him. "What is it?" I asked.

"Nothing more than a system of mirrors." His hand toyed with the circlet on Ava's arm. "The inventor has merely made use of the principles of reflection and refraction of light. Each of these facets is a tiny mirror of some substances I don't know yet, but it must be something that reflects the light corpuscles with absolutely no *diffused* rays. *That makes the mirror invisible in itself.* (See note foot of page 818.) Furthermore he has joined these miniature reflectors to each other at such angles that a ray of light, striking upon any one, is bent from mirror to mirror until it emerges on the reverse side, at a point directly perpendicular to its point of entrance. Here is the idea, roughly—"

He drew a sheet of paper to him and rapidly sketched a circle with a series of points which he labeled *a, b, c, d, e, f, m, n, o, p, r, s.*

"You understand, of course, that I have indicated here merely the surface mirrors. Between each two of these is probably a series of double refraction surfaces to receive any rays that might otherwise be deflected to the observer's eye. But, generally speaking, this is what happens: The light from any object, as, for instance, the young lady's arm, strikes upon *m* and is reflected through *f, e, d, c, b* or *n, o, p, r, s* (depending upon the angle at which it enters) emerging at *a*, exactly opposite. To our eyes, unable to perceive the intermediating surfaces, *the light seems to come directly from the arm!*"

He paused, glanced swiftly from one to the other, as tho keen to see whether we were following his exposition, and then went on with increased emphasis: "You see the result! *The bells, under their remarkable covering, are entirely invisible!* The same thing happens from any other point. Looking at *b*, the light from the object at *n* would seem to be coming in a straight line; from *s* we would see the object at *f*, and so on. It is all very simple ——" He ended with one of his queer, dry smiles—— " —— after some one else has worked it out for us!"

I drew a deep breath in admiration of the startling ingenuity that had conceived this strange object and the acumen that had penetrated the mystery.

"There is no doubt about it. They had only to inclose their planes in cylindrical or spherical coverings, built on the principle of this bracelet; but, of course, on a tremendously larger scale. Then, by applying the silencer to their motors, they could approach us unseen and unheard, to plant the contact points for the atomic detonators wherever they chose and send them off with a current from their selenium cells as soon as they were at a safe distance."

"Why didn't the selenoid towers record their presence?"

"For the same reason that our eyes didn't. The sol-rays past *around* their mirrored surfaces, so no image was recorded on the plates."

"Does this mean that you can now prevent further attacks?" asked Ava. She had risen and stood like a goddess from her own planet, her whole figure tense with the sudden animation of hope and victory.

Firman and I started, almost guiltily. In the satisfaction of having solved the mystery we had forgotten the danger still ahead of us.

Firman smiled up at her admiringly. Something of her unearthly beauty had arrested even his usual cold indifference to the charm of femininity. "You are right," he admitted. "Our work has only begun. But I have an idea that may work out successfully. Bring your precious bracelet in here."

He lifted his immense frame from the chair and led us to the projecting room adjoining his laboratory. Arranging his apparatus, he placed Ava's arm before a Helium-Planoscope screen and with a few swift adjustments directed a powerful helium ray upon it. Eagerly we crowded around it. An outline of the flesh and bones greatly enlarged was visible, as in an ordinary X-ray photograph, and around the wrist *was a circlet of tiny bells!*

I found myself clearing my throat hoarsely as tho choking. Before I could utter a word of explanation Firman was saying with deep satisfaction: "Just as I expected! The substance of these mirrors is transparent to the helium ray. Now, then, you two leave me alone to work out my plans—and, Elvan—" He caught me by the shoulder as we were passing out. The deep lines in his swarthy face wrinkled with sudden relief into a grim smile. Sheer mental power had seen, grasped and already was at work on the problem. The acquisitive, searching brain had selected, classified and was inwardly ordering about the principles of science that would cope with the menacing disaster. He dropt into an almost whimsical mood, the great commonplaceness of him returning to ordinary banter.

"When the Council meets again, Elvan," he went on, "let them get ready a final answer to the Martian demands; let them tell those damned devils that they can go right straight to—O, I beg your pardon—I forgot the girl! Well, anyway—Good night! I'll call you as soon as I have things shaped up." In another moment he was gently but firmly thrusting us into the outer corridor. His door shut with a decisive snap that found an answering echo of confidence in my heart. The master was at work!

Sunday past quietly. The outside world knew little or nothing of the mighty project at work within that fateful laboratory. That same evening the Interplanetary Coun-

(*Continued on page* 871)

The "May" Number

Well, Friends, we sure have procured some mighty interesting articles for the "May" number of the ELECTRICAL EXPERIMENTER, *if we do say it ourselves. And while we are on the subject, please note that in the issue before you, we have a page entitled "The Editor's Mail Bag." We ought to receive a sufficient number of good, conscientious letters from our readers regularly to fill up that page every month. Why don't you write us a short letter now and then? Tell us what you want and we will do our best to publish it. A little friendly criticism now and then, is relished by the best of Editors. We can't read your mind, therefore tell us what you think—it will cost you three cents—that's all. Now for the "May" E. E.:*

"How Radium Emanation is Helping to Cure the Sick," by George Holmes.

"Electric Vacuum Tubes—The Principal Types and Their Uses," by H. Winfield Secor.

"Shooting Electrical Troubles on Automobiles—A Clear Treatise on How to Test Your Battery, Motor, Generator and Wiring."

"Experimental Electrical Furnaces"—an instructive and well illustrated discourse by an expert.

"New Electric Stage Tricks."

"Theory of Tuning, Wave Lengths and Harmonics"—of distinct importance to all Radio Students, by Prof. F. E. Austin, Instructor Electrical Engineering, Dartmouth College.

"Experimental Mechanics"—Part III, by Samuel Cohen.

"How to Build an Electrically Played Piano"—a real "live" article, by Charles Horton, Consulting Engineer.

"Research and Its Importance to Human Progress," by Dr. W. R. Whitney, Research Laboratory, General Electric Co.

"Wave-meters—Their Uses and Construction"—Part III, by Morton W. Sterns.

"Then this is the method by which the Martians have made themselves invisible to us!" I exclaimed.

"Yes or No" an Electrically made Drama

By George Holmes

HUMAN nature! An unfathomed source from whence must spring the theme upon which every truly successful play is built. First-nighters and frequenters of New York's "Gay White Way" have been literally "fed up" with the eternal triangle; therefore it is somewhat of a miracle when a new play can so impress an audience as to make it sit up and take notice!

The seemingly impossible has been realized in Anderson and Weber's new theatrical production bearing the title—*"Yes or No."* Under a new setting and manner of presentation we see a vital human issue argued and answered in the "uptown home" amidst richness, sumptuousness and splendor—and on the other hand in the "down-town home" with poverty, pathos and squalid surroundings on all sides. A most graphic story of American wives and their homes.

The play proper is preceded by a prologue revealing a discontented wife about to run away from home with her neglectful husband's false friend. As she wavers on the brink, hesitating whether to say "yes or no" —the voices of her aunt and mother speak —and beg her to listen to a story of two women and how they met the same crisis in their lives.

Then follows the dual story of how two neglected wives each met a situation in which they were highly tempted to wander from the straight and narrow path. The wife of luxury, whose particular curse has been idleness, yields to temptation and rues it; the other who has seen nothing but drudgery resists and is more fortunate.

The epilogue brings the two stories together and the experiences set forth teach the wife of the prologue a strong lesson.

The cast is notable, both by its numbers and excellent portrayals. Suffice it to say that everyone acquitted themselves admirably.

The stage mechanism of this simultaneous narrative has been conceived by Jesse J. Robbins, and is a distinct as well as surprising novelty. The various settings are permanently arranged on three movable platforms, with guides arranged to keep them plumb and in place. They operate noiselessly, being supported on rubber tired wheels. The electrical equipment, including the lighting and the control of the electric motor is such that it moves with the platforms.

A large electric motor is set in the cellar as shown, of about 10 horse-power capacity and arranged with two rope winding drums, one of which revolves rather *fast,* and the other *slow.* The "prologue" takes place on platform No. 1—and while the two voices are speaking, telling the young wife to hesitate, the platform in the semi-darkness (this scene taking place with just a ray of moonlight coming thru a bay window) is moving slowly toward the back or "up stage." This is accomplisht by the operator in the cellar who pulls on cable No 1, by winding it on one of the motor driven drums. As soon as the last words are spoken, the stage is in darkness and scenes numbers two and three are quickly brought together with cable No. 3 by snubbing it on the fast drum—Scene two being the "uptown mansion" and scene three the "poor down-town home." By an ingenious arrangement two moving curtains, working automatically, block out scenes two and three while scene one is being moved, but as soon as that has been set back, the curtains keep moving to it so as to be out of the way when scenes two and three are brought together.

There is no division wall between the two sets and both are always in view. But only one scene is used at a time. Attention is focused on the side where the action is progressing by a clever arrangement of lights.

On the front of the auditorium balcony are six pairs of "baby spotlights," one in each pair giving *amber* light and the other *white* light. When the scenes of luxury and idleness are progressing, they are illuminated with amber light; the other side of the stage being in deep shadow. The tenement scene, in turn, is flooded with white light and the amber rays dimmed. The effects of contrast are telling and exceedingly novel.

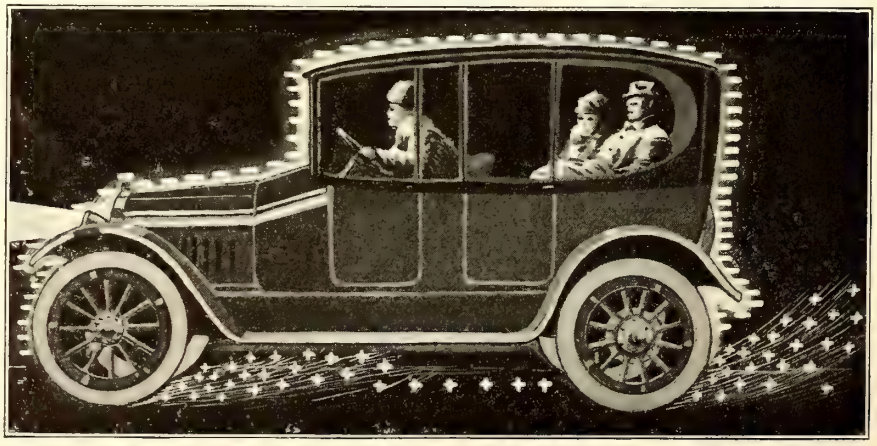
After the first act the two clamps on cable No. 3, are placed in the new positions, P1 and P2, as indicated. The end of cable No. 3, with clamp No. 1 is shifted to platform 3—position (P1) by the stage attaches, while clamp No. 2 is shifted to platform 2—position (P2). Each platform has a small trap-door as indicated, which gives ready access to cables and clamps. The work of changing the clamps on the cables is the work of but a few seconds and easily accomplisht. The positions of platforms 2 and 3 are not changed during the progress of acts one, two and three.

At the end of the third act the stage is darkened and cable number 3 is worked on the motor-driven drum in same direction as previously, thereby pulling the two platforms apart. Cable number two is pulled next, bringing platform number one and its setting "down stage." Then the lights go up, friend wife sees how narrow has been her escape, hubby comes home, and this being her birthday, a grand party takes place and "all's well that ends well."

STATIC ELECTRICITY AND THE AUTOMOBILE.

Have you ever stood on a crisp, cold winter morning on one of our asphalt streets and watched automobiles whizzing past, which may have temporarily blocked your progress across the streets? Like as not you have heard a peculiar swishing sound not unlike the sound produced by escaping steam, the sound being apparently produced by the wheels of the automobile. It probably occurred to you that this sound was totally unlike the sound you hear at other times of the year, as for instance on a warm summer morning or on a wet day.

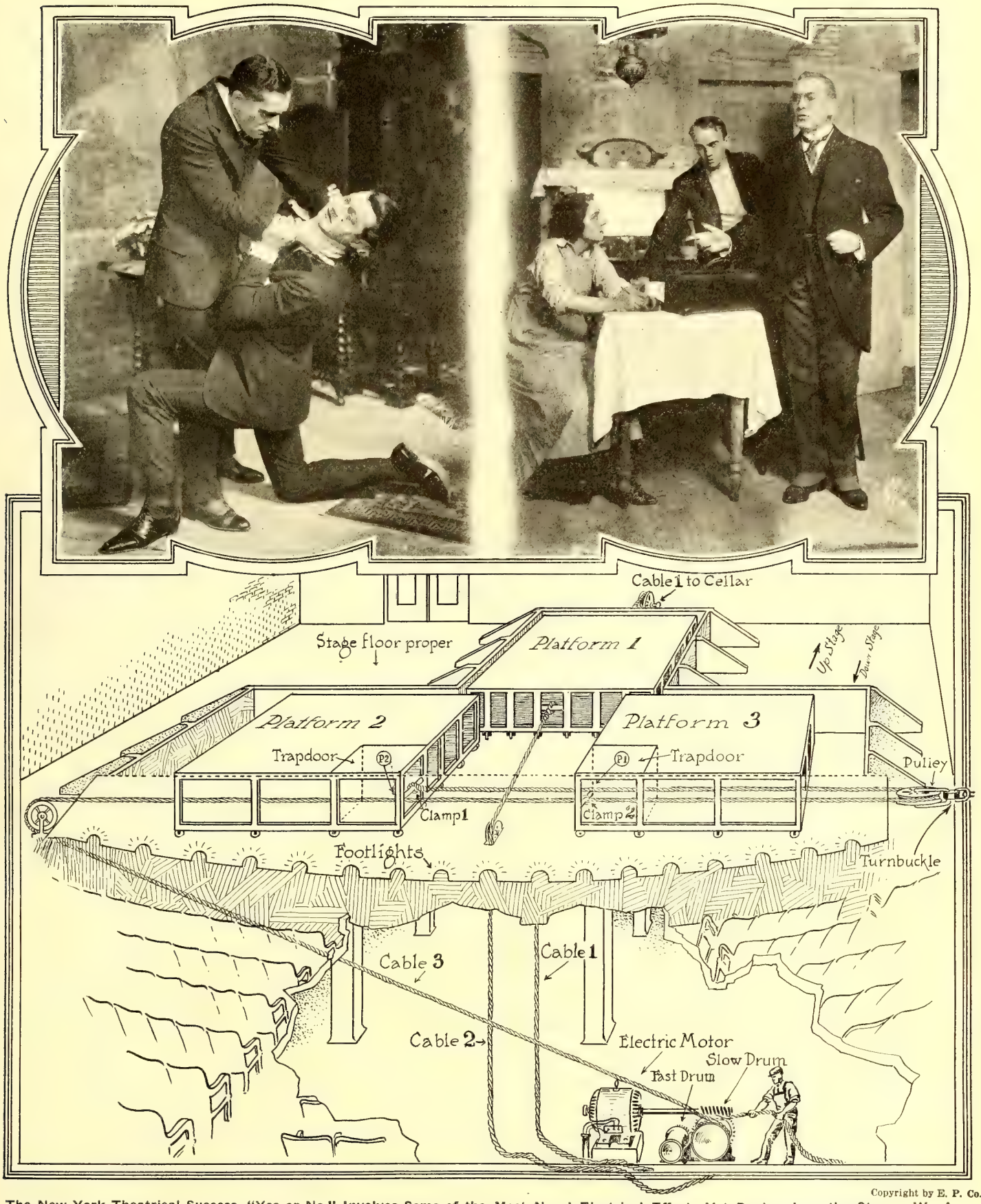
If you are at all observant you must have wondered at the great difference in sounds. There is, of course, an explanation. On a cold, crisp winter morning, the conditions for static electricity are ideal. Any possessor of a static electric machine will readily confirm this; hence, we find that an automobile, which is nothing but a huge static machine on rubber rollers rubbing against a highly electrified asphalt pavement, produces static electricity in an abundant quantity. As any owner of a static machine knows if the crank is turned and the electricity escapes, a peculiar hissing sound is observed which is due to the fact that the static electricity escapes into the air. The same thing happens when an automobile runs at high speed along the asphalt, the electricity emerging from the rubber tires and escaping into the surrounding air with the aforementioned swishing noise. In this case the automobile is negatively charged, while the ground (asphalt) is positively charged, and the high speed of the rubber tires rolling along the asphalt produces a sufficient electro-static stress which may amount to several thousand volts. This, of course, charges or electrifies the automobile to a high degree, and it has often been noted by motorists, that long sparks can be drawn from such an electrified automobile the minute it comes to rest. Of course, this charge is dissipated and lost a few minutes after the car comes to rest.



Did You Ever Hear the Strange, Swishing Sound Made by an Automobile, Running Along the Asphalt on a Clear Cold Winter Day? If You Did You Heard a Static Electricity Discharge.

While there is no danger, as a rule, by thus highly electrifying an automobile, it sometimes happens that should a person, who had not been riding in the same car and who stands on the ground should touch the gasoline tank (which perhaps had been leaking), an explosion often follows. The reason for this is that the car is still highly charged, while the body of the third person presents a good path for the electricity to surge into the ground, and if the spark made is anywhere near the gasoline tank, of course, results are apt to be disastrous. Using anti-skid chains on auto wheels obviates this.

"YES or NO" presents New Stage Features



Copyright by E. P. Co.

The New York Theatrical Success, "Yes or No," Involves Some of the Most Novel Electrical Effects Yet Produced on the Stage. We Are All Accustomed to See the Front Curtain Rise and Fall on the Successive Acts in a Play. But Here No Curtain Is Used. Even While the Scenes Are Being Changed, a Powerful Electric Motor, Located underneath the Stage, Solves the Mystery of Moving the Scenes Noiselessly and Quickly in the Fraction of a Minute. In "Yes or No," the Prologue Takes Place on Platform No. 1; While the two voices are Speaking, the Stage Assistant in the Basement Snubs Cable No. 1 on the Motor Drum—This Slowly Moves Platform One to the Rear—All in Semi-darkness. In a Few Seconds the Stage Attaches Have, by Snubbing on Cable No. 3, Brought Platforms Nos. 2 and 3 Together, Which, by a Clever Electric Lighting Effect, Produce Alternately the Dual Scene of Luxury and Poverty Above Illustrated. By Reversing the Platform Cable Clamps the Scenes on Platforms Nos. 2 and 3 Are Pulled Apart, and, by Snubbing Cable No. 2, Scene One Is Brought Down Stage for the Close.

The Electrical Production of Synthetic Gasoline

THE world needs gasoline—thousands of internal combustion engines are daily consuming untold gallons of the valuable fuel and have sent the price skyward at a rate that would give the average motorist heart failure. And just at the time that the situation promised to become acute an inventor comes forward with an electrical method of producing it from kerosene, solar oil and low-grade distillates.

Briefly the process is as follows: Take some kerosene, vaporize it, mix in a little natural gas and shoot a bolt of electricity thru it. Wash with acid, soda ash and water, then distill and you have pure, water white gasoline that will clean kid gloves or drive a motor car. Simple, isn't it?

But it took two years of experimental work to bring the process to its present practical condition. One of the illustrations herewith show Mr. Louis B. Cherry, the inventor of the process, and the first plant that proved his ideas practical.

In order to understand the working of the Cherry process for producing gasoline it would not be out of place to describe briefly the usual process of distillation of crude oil. Then a better idea will be gained of how the new process can be readily adopted to the present refineries.

The oil as it comes from the well is black in color, having a disagreeable odor and quite thick. In this form it is known as crude oil and, depending on the part of the country from which it comes, will have very little gasoline, or possibly as high as 15 to 30 per cent of gasoline, in it.

This oil is pumped into a large still which may hold from five to fifteen hundred barrels. This still is usually of cylindrical form and is mounted on brickwork similar to a horizontal steam boiler. Fire is placed under the still and the temperature of the oil gradually raised. When it reaches a temperature of 90 to 100 degrees, Fahrenheit, gases will pass over into a condenser which consists of a large coiled pipe immersed in a tank of water. These vapors condense and thus is obtained high-proof gasoline or petroleum ether.

The temperature is further raised until all the gasoline vapor passes over. The end point or the maximum temperature at which gases are allowed to pass over is 400 deg. F. This fraction or *cut* is known as crude benzine by the refiners and is then treated with sulfuric acid, soda ash, washed with water and redistilled. This results in the commercial gasoline used for motor cars.

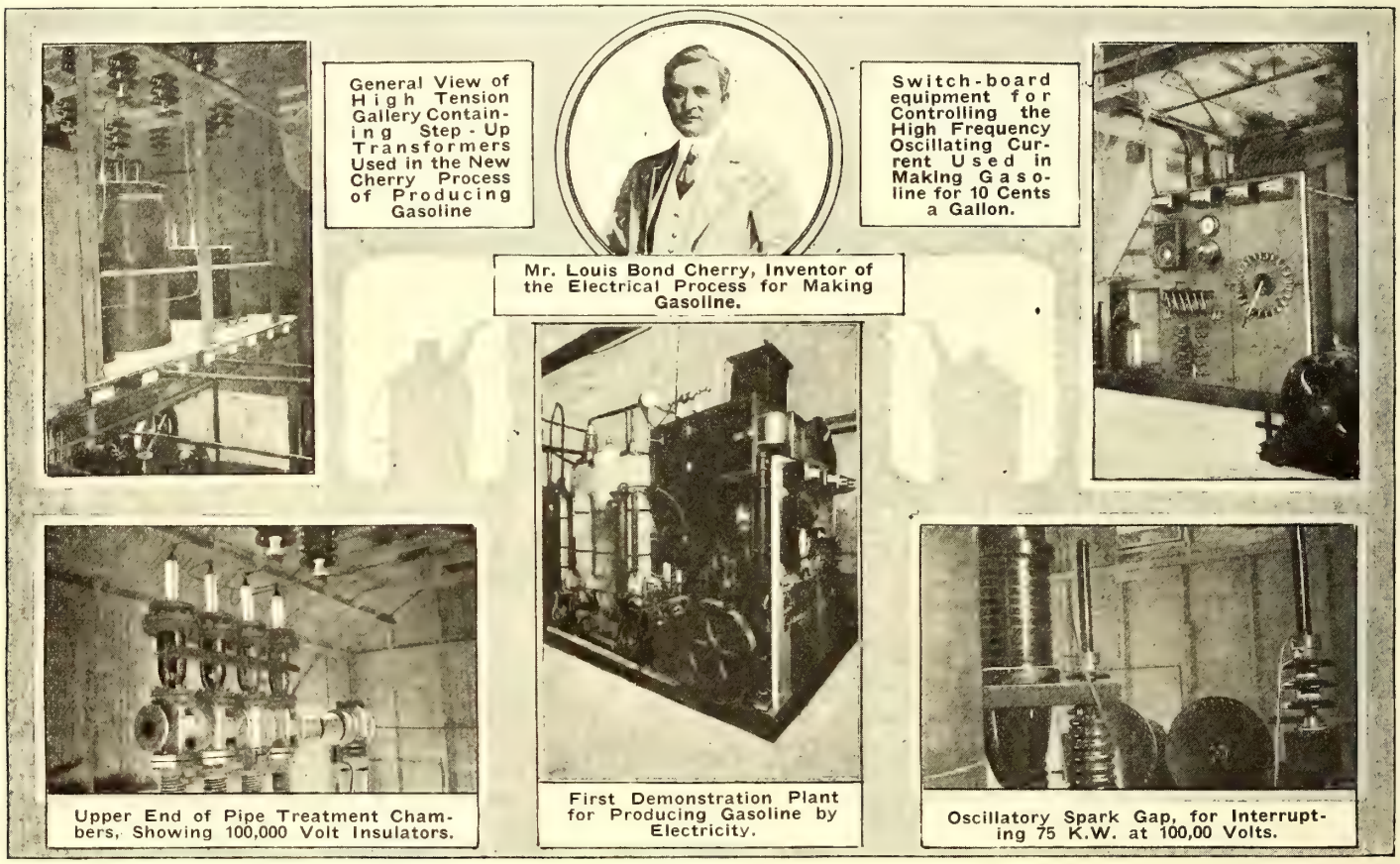
The above process takes out all the gasoline, further heating causes kerosene, solar oil and heavy lubricating oils to pass over and condense in turn. This operation is known as *fractional distillation,* the residue remaining in the still after a high temperature is reached being coal tar, which is the source of our dyes and other products.

Now turning to the Cherry process. It is a well-known fact that all crude oil products from gasoline to paraffin wax are hydrocarbons—that is, they consist of varying mixtures of hydrogen and carbon. It is apparent that were some means found for controlling the relative proportions of the hydrogen and carbon it would be possible to produce any of the various products at will; that is, obtain all paraffin or all gasoline, as desired. By studying the constituents of the various hydrocarbons, Mr. Cherry noted the fact that if natural gas could be combined chemically in proper proportions with the various distillates, he would then have gasoline. Acting on this he discovered that a high-tension electric current would affect the necessary reaction and produce gasoline.

In practise, the still used is similar to that employed in refining crude oil, but has a perforated pipe at the bottom. The kerosene or other low-grade oil is placed in this still and while being heated natural gas is forced into the perforated pipe and escaping up thru the liquid is heated to the same temperature and thoroly mixed with the oil vapor. This vapor then passes into a series of electrically heated pipes that have a central electrode, this electrode as well as the pipes being connected to a source of high-tension current of extremely high frequency.

The gases are subjected to this silent discharge as they flow thru the pipes and their chemical structure is so altered that the resulting condensate is a crude benzine. For the proper results it is necessary that the temperature of the gases, their rate of flow, as well as the voltage and frequency of the current be properly adjusted. On treating the benzine so obtained a liquid results that cannot be detected from gasoline—in fact, it is gasoline!

To produce 60,000 gallons of gasoline by the above process daily, an electrical equipment rated at 75 K.W. (75,000 watts) is required. The illustrations give a good



General View of High Tension Gallery Containing Step-Up Transformers Used in the New Cherry Process of Producing Gasoline

Mr. Louis Bond Cherry, Inventor of the Electrical Process for Making Gasoline.

Switch-board equipment for Controlling the High Frequency Oscillating Current Used in Making Gasoline for 10 Cents a Gallon.

Upper End of Pipe Treatment Chambers, Showing 100,000 Volt Insulators.

First Demonstration Plant for Producing Gasoline by Electricity.

Oscillatory Spark Gap, for Interrupting 75 K.W. at 100,00 Volts.

idea of the apparatus employed in a plant of the above size. The general view of the high-tension gallery shows the transformer in the background, with the condenser used in the closed oscillating circuit at the left. Another illustration shows the rotary spark gap having two large rotating disks fitted with plugs to obtain a high rate of discharge thru the closed circuit, the primary of the oscillatory transformer being shown at the left.

The treating chambers are shown in another illustration in which the mixed vapors are treated. The large porcelain insulators can be clearly seen that insulate the central electrodes. The pipes are also wound with electric heating coils to obtain the proper temperature.

All this apparatus is controlled from a switch-board that is shown in another illustration, which also mounts the meters that indicate the currents flowing in the different circuits at any time.

The entire operation taking place at atmospheric pressure, it is a simple matter to fit the ordinary crude oil still with the necessary treating chambers and electrical equipment. Tests tend to prove that the cost of treating *one gallon of kerosene does not exceed one cent,* while the value of the process will be better appreciated when it is stated that it is practical to convert nearly all the volatile oils into gasoline without undue precipitation of carbon or the production of fixt gases.

At a recent test *it was possible to change* 78.68 *per cent of the kerosene used into pure gasoline, but the plant under construction is expected to raise the percentage to* 98 *or* 100. Mr. Cherry has offered to furnish the government all the gasoline it requires for a flat rate of 10 *cents per gallon,* and to say the least this offer has caused quite a commotion among those interested in gasoline production.

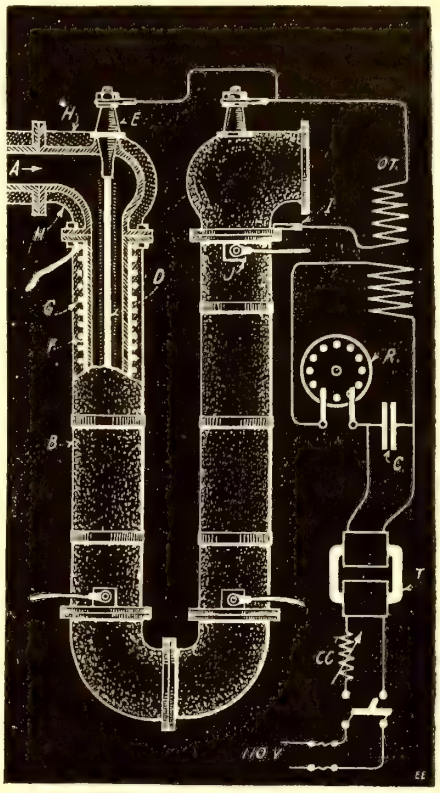
Is this but another step along the road to the production of gold from the baser metals? According to the more recent theories of the electrical nature of matter it should be possible to affect such a change by electrical means. All matter being made up of electrical charges, it merely remains for some one to find a way of controlling the grouping of these charges and they can instantly produce anything from the material in hand.

The kerosene vapor with which has been mixed natural gas, enters at A and passes into pipe B. The latter is of iron covered with a layer of electrical insulation, such as mica, shown at F, over which is wound the resistance wires G, for heating the chamber. These wires are in turn covered by a thick layer of heat insulating material to retain the heat and keep the temperature constant.

The electrode D is mounted centrally in the chamber, being supported and insulated by the porcelain E. At J is shown the terminals of the heating winding.

The sectional view also shows the wiring to produce the high tension high frequency currents required to treat the vapors. An alternating current supply is connected to the primary of the step-up transformer T, thru a choke coil CC. A condenser C is shunted across the secondary of the transformer, while a rotary spark gap R serves to discharge the condenser periodically thru the primary of the oscillation transformer O. T. In this manner high frequency currents are induced in the secondary of the oscillation transformer, which flow to the rods D, connection being made from the other terminal to the pipes as shown at I.

The heating coils are connected to the current supply thru an adjustable resistance not shown in the drawing.



Sectional View of Electrified High-Tension Vapor Chambers Used in Producing Synthetic Gasoline.

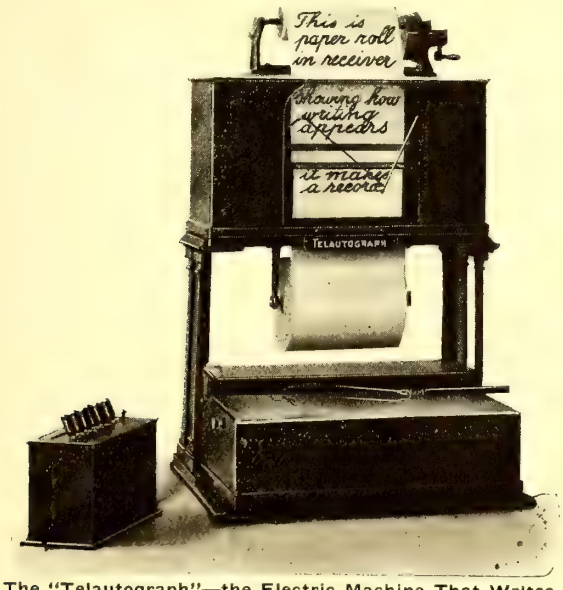
ARGENTINE GOVERNMENT WANTS ELECTRIC VOTING MACHINE.

The Argentine government has invited American electrical manufacturers to submit bids on making and installing an electric voting machine in the chamber of deputies of Argentina.

The Telautograph

What It Is

The Telautograph, practically unknown to the vast majority of people not actively engaged in business, has become during recent years a very familiar and important part of the message transmission in commercial and industrial life of this country. The Telautograph, as its name indicates, being derived from the Greek words "Tele" "Auto" and "Grapho," means, literally translated, one's writing at a distance. It is a little more than a telegraph, in that the actual handwriting of the operator is transmitted almost in facsmile.



The "Telautograph"—the Electric Machine That Writes. Intercommunicating Switch-box at Left Which Connects Any Desired Station.

To express it in another way, with the Telautograph you write over wires as with the telephone you talk over wires.

History.

As with almost every new and important invention the history of the development of the Telautograph is interesting, because it has spread over a long period of years and has required constant and unceasing effort of many inventors before the instrument was brought to its present commercial and practical construction.

Telautographs in one form or another have been invented and patented as far back as 1876, followed by different ideas for acomplishing the same purpose in subsequent patents issued to different men in the United States and England in 1879, 1884, 1886 and 1888. In these early types of telautographs the paper on which the message was written by the operator and also that on which it was traced by the receiving pen was caused to move continuously, necessitating considerable skill on the part of the writer in forming the characters to assure a legible reproduction of handwriting and affording no facilities whatever for the transmission of figures and sketches.

A story is told by an old Chicagoan that one day in the winter of 1886, or 1887, he entered the office of a friend, a well-known Chicago financier, and found this financier gravely watching a tall, gray-bearded man manipulate a cane and umbrella which had their handles hooked together, and was sliding them about over the top of a flat desk while he told of a new kind of telegraph that he had gotten up. The gray-bearded man was Elisha Gray, of telephone fame and with the cane and umbrella he was demonstrating the principle of the now well-known Telautograph pen-arm movement.

Whether this story is true or not, it was about this time that Mr. Gray built his first telautograph. It was smaller than a grand piano and its mechanism was composed mainly of weights and strings, but it worked and actually transmitted handwriting after a fashion over wires between the inventor's house and his laboratory, about five hundred yards distant.

The results obtained with this crude instrument were sufficiently encouraging to Mr. Gray to cause him to put in a great deal of hard work during the next few years, endeavoring to develop an instrument that would be suitable for commercial use.

(*Continued on page* 874)

Electricity in French Machine Gun Tests



Fig. 1—A French Underground Electrical Laboratory in Which Machine Gun Tests Are Conducted. The Audible Time of Reaction of a Machine Gun Is Being Measured.

Fig. 2—This Picture Shows M. Laby, French Military Expert and Scientist, Conducting an Electrical Test for Determining the Respiratory Variations of Rifle Fire.

Fig. 3—Experimental Apparatus Used In Studying the Rapidity of the Shocks of the Machine Gun, in the Repetition of a Movement.

ELECTRICITY often finds peculiar applications in the present World War. Here are several views of a battlefield laboratory in France—that of M. Laby, the distinguished French expert, who is seen conducting exacting tests on the effects of machine gun operation on soldiers, as well as other researches on the action of these small but highly effective fire-arms, some of which are capable of firing from 400 to 1,000 shots per minute.

Thus it is no easy problem to split up the seconds and fractions of seconds transpiring while one shot is occurring. The French machine guns have withstood the most rigid tests.

Fig. 1 shows M. Laby measuring the audible time of reaction of a machine gun. On the table is a Ruhmkorff coil, used to produce a spark for the rupture of the current as well as a variety of other electrical precision apparatus. This laboratory is in a bomb-proof cave.

Fig. 2 illustrates another French machine gun test—registering the respiratory variations of rifle fire for the study of functional plasticity. M. Laby, the distinguished French expert, seen at the extreme right of the photo, is conducting the tests.

The illustration, Fig. 3, shows the electrical apparatus for the study of the rapidity of the shocks of the machine gun in the repetition of a movement. These tests are being made also under the supervision of M. Laby, military expert of the French Army.

HEALTHFUL HEATING OF THE TISSUES BY ELECTRICITY.

By Dr. Leonard Keene Hirshberg, A.B., M.A., M.D. (Johns Hopkins University).

IF you can heat the human fabric by a variety of electricity, which has other virtues also, you may begin to relegate the *hot-water bag* to the rear. This can be done.

Several thousand "milliamperes" or small electric units, can be past thru the living body with alternations of the electric current which amount to several millions a second. This yields a high degree of heat which passes thru the skin the same as X-rays do. It is called "diathermia" or thru heating.

This form of electricity is little known and therefore seldom used. Yet it performs wonders in the way of healing the tissues.

Dr. Albert C. Geyser, Professor of Physiological Therapy at Fordham University, New York City, stands in the forefront of those who espouse the wide use of this type of electricity for the treatment of joint inflammations, swollen joints, and various kinds of arthritis.

It is the "high frequency" electric current, which makes this kind of heat. The resistance of the human textures to electricity is like their resistance to the fluid in a hypodermic syringe.

If you would understand about this, you can picture the electricity as the fluid in the syringe. To overcome the resistance of the tissues, you must force the stuff strongly enough to overpower the resistance.

Then you have deposited in the tissues the contents of the syringe or the electric machine. An *ohm* is the unit used by science to measure the amount of resistance to the spread of the electricity, just as *pounds* is used to measure the amount of pressure needed by water to overcome resistance.

A *volt* is the electric unit of pressure, and the rate of electric speed or flow is called the *ampere*. You could say of the syringe that the *amperage* or rate of flow into the human fabric needs an adequate amount of pressure or *voltage*, exerted upon the piston to overcome a certain amount of resistance or *ohms*. Thus if you read that a lineman was electrocuted by several thousand volts, you know it was the *electric pressure*.

Alternating current electricity is a current made by changing or alternating the direction of the electric flow or vibration 120 times or more a second. It is an electric current, which flows in one direction only 1/120 of a second, stops like the pause between two heart beats, and abruptly changes its direction. A complete cycle is then 1/60 of a second or sixty cycles to the second. When such a current alternates at more than 10,000 cycles per second, it is termed a *high frequency* current.

If such an alternating current is past over a spool—called a coil—or wire on a cylinder, so one can slide inside the other, the latter coil or secondary circuit receives and has induced into it a series of electric shocks from the primary coil.

The primary coil consists of fewer turns of coarse wire than the superimposed secondary coil. This has thousands of convolutions of fine wire.

This ratio of 1 to 1,000 has an important bearing on the voltage. If the primary coil gave 100 volts, 1,000 extra turns on the secondary will multiply the voltage to 100,000. This has been gained at the expense of rate of flow or amperage. This is known as a *step-up transformer*. A step-down transformer is made by having the finer wires in the primary and the coarser wire on the secondary coils.

High frequency electricity is made at first from "a step up" transformer. When these 100,000 volts are led into a pair of metal lined glass jars, called *Leyden jars*, which you can see in any electric supply house, it leads the current into a condenser.

A condenser is a device where electric conductors such as metal, salt, the human body, or what not, are separated by some non-conductor such as glass, tissues, or rubber, which act as an electric sponge.

A spark gap is connected with the Leyden jars. When the gap is closed the current flows onward. The negative and positive direction of the flow is quickly equalized. Every electric current, like gas or water, takes the path of least resistance.

Open this gap ever so little, and it offers a resistance to the electricity. As a consequence it spreads all over the inside of the Leyden jar, until it accumulates a pressure strong enough to overcome and force its way across the gap that is open.

(*Continued on page* 858)

Electricity to Prevent Future Fuel Crisis

BY

William H. Easton, Westinghouse Electric & Mfg. Co.

"IT must never happen again"—is the unanimous verdict of Americans on the present fuel crisis. Much has been said in the past concerning the necessity for conserving fuel, but now that we have actually suffered from a shortage of coal there is no further room for academic discussion. The time has come for action, and the important question of to-day is, therefore—"What can be done to avoid powerless factories and heatless homes, under no matter what unfavorable combination of circumstances?"

Our present difficulties arise from two causes: We need more coal than can be mined, and the railroads, with their extra burden of war work, are unable to handle such coal as is being mined. A plan, therefore, that would, while providing us with ample power, reduce our coal consumption per horse-power by at least one-half, and would at the same time increase the capacity of the railroads and also reduce to a fraction the amount of coal to be transported by the railroads, would appear to be a complete remedy for our troubles.

Fortunately, we have such a remedy at our disposal and tho little or nothing can be done until after the war, except to use our existing facilities as efficiently as possible, the application of this remedy is certain to be the great work of American engineers during the next decade. This remedy consists in a general *electrification* of our industries, including much of our railroad mileage—the current to be supplied from huge central generating stations connected together by power transmission systems hundreds of miles long.

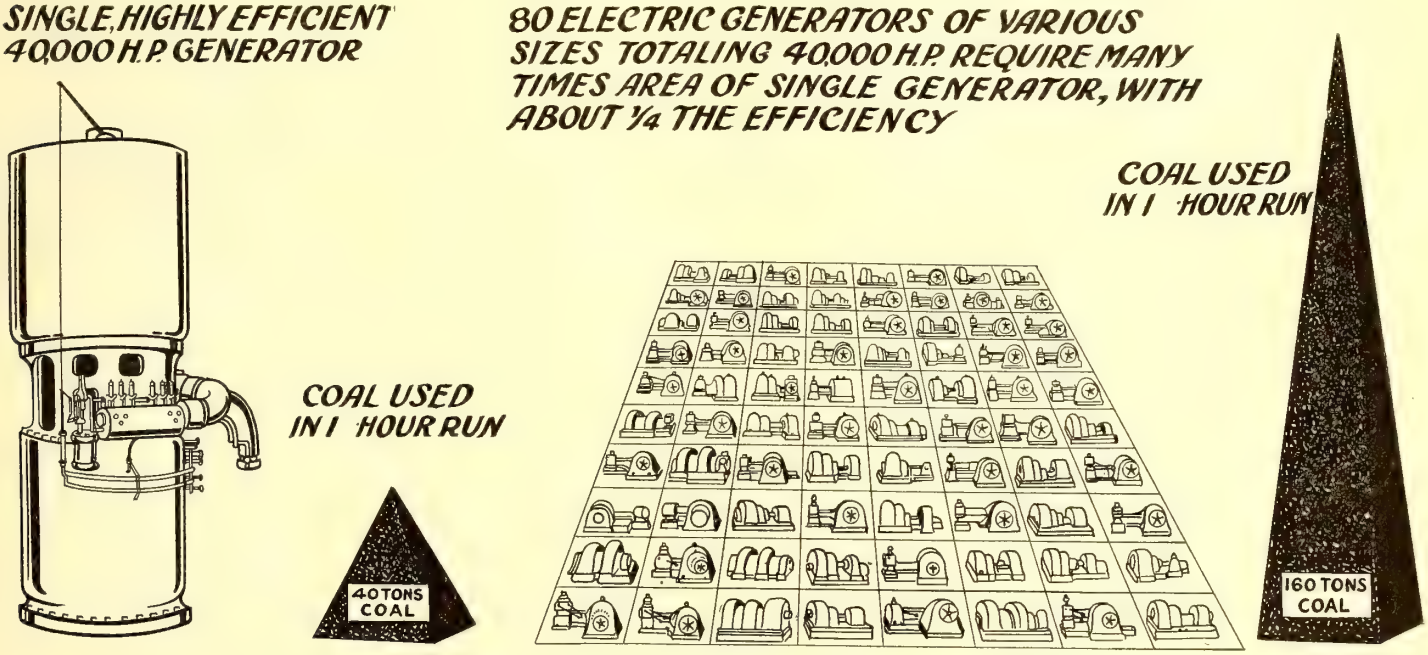
single cites or to relatively small areas. The time has long past when a man can raise his own food, make his own boots, and provide his own transportation, nor can these things be done by local concerns. Economy demands that most of our demands be supplied by agencies of a national, or indeed international, scope. The same is true of the generation of power. Small scale production is now out of the question.

Were great electrical systems, such as described, now in operation, the present fuel crisis would not have occurred. The main reasons for this statement can be summarized as follows:

1. Millions of horse-power of electrical energy would be generated from water-power and our coal consumption decreased by a corresponding amount.
2. Where coal would still be needed for power purposes (as in the East), it would be utilized in huge generating stations burning *less than one-half the amount of coal* now needed to produce the same amount of power.
3. Many of these large generating stations would be at the coal mines, and no railroad haulage would be needed to serve them.
4. The problem of bringing coal to those stations that would be situated remote from the mines would be vastly simpler than that of supplying the thousands of small plants that exist at present.
5. The electrically-operated railroads would be able to haul a much greater amount of freight in a given time than

need be said. The folly of consuming millions of tons of coal and oil when upwards of 60,000,000 horse-power of water-power are allowed to run to waste is now fully recognized, and one of the first steps that will be taken after the war will be to convert this waste into useful energy.

Coming to the second point, tho some water power is available in the important region east of the Mississippi and north of North Carolina, there is not enough to supply the needs of the vast industries located here, so that coal will still be required here for power purposes until some new method of developing energy is discovered. What is necessary, therefore, is a more economical method of using this coal. One of the important recent tendencies in electrical development has been the construction of very large single generators. Fifteen years ago a generator of 7,500 horse-power was considered immense; today several generators of from *40,000 to 60,000* horse-power are in operation and units of up to *100,000 horse-power* are under construction. These great machines are far more efficient than smaller sizes. A 40,000 horsepower generator can operate at full load for one hour on about *40 tons of coal* (1 carload); whereas *80 generators of different sizes* averaging 500 H.P. capacity each (totaling 40,000 H.P.), require from 80 to 160 tons (4 carloads) to run at full load for the same time. The accompanying sketch illustrates this fact forcibly. The amount of fuel that could be saved if most of our industries were supplied with power from such huge, centralized generators is obvious.



One Thing Is Certain—the War Conditions Imposed on Us Has Brought to Light Many Inefficient Methods of Producing and Utilizing Electric Power. This Graphic Illustration Shows in a Marked Manner Just What Happens When, in a Given Case, We Permit a Whole Handful of Little Steam-Electric Generating Plants to Operate on Coal Fuel, Compared to the Gain in Efficiency by Centralizing All These Individual Plants In One Unit.

It is true we are using electricity today to perform much of our work, but practically all this power is generated and distributed locally—either in small isolated plants or in central stations restricted to supply

is now possible with steam operation. Let us examine these reasons in greater detail.

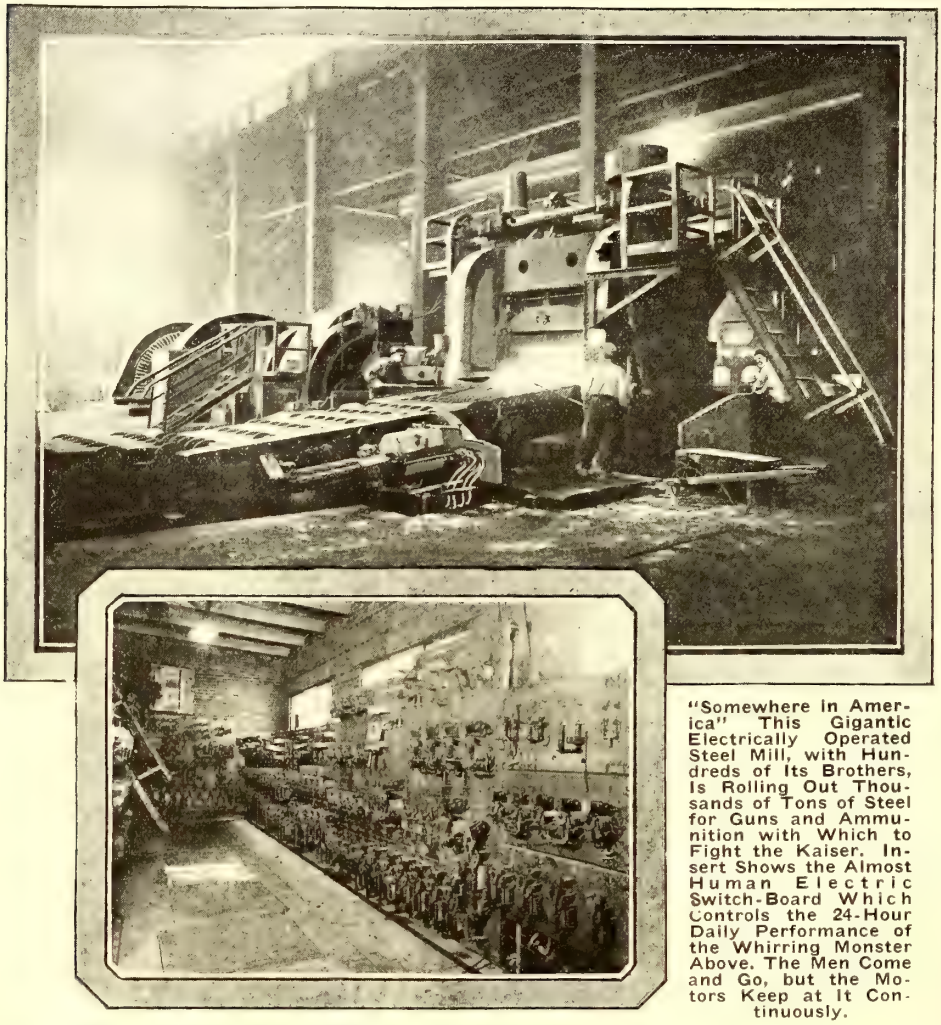
As to the first—the use of our immense of water power—nothing further

There is, however, a greater economy possible than the above figures suggest. Let us suppose that 80 plants, which formerly needed generators aggregating 40,000 H.P.,

(*Continued on page* 873)

How the Mystic Current Makes Steel

The accompanying illustration shows the gigantic electrically operated steel plate mill in a large Cleveland, Ohio, steel works. Some of these steel mills are driven by veritable monsters of electric motors, and to control them is not the easiest thing in the world. The white-hot steel billets emerge from the motor-driven rolls at the right, while off in a little room, hundreds of electric fingers are sending messages to the electric motors that run the machines.



"Somewhere in America" This Gigantic Electrically Operated Steel Mill, with Hundreds of Its Brothers, Is Rolling Out Thousands of Tons of Steel for Guns and Ammunition with Which to Fight the Kaiser. Insert Shows the Almost Human Electric Switch-Board Which Controls the 24-Hour Daily Performance of the Whirring Monster Above. The Men Come and Go, but the Motors Keep at It Continuously.

"Stop!" "Start!" "Slow!" "Reverse" is the endless, monotonous series of orders dispatched with the speed of lightning and the sureness of a trip-hammer blow.

Men may come and men may go at the steel plant but the automatic motor control switch-boards keep up the heavy stream of steel production 24 hours a day, week in and week out. Today, hundreds of these powerful electric steel rolling mills thruout the length and breadth of the land are humming away night and day — rolling, squeezing, and swaging the glistening white-hot ingots into sinews of war—guns, shells, torpedoes, aeroplane parts, engines, and stock for thousands upon thousands of other much-needed implements used by the American Sons of Mars.—*Photos courtesy G. E. Co.*

PLATFORM FARE BOX FOR SUBWAY SERVICE.

For handling large crowds, such as in subways, elevated stations, terminals, etc., a Chicago concern has developed a motor-driven fare box, which embodies several interesting features, as applied to the standard registering and counting mechanism which has been extensively used in street railway service for several years.

Heretofore large crowds at such points have usually been handled by means of non-registering hopper fare boxes which received *tickets* only, but with this improved box the paper tickets will be eliminated and the rider *will deposit cash fare directly in the box* as he passes thru the gates, the coins being automatically registered and deposited in a locked receptacle.

This station platform box has been tried out for several months in New York subway service with such satisfactory results that the Hudson & Manhattan Railroad Company has ordered a sufficient number of boxes to equip all of its stations, and a large order has recently been received from the New York Municipal Railway Corporation.

The hopper is of bowl construction, of liberal diameter, deep and with sufficient holes for all "rush-hour" requirements. As many as 119 *fares* have been handled by the box in *one minute;* its ability to handle fares is limited only by the speed with which it is possible to pass people thru the gates.

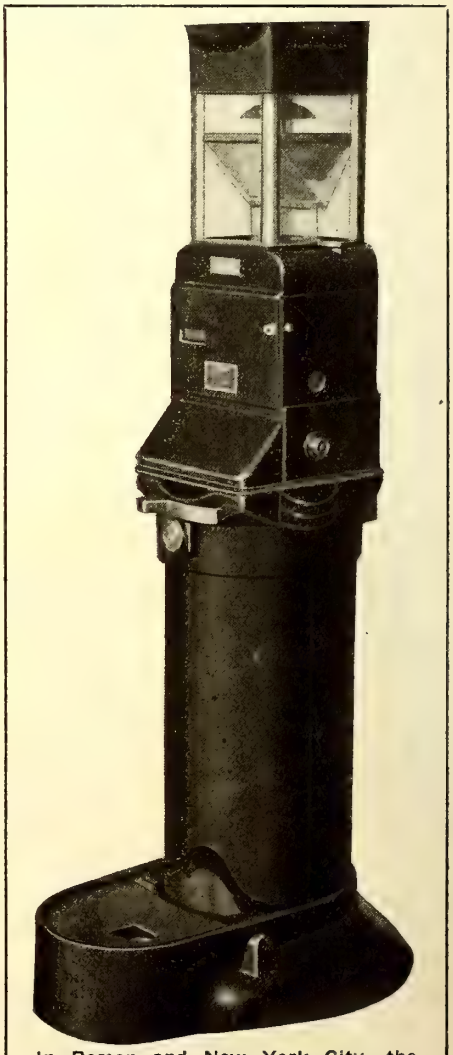
The inspection chamber is of ample size, allowing ample light, with "baffle" plates of simple construction, insuring the coins lying flat on the black coin belt, giving a clear view of all coins at all times, yet shielding the operator's eyes from all light by reason of the light being situated at the back of the box. The coin belt is of dark leather which causes all coins whether of silver, nickel or bronze, to show up in contrast, relieving the eye strain of the operator. This belt is operated over two rollers, the entire construction being very simple.

From the agent's or operator's standpoint, he has clear vision and ample time for coin inspection without eye strain. He has a small catch to stop the coin belt, if needed, to call a passenger's attention to a false coin deposited. Should a mutilated coin or foreign material be dropt into the fare box, clogging or stopping the machine, a small crank is supplied which allows the operator to force the foreign pieces thru and clear the machine from all obstructions.

Another valuable feature is, that during the removal of any of the parts of the mechanisms, the money is always fully protected, because in the design of this box the feature of having the operating mechanism entirely separate from the coin receptacle and chamber is fully carried out.

Further, with reference to collecting the money: The locking mechanism is so timed that the collector cannot insert and turn his key to unlock unless the current is out off the motor. This prevents the possibility of money deposited in the hopper being past thru the box should the coin receptacle be out of place.

After the collector has stopt the mechanism and unlocked the coin receptacle chamber, he cannot remove his key until the filled receptacle is removed and an empty one properly inserted and the coin receptacle is removed before the mechanism can be started again.



In Boston and New York City, the Subways Are Using This Motor-Driven Fare-Box. They Take Pennies, Nickles and Dimes, and Save Ticket Paper As Well As Congestion.

AUTO TRUCK "DOUBLES UP" AS LIGHTING PLANT FOR PARK.

An automobile truck was prest into service to furnish lighting current for the Yosemite National Park when it was found impossible to complete a new hydro-electric station in time.

WASHINGTON STATE COLLEGE TO HAVE SIGNAL CLASSES.

Washington State College, Pullman, Wash., will heed the call of the government for 15,000 trained men for the signal corps and will attempt to provide between 50 and 100 men qualified for this service in as short a space of time as is possible. Classes in signal corps work will be started immediately. Training will be given in the international wireless code, a speed of 20 words a minute in sending or receiving being required before the completion of the course. The code to be taught is used thruout the signal corps service in wireless, wigwag and buzzer signaling.

A storage battery of the size which allows it to be substituted for the standard dry cell is now sold for use in connection with portable electric lanterns.

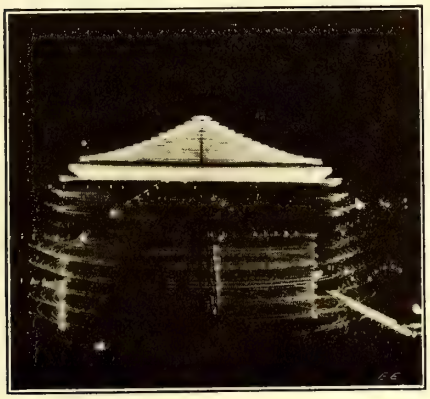
THOSE "ODD" ELECTRICAL PHOTOS.

The accompanying photo shows a really novel electrical effect—the kind we are after and stand ready to pay $1.00 cash each for. Say, readers, we really wonder if you have ever read the notice publisht on the title page of the "Question Box" in every issue for the past six months. This notice to all readers, whether regular subscribers or not, says that $1.00 will be paid for any photo we can use—but they should be "odd ones," like that below.

The present picture is—perhaps the Radio hounds will swear it's nothing but a highly charged helix—a short-time exposure of the electrically illuminated "Captive Aeroplanes" at Luna Park, Coney Island. The photo is not retouched and was copied directly. Now why can't we get dozens of other novel, odd, striking electrical photos? Something with a "kick" in them. Don't be afraid to waste a "film" or "plate"—take a crack at something. If at first you don't succeed, etc.—you know the rest.

Mr. Strickfaden took this photo, the original being of ordinary pocket kodak size, or 3¼ by 5¼ inches.

Now, readers, and there are several hundred thousand of you, for the love of

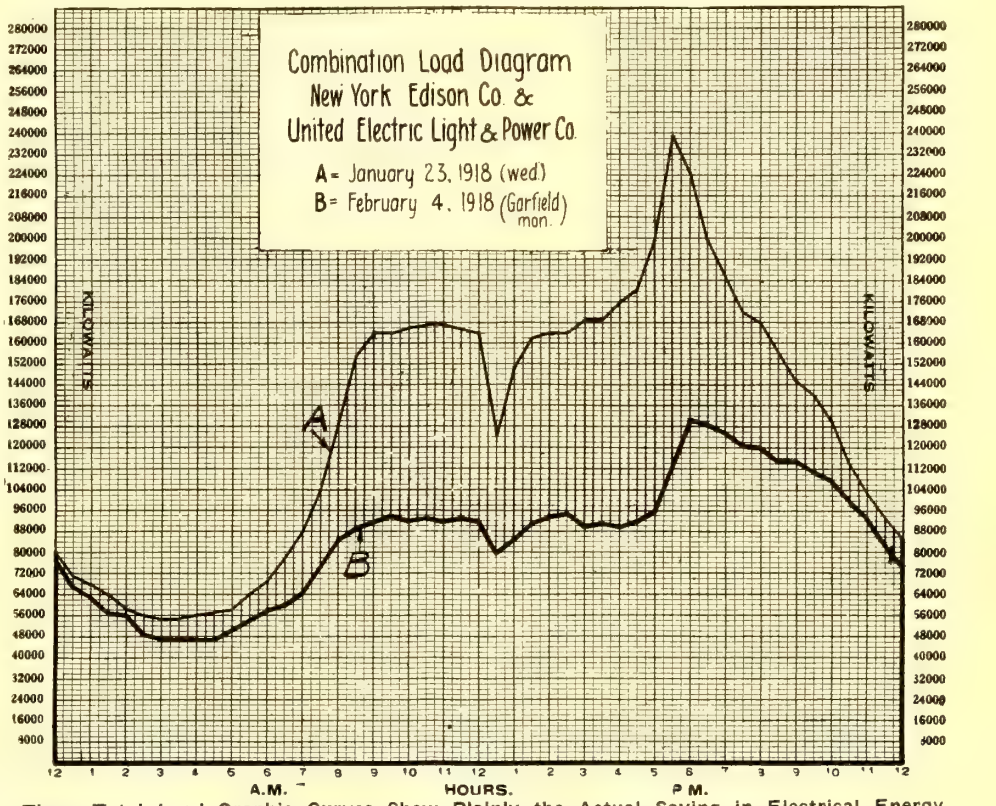


No! Radio-Hounds! It Is Not a Wireless Helix, But a Night Photo of the "Captive Aeroplanes" at Luna Park.

Horse-thief Pete, get out that kodak or plate camera. Dust her off and go shooting for that "odd photo." We know it's there, but as we can't travel all over the United States and thru foreign climes to ferret out these interesting subjects

Patriotism, Dr. Garfield, and New York

MANY persons have undoubtedly wondered just how patriotic the various sections of the country were during the recent "blue" Garfield Mondays, when the wheels of industry and business were closed down by official order. We are fortunate in being able to present direct evidence for at least one important case, that of New York City. The accompanying graphic curves show the total consumption of electrical energy in kilowatts for a period of 24 hours on two different days—one a heat-less, fuel-less, work-less day, and the other a normal day.



These Total Load Graphic Curves Show Plainly the Actual Saving in Electrical Energy Brought About in New York City Alone on a "Garfield" Monday, as Compared to a Normal Work Day.

The upper curve shows the consumption of electrical energy on Wednesday, January 23, 1918, and the lower, heavy line curve the amount of electrical energy used on "Garfield Monday," February 4, 1918.

As a glance at the figures and curves demonstrate clearly, the greatest saving effected on Garfield Monday, February 4, occurred at 5:30 P. M. in the evening, when the New York Edison Co. and the United Light and Power Co. *together* supplied about 112,000 kilowatts. At the same hour on a normal work-day, or on Wednesday, January 23, the "peak" of the load at 5:30 P. M. shows a total consumption of approximately 240,000 kilowatts, or the saving at the "peak of the day's load was 128,000 kilowatts, a saving of 53½ per cent.

From 12 o'clock midnight of Sunday, and on thru the early morning hours up until 7 A. M. Monday morning, the difference in electrical energy consumed on a typical Garfield fuel-less Monday, as compared to an ordinary work-day, indicates that only a slight difference was effected in electrical energy saved, or, on an average, about 8,000 kilowatts.

Proceeding from 7 o'clock in the morning, the saving due to the closing down of industrial plants, office buildings and stores etc., were entirely closed down and the mean increase of about 10,000 to 12,000 kilowatts in the afternoon is due largely to the theatres, a considerable number of which gave special Monday matinees. The theatres were allowed to remain open Monday afternoon and night by Fuel Administrator Garfield, but were closed Tuesdays all day and evening.

As the evening of Monday approached, or at the hour of 6 P. M., the highest point of the day's load occurred, which for Garfield Monday was 130,000 kilowatts. As aforementioned, the total saving at the "peak" of the day's load due to the Fuel Administrator's order in closing all stores, except food and drug stores, besides factories and office buildings, amounted to 128,000 kilowatts saved, or 53½ per cent.

Curve "B" for Monday parallels on a lower level in general the contour of curve "A" for Wednesday, and the reason why this is so, particularly in the evening period, is because of the extensive street lighting and traffic power requirements in such a large city as New York. The evening load factor remained fairly large from 7 to 10 P. M. owing to the theatres and restaurants.

From this point the load graph continues on downward until it reaches the end of the 24-hour period coming under the Fuel Administrator's orders, with a total energy consumption of 74,000 kilowatts. After passing 12 o'clock midnight of Monday, the curve would continue to drop to about 54,000 kilowatts at 3 P. M.

Yes—New York City was quite patriotic!

AMONG the hundreds of new devices and appliances publisht monthly in the Electrical Experimenter, there are several, as a rule, which interest you. Full information on these subjects, as well as the name of the manufacturer, will be gladly furnisht to you, free of charge, by addressing our Technical Information Bureau.

"Edison Pioneers"

ON Jan. 2, 1918, a call signed by Messrs. Frederick A. Scheffler, Charles Wirt, Sidney B. Paine and William J. Hammer was sent to many of Mr. Edison's earliest assistants and associates requesting those who had entered his service before and including the year 1885, to attend a meeting at the Engineering Societies' Building, New York City, on the evening of January 24, 1918, with a view to effecting a permanent organization. The forming of such an organization had often been broached by the men who had been intimately associated with Mr. Edison and his interests at his famous Menlo Park, N. J. Laboratory, 65 Fifth Ave., (New York headquarters of the Edison Electric Lighting interests), the Edison Lamp Works, Machine Works, Underground Tube Works, and the various other commercial, engineering and manufacturing interests connected with Mr. Edison's electric lighting, telegraph, telephone, phonograph, electric railway and other interests in this country and abroad, and on Jan. 24, twenty-eight of Mr. Edison's early associates, shown in the accompanying illustration, met in the Board Room of the American Institute of Electrical Engineers, thru the courtesy of the Institute, and took the initial steps to form an organization to be known as *"Edison Pioneers."*



Thomas A. Edison and Miller Reese Hutchinson, His Chief Engineer, at a Meeting. Mr. Hutchinson Epitomizes the Proceedings and Taps a Report in Morse on Mr. Edison's Knee.

Many letters were read which had been received by men entitled to belong who were unable to be present, and who one and all approved of the movement and wished to be included. Others wrote requesting that the line of demarcation be drawn at various dates subsequent to 1885 so that they might be included, but it was decided that as perhaps one million persons have been connected directly or indirectly with Mr. Edison's various interests here and abroad, it was essential that the organization should at present be limited to the very earliest of those connected with the inventing, developing and commercializing of Edison's inventions, and later on taking in on some basis certain men whose work has been of most importance in Mr. Edison's later spheres of usefulness, such as the storage battery, moving pictures, etc., etc.

The following officers were elected: President, Francis R. Upton; vice-president, Samuel Z. Mitchell and T. Commerford Martin; secretary, Robert T. Lozier; treasurer, Frederick A. Scheffler; historian, William H. Meadowcroft.

Various committees upon organization, constitution and by-laws, etc., were appointed, and a telegram was sent to Mr. Edison apprising him of the formation of the *"Edison Pioneers"*, and after indulging in

(*Continued on page* 857)



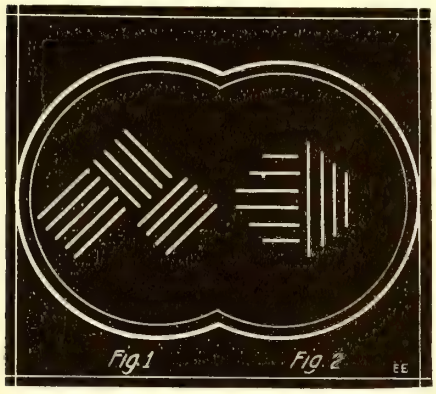
Left to Right: Back Row—1, Arthur S. Beves; 2, Charles A. Benton; 3, Dr. S. S. Wheeler; 4, Wm. M. Brock; 5, Howard A. MacLean; 6, H. A. Campbell; 7, Frederick D. Potter; 8, George G. Grower; 9, Frank A. Wardlaw; 10, Christian Rach; 11, E. W. Kiddle; 12, Sidney B. Paine; 13, F. S. Smithers; 14, Robert T. Lozier, Sec'y; 15, T. E. Crossman, Stenog. Around Table—16, E. W. Hammer; 17, Wilson S. Howell; 18, Charles S. Bradley; 19, Fremont Wilson; 20, Fred'k A. Scheffler, Treas.; 21, S. Z. Mitchell (V.-Pres.); 22, Peter Weber; 23, William J. Hammer; 24, Francis R. Upton, Pres.; 25, Cammerford Martin, V.-Pres.; 26, S. D. Mott; 27, William Carman; 28, E. H. Latimer.

COSMIC FORCE

By L. M. Correll

Engineering Department, Anaconda Copper Mining Company

AN inventor's recent claim of our ability to utilize the cosmic force has brought forth considerable conjecture concerning the meaning of such a discovery (referring to the claims of one—Garabed Giragossian, of Boston). "Cosmic" is defined as pertaining to the universe, universal or orderly,



One Form of Energy Made Up in a Certain Complex Form Would Have Its Own Characteristics, as Copper Might Have Ions Like Fig. 1, and Iron with Ions Arranged as in Fig. 2, Etc. This Probably Explains Why Different Materials Take a Definite Crystalline Form.

and "Cosmical Physics" as a term broadly applied to the totality of those branches of science which treat of cosmical phenomena and their explanation by the laws of physics.

The sun is considered as the source of all energy, which is conveyed thru space by a condition which, as far as we have been able to determine, is ether. These particles of energy in some form apparently shoot thru all space, altho it may be determined that the planets and other celestial bodies focus the sun's energy upon themselves by or on account of their own gravitational attraction. The earth is continually being bombarded by minute specks of energy from the sun, rather than by waves of any magnitude, which on passing thru the elements of the atmosphere enveloping the earth are transformed into light rays, heat waves and numerous other forms of energy, some of which we have been able to determine by recent scientific research. This conclusion has exploded the old theory that the sun gives off light and heat directly, which theory was indeed absurd, it having been assumed before the present electrical age and should be discarded, now that we have begun to see the "light."

An understanding of the first principles of cosmic force must first be secured, as this force is the power to be developed into our different requirements, and, as the principle is revolutionary to the old teachings it will be more clear to many if an example is cited. In ascending to a high altitude, as on a mountain, where there is a different atmosphere, i. e., an atmosphere which is more rare than at the lower altitude and therefore with less transforming effect on the form of energy received, the temperature of the atmosphere becomes colder and more noticeably so in the higher altitudes reached by balloons, and also it is noticeable that there is *less light*, regardless of the fact that they are constantly *approaching* the sun. Both light and heat diminish inversely as the square of the distance from their source, so that if the sun radiated both light and heat, the air should be at a much warmer temperature and more light should be given at the higher altitudes, which easily proves the fallacy of the older theory. If we consider the extreme distance of the space in which the energy in its true form must pass as it is propagated from the sun, it must arrive at the earth's upper strata of atmosphere with little or probably no loss of intensity. In its true term a minute speck of energy is used in the sense of a minute pulsation or vibration and not as a small particle of matter or substance.

Vibratory energy is classified according to the intensity and rapidity of its vibrations. The first evidence that we are able to recognize is sound, and, as the rapidity of vibration increases, to heat, electricity, light in its different colors is recognized, each color having a different rapidity of vibration. The human eye is not able to distinguish all colors of the spectrum, the rays below red on the lower scale and violet on the upper becoming invisible, but we know that some of these rays are seen by some birds and animals. This is about as far as our senses are able to discern these conditions unaided, as most of the higher order of vibrations cannot be studied directly, but only by witnessing the effect they produce under varying conditions, which are chemical rays, wireless or Hertzian waves, ultra-violet, X-ray, and thru research with radio-active material there have been discovered the alpha, beta and numerous rays of high frequency.

When calibration of the amplitude and velocity of all of these vibratory forms is perfected, a new field of research will be opened up which will have unlimited possibilities, as energy is not only in simple form but it is also in complex combinations. We may be able to take this energy as we receive it from the sun, calibrate it, pass it thru some element or substance, possibly an inert gas with a known resistance, and transform it into *all light* or *all heat*, as may be required, not unlike the method of transforming an electric current into a higher or lower voltage, or by the transforming of electrical current thru an incandescent lamp into light rays.

It has been estimated that the potential energy on the surface of the earth amounts to about 5,000 horse-power to the acre and numerous attempts have been made to apply a part of it to industrial uses by lenses, mirrors, etc., so as to concentrate the heat that has been already transformed by the energy passing thru the earth's atmosphere, to a point of application, but when we are able to transform all the energy into heat, then it will be a simple matter to produce steam, smelt ores and metals, and even serve for domestic use. When this is accomplisht, mining, transportation and the methods of use of fuel today for the same purpose will seem to be crude indeed. These are principles worthy of consideration, however advanced they may appear, for at any rate it is only a question of time until they will be developed, considering the wonderful strides made in their study in the last decade.

We may go even farther than this and actually demonstrate conclusively that matter is only a form of crystallized energy, directly related and a part of the cosmic force, and to our uses as a material, solely a creation of the mind. Scientists are approaching this principle thru the study of radium and radio-active material which radiate energy in forms that can be observed. Effects from such unstable molecules must not be considered as shooting off an electron, which is an infinitesimal particle of matter, thru some other element, but they should be considered as a speck of energy which passes as a vibration, not unlike sunlight in its passing thru a transparent substance like glass.

It has been verified that what we characterize as matter is a substance in a violent state of motion. Matter consists of molecules, atoms, ions and even a finer divisibility, all comprising a form of energy in a balanced state. When the balance or stability of an electron, atom or molecule is destroyed, a certain amount of energy is

(*Continued on page* 872)

TABLE OF VIBRATIONS

WHOSE EFFECTS ARE RECOGNIZED AND STUDIED

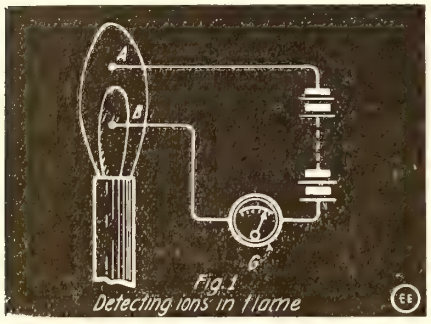
	Number of Vibrations per Second	
1st Octave	2	
2nd "	4	
3rd "	8	
4th "	16	SOUND
5th "	32	
6th "	64	
7th "	128	
8th "	256	
9th "	512	
10th "	1,024	
15th "	32,768	
20th "	1,047,576	UNKNOWN
25th "	33,554,432	ELECTRICITY
30th "	1,073,741,824	
35th "	34,359,738,368	
40th "	1,099,511,627,776	UNKNOWN
45th "	35,184,372,088,832	
46th "	70,368,744,177,644	HEAT
47th "	140,737,468,355,328	
48th "	281,474,976,710,656	
49th "	562,949,953,421,312	LIGHT
50th "	1,125,899,906,842,624	CHEMICAL RAYS
51st "	2,251,799,813,685,248	UNKNOWN
57th "	144,115,118,075,855,872	
58th "	288,230,376,151,711,744	X-RAYS
59th "	576,460,752,303,423,488	
60th "	1,152,921,504,606,846,976	
61st "	2,305,843,009,213,693,952	
62nd "	4,611,686,618,427,389,904	UNKNOWN

The Phenomena of Electrical Conduction in Gases.

PART I. WHAT IS IONIZATION?

By Rogers D. Rusk, M.A.

A FEW years ago scientists were so busy studying currents of electricity in wires and liquids that they thought very little about currents of electricity in gases. In fact, up until 1880, it was supposed when an electrified body lost its charge in the air that this was due only to dust, or moisture in the air, and to faulty insulation. Now we know that



Simple Experiment by Which It Becomes Possible to Detect "Ions" In a Flame. Due to the Ions Formed In Such a Flame, It Conducts an Electric Current, as the Galvanometer Proves.

the molecules of the air or a gas may themselves act as carriers of electricity and thus conduct the charge away in addition to the other factors mentioned.

This idea has been much more revolutionary than most people suspect. It has helped us to completely change our ideas of matter thru what we have learned of these molecular carriers of electricity. It has helped us to discover marvels as great as in any scientific field, as for instance the production of light without heat by ionization. It has given us the Audion and all similar detectors useful in wireless telegraphy, which are applications of what is called the *Edison effect.* Beyond all this it has given us, more than any other field, facts which substantiate and prove the *electron theory of matter,* and universal nature of electricity.

The field of ionization in gases is truly a Twentieth Century branch of science because only since 1900 has it been studied as a separate field in itself. Unlike most branches of Physics and Electricity its youth keeps it from having reached the degree of complication and mathematical complexity usually to be encountered. Neither is the history of the study of ionization in gases long or involved nor is it buried under mathematical formulae. Brilliant experiments are often accomplisht with simple apparatus, and for these reasons and for the things of the future which may be expected, it seems that a study of this field should prove doubly interesting both to the tyro in scientific matters and also to the professional scientist.

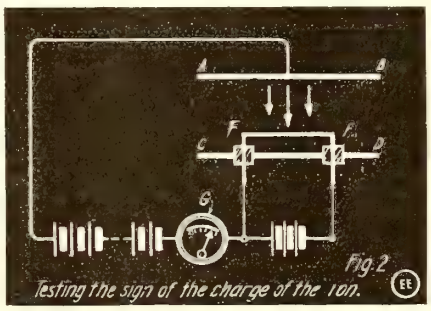
By ionization is meant that change in a non-conducting gas or liquid which renders it conducting. Evidently this may be effected by either the molecules of the conducting medium, splitting up, remaining single, or grouping themselve together in little clusters, and then acting as carriers for positive or negative charges. It is common knowledge that in liquids the molecules break up into two parts carrying equal and opposite electrical charges, and these ions travel in opposite directions toward their respective electrodes, and thus carry the current from one pole to the other. The same thing is true in gases except that the ions do not slide along as in a liquid but fly thru empty space, colliding with each other frequently, and zigzagging along. Also in the case of gases we may have parts of molecules, whole molecules or groups of them acting as the carriers, depending on conditions.

It is because of these ions which are formed in a flame that a current of electricity can be made to jump a gap between metal points, if a flame is held between them. In Fig. 1 a device is shown for testing the electrical conductivity of a flame by means of a galvanometer. When the flame comes in contact with the points A and B a swing of the galvanometer needle will denote a current across the gap AB.

In the same way and due to the presence of ions, a current will pass thru air or a gas upon which has fallen X-rays, ultra-violet light, or the rays from radio-active substances. For the same reason, too, a current will pass in an Audion bulb from the plate to the filament.

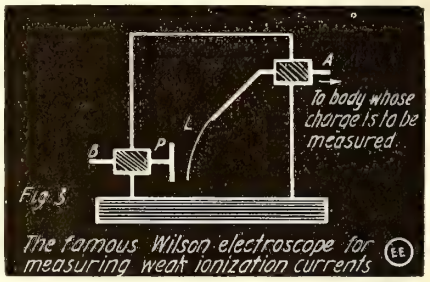
In order to understand properly where the study of ionization begins it is necessary to note the high points of experimentation which have brought us up to our present position. Faraday, the great pioneer electrical student, disclosed the keenness of his scientific insight in a statement which he made about 1840 when he was studying electrical sparks in different gases, in which he says the idea came to him that there was *"A direct relation of the electric forces with the molecules of the matter concerned in the action."* Faraday saw that the molecules of the gas, themselves, had something to do with the action, but little came of his suggestion for a long time. In 1879, Crookes arrived at the startling conclusion that cathode rays were minute charged particles of matter, and soon after the discovery of the X-rays, in 1895, the cathode particle was named the *electron* and actually measured in mass and charge by many investigators including J. J. Thomson. These fact led J. J. Thomson, along with E. Rutherford, his co-worker, to formulate the *ionization theory of gases* which is now universally accepted, and which assumes that the molecules of matter themselves act as carriers for the charges or electrons.

One of the first things to be noticed in the study of ionization is that under some



By Means of This Apparatus the Investigator Is Enabled to Test Various Chemicals to Determine What Kind of Ions Are Given Off—i. e., Positive or Negative.

conditions immense numbers of positive ions may be present and very few negatives, while under other conditions exactly the opposite may take place. This, of course, would have been entirely impossible in liquids where always the same numbers of negatives and positives are present. Investigation has shown that different solids give off different kinds of ions, when heated, and that even the same solid may give off different kinds of ions when heated to different temperatures or surrounded by different kinds of gases. For instance, the nitrates of calcium, strontium, and barium give off negative particles or electrons when



This Form of Extra Sensitive Electroscope Was Devised by Wilson for the Purpose of Detecting and Measuring the Minute Electric Currents Due to Ionization.

heated, while on the other hand aluminium phosfate gives strong positive ionization. A mixture of one of the nitrates and aluminium phosfate gives off both kinds of ions. Anyone can easily test various chemicals to see what kind of ions are given off by use of an apparatus as shown in Fig. 2. AB and CD are the sides of a metal tube in which a wire filament FF is led thru insulators. The filament FF is coated with the compound to be examined and then heated to incandescence by means of a suitable battery. A galvanometer and auxiliary battery are bridged around the tube and the filament so as to complete the circuit thru the galvanometer across the air gap between the filament and tube. If the filament gives off negative ions or electrons the current will pass in the direction of the arrow but not in the opposite direction. If the ions given off are positive the reverse is true. The auxiliary battery may be reversed in either case to complete the test.

For such work the ordinary galvanometer is not found as sensitive as is often desired and usually an electrometer or some form of electroscope is used. Frequently, instead of measuring the current across an air gap, a charged body is placed in the presence of the ions and the rate of leak of its charge is taken as an indication of the strength of the ionization. In such work the field of static electricity renews its practical value and the old gap between static and current electricity almost disappears.

It used to be thought that static electricity was more or less of a plaything only, and that the electroscope was useful only in demonstrating simple facts about electrification, and was not an instrument of scientific precision. Now, in improved forms, it is one of our most sensitive instruments and is one of the most common employed in measuring minute quantities of electricity, especially ionization currents. The form of the ordinary gold leaf electroscope is familiar to everyone, but some of the more improved types do not resemble it very much, altho they work on exactly the same principle. The form of the Wilson electroscope, one of the most sensitive types, is shown in Fig. 3. Two electrodes are led into a

(*Continued on page* 876)

NEW PORTABLE ELECTRO MEDICAL APPARATUS.

The beneficial effects of electrotherapeutic treatment are coming to be so generally recognized that a large demand has arisen for simple and reliable equipment by which it may be applied by the ordinary layman. Especially is this true with high-frequency apparatus, which gives an invigorating and perfectly safe as well as pleasant treatment found very satisfactory by physicians, chiropractors and beauty experts for many ailments and for toning the tissues and nervous system.

The accompanying illustration shows a combination cabinet and wall plate for physicians' use. It provides in one compact set for the four treatments commonly used in electrotherapeutics, namely, galvanic, faradic, high-frequency and sinusoidal currents. It includes a cord for connecting to the ordinary lighting circuit, an adjustable induction coil, a rheostat, a Tesla coil, a milliammeter, two lamps for illumination and resistance, a spark gap, special electrodes or applicators, connecting cord, terminals, etc. Ease of adjustment is provided for in every detail. Means are also arranged for connecting and regulating diagnostic lamps.

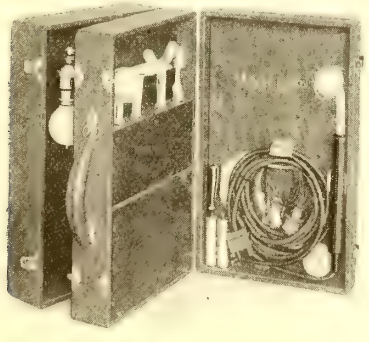
This outfit is mounted in a portable and handsome oak case, measuring only 16 by 10 by 7½ inches. It can be carried like a suitcase, or quickly mounted on the wall.

The *galvanic current* is produced without the aid of dry cells and at all times the current is smooth, steady and even. The slightest change in the current is immediately communicated to the sensitive milliammeter mounted on the face. The current can be regulated to any degree of strength and will be maintained so to any desired time.

The *faradic current* is produced by the faradic coil mounted beneath the milliammeter. The core of this coil is made of annealed Norway iron wire, which insures greater magnetic saturation than the solid core. The primary and secondary winding are wound in exact proportions in order to give absolute resonance.

The *high-frequency current* is produced by the same coil in conjunction with a Tesla coil. The High-Frequency current is regulated by means of a spark gap mounted underneath the coil and also by the knob regulator on the coil itself. The knob regulator controls the vibrator spring. The current can be decreased from a spark of over three inches to such a fine current as to be almost imperceptible; at the same time maintaining its smooth, even flow.

The various electrodes are attached to a small handle which is very convenient. The cord from the instrument to the handle is of pure gutta percha.



Unique Portable Electro-Medical Set For Private or Physicians' Use.

The shunt rheostat regulates the voltage and intensities of the different currents. It is wound to a high resistance and is claimed not to deteriorate or heat.

AN ELECTRIC MAGAZINE SOLDERING IRON.

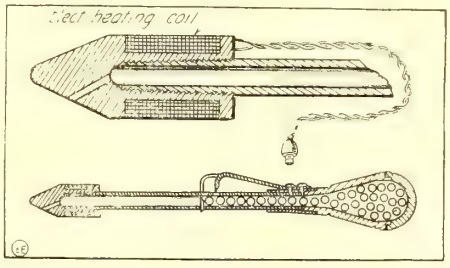
A clever magazine soldering iron has been patented by Ray M. Tilton, of Panora, Iowa, which possesses several desirable features. One object is to provide a magazine soldering iron having a hollow shank connected with a handle at one end and a soldering iron member at the other end, with means for controlling the passage of particles of solder thru the shank.

The top finger extends above the shank and outside said shank, as shown, whereas when the two arms, which stand side by side, are prest toward the shank, the upper finger extension enters the shank while the lower finger leaves the shank.

The two arms are so arranged as to be rigidly engaged by the thumb of a person whose hand grasps the handle. The upper and lower metal fingers are spaced apart such a distance longitudinally of the shank, that between them is the proper space to receive a small pellet of solder.

In the practical use of this improved soldering iron, the handle and the portion of the hollow shank adjacent to the handle is filled with solder pellets, when the cover is removed. One arm normally holds the lower finger in position so that the pellets are moved toward the point of the iron.

By pressing the two spring arms toward the shank and holding the entire device in the proper position, the pellet nearest the iron will be permitted to roll downwardly into the iron, where it will be heated and melted, and will flow thru the narrow passage shown to the exterior of the iron.



New Magazine Soldering Iron—the Solder Pellets Are Held in the Handle. A Finger Trigger releases the Pellets as Required.

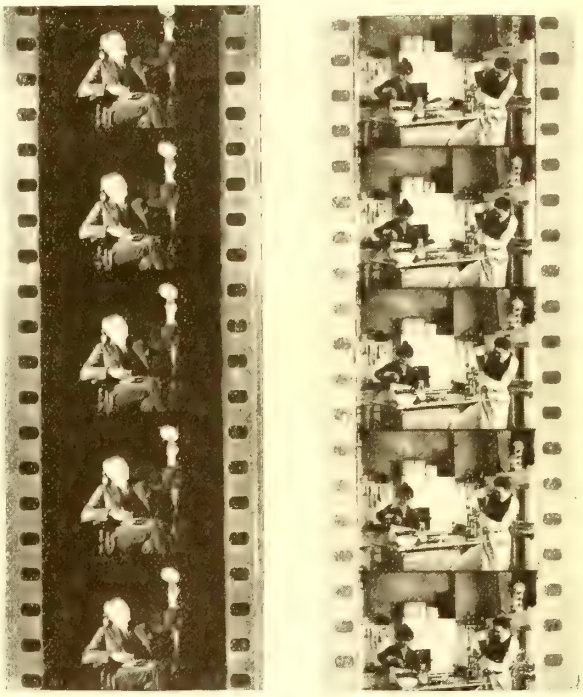
INDIANA TOWN BECOMES DARK WHEN CITIZEN TAKES BATH.

For the space of one minute all the lights in Marion, Indiana, recently went out and all institutions depending on Marion current for operating were stilled, all because John Coats, while taking his regular Saturday evening bath at his home, got hold of a live wire, in attempting to shake into life a defunct electric light globe and could not let go.

Standing in the water with 110 volts coursing thru his body, all Coats could do was to yell for help. A neighbor quickly discovered Coats' plight and telephoned the light company, which turned off all the current. Mr. Coats was in a serious nervous condition for some time afterward, but suffered no serious injury.

"MOVIES" HELP TO PUSH ELECTRICAL SALES.

The "movie" is the greatest salesman in the world today—a merchandising method considered to be between 95 and 100 per cent efficient because, says the *Society for Electrical Development*:—1. It gets the undivided attention of its entire circulation 2. It interests everyone because it's a movie—a story—because it is life itself, the most interesting thing in the world. 3. It "gets over" a selling argument more thoroly and effectively than a human salesman possibly could—and to hundreds of persons in a few minutes!



In the "Movies" They Do It—Electrically Chop the Food, Fry the Eggs, Etc., All For the Purpose of "Educating" the Public.

In other words, an entire sales argument is comprest into a few feet of film—an argument which would take hours to explain, and pages and pages to describe—and not near so convincingly!

"The Home that Runs by Magic" is the title of one very interesting "Universal" motion picture, which emphasizes the fact that the modern home is electrically equipt thruout and that the labor of housekeeping is appreciably lightened by the use of electrical appliances.

It is a heart-interest story about a young bride whose husband gives her an All-Electric home. The first scene shows them riding up to it in their new Electric Car. Next you see them at breakfast using their Table Appliances—then getting dinner in their Electric Kitchen. Next wifie makes wash day Wash Hour in her Electric Laundry. Other similar scenes follow. The picture vividly demonstrates the utility and comfort of Electric Appliances and drives home their practical appeal this year. It shows in actual operation: Toasters, Grill, Warming Pad, Percolator, Electric Car, Flat Iron, Samovar, Radiator, Floor Lamp, Electric Range, Kitchen Utility Motor, Washing Machine, Electric Refrigerator and Drink Mixer.

These films are available at a nominal figure, and are run in the electrical contractors' home town "movie" theaters. This scheme is both instructive and educative as to the ways in which electricity can be used in daily life, besides being a mighty good booster of electrical sales.

Utilizing Burnt-Out Lamp Bulbs

By H. Gernsback

HOW can we utilize burnt-out electric lamp bulbs? Almost everybody has several of these lying around idle. For the purpose of having the household as well as the experimenter make use of such discarded bulbs, the present article has been prepared.

We will pay until further notice monthly prizes as follows: **First prize—$3.00** *for best suggestion;* **Second prize—$2.00; Third prize—one year's subscription to the ELECTRICAL EXPERIMENTER.** *Every reader may join in this contest, and you need not be a subscriber to participate. Ideas will be publisht monthly under the head of* **"Burnt-out Lamp Contest."** *All letters should be addrest to "Editor,* Burnt-out Lamp Contest."

EVERYBODY who has electric light has, as a rule, a good many burnt-out lamp bulbs lying around idle which are not of any use, and sooner or later are discarded or perhaps thrown at nocturnal song makers on the fence, with indifferent results to the singer.

The thought of utilizing such bulbs had been a pet idea of the writer's for a long time, and the present article, and the ones we hope will follow, aim to save these old bulbs. The few ideas which we illustrate in the present article do not, of course, cover the whole subject. We are quite confident that there must be hundreds of other uses for the burnt-out bulbs, and we hope to present in our future issues further—and better—ideas of our ingenious readers.

The applications shown in Figs. 1, 2 and 3 are rather old, and are merely shown in this article to make it more complete. The other ideas were evolved by the writer and are supposedly new.

Fig. 1 shows how an excellent barometer, that will correctly predict changes of the weather, can be made from an ordinary lamp bulb. Take a burnt-out lamp, it matters not whether it is of the Tungsten or carbon variety, and place it in a basin of water, tip down. Now, by means of a heavy, sharp pair of scissors, cut off the glass tip, *while holding the lamp under water.* The use of pliers is not necessary, and the scissors will not be damaged by cutting glass under water. Be careful that when cutting off the tip not too much is cut off; *just a very little will do.* Immediately upon cutting the water will rush into the bulb with a violent boiling effect.

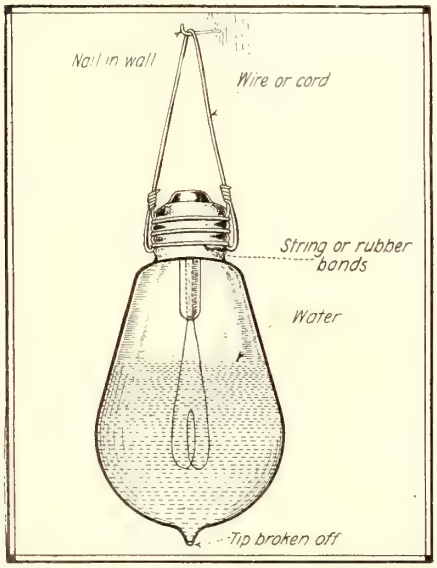


Fig. 1. Did You Know That an Old Burnt-out Lamp Bulb Makes an Excellent Weather Predictor? No? Here's How.

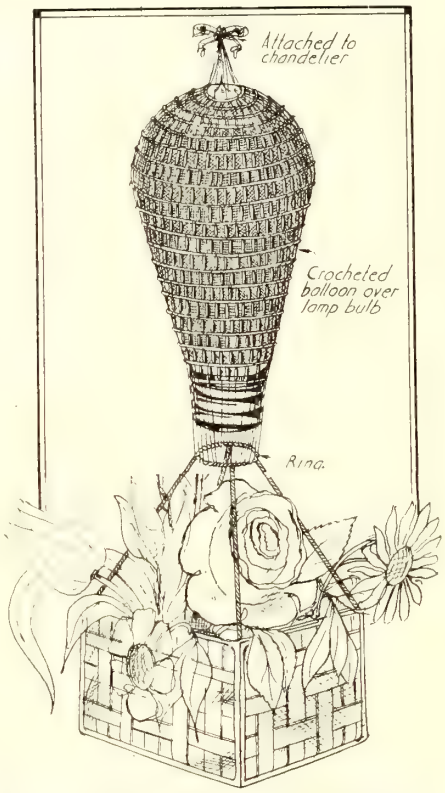


Fig. 2. Utilizing Burnt-out Bulbs and Utilizing Ma and Sis to Crochet Artistic "Balloons" for the Parlor Will Soon Be the Rage. Colors, of course, Red, White and Blue!

It takes but a few seconds to fill the bulb almost full. When taking the bulb from the water, contrary to expectation, the water will not flow from the small aperture at the former tip of the lamp. We now take the lamp and fasten a wire or cord around the screw part, so that the lamp is suspended tip downward (see illustration).

When the weather is fair for several days, no water will issue from the tip of the lamp. If, however, rainy weather impends, a drop of water will be observed at the tip, and it is quite surprising that a simple barometer of this kind will actually predict rain or fair weather twelve to twenty-four hours ahead of time. After a while, particularly, if there is much rainy weather, the bulb will become empty, as sometimes a few drops of water will come out of the bulb. This does not necessitate the throwing away of the bulb, and the writer has found a simple means for refilling it. Heat the bulb over a hot fire so that it becomes quite hot, then plunge into a pan of *hot* water, and the water will rush into the bulb filling it about three-quarters. Inasmuch as ordinary water is colorless, the writer suggests putting a coloring matter in the water before filling the bulb, which not alone makes the device more attractive, but at the same time makes it more easy to observe the tip when the water leaves it.

Our next illustration, Fig. 2, shows a simple device which you perhaps have seen already. This is something for the ladies, and particularly those who like to knit or crochet. An ordinary lamp bulb is decorated with red or other colored silk crochet work as illustrated, the idea being to form a balloon. Directly underneath the screw part of the bulb, an iron ring which may be a small key ring is located, which may be crocheted over. This ring is suspended from the bulb by means of silk threads as shown. The ring itself in turn supports the crochet basket or the car, which latter may be used to hold artificial or real flowers, as may be desired. Our illustration shows this accurately. At the top of the lamp a stout silk cord is sewn, and the whole may be attached to the chandelier in the parlor, or dining room lamp, giving a very pretty effect.

In illustration No. 3 is shown how the average experimenter can make small chemical vessels for experimental purposes, simply by using only the glass part of discarded lamp bulbs. One illustration shows a wooden block with wire work and handle on the style of soda fountain tumbler-holders, while the other illustration shows a similar idea, but here the holder is made of wire only. The lamp bulb may be cut by means of a three-cornered file, and it is safe to first break off the tip of the lamp to let the air in. This makes the cutting safer. The tip may afterwards be placed in a Bunsen burner to seal up the small hole which, of course, is necessary, otherwise liquids or acids would run out from

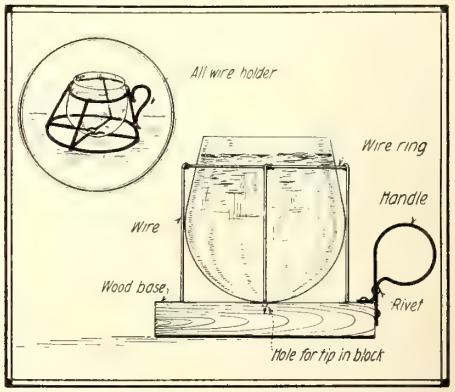


Fig. 3. No, Ma'am, This Is Not a Soda Water Glass. It's Used in Your Young Hopeful's Chemical Laboratory. Yes, It's Made from a Burnt-out Bulb.

the improvised chemical vessel. Another way to cut the lamp in case no file is had, is by taking a heavy string of cotton cord,

soaking it in alcohol and wrapping it two or three times around the point where the bulb is to be cut. Hold the bulb in the hand and light the cord with a match. After all of the alcohol has burnt out,

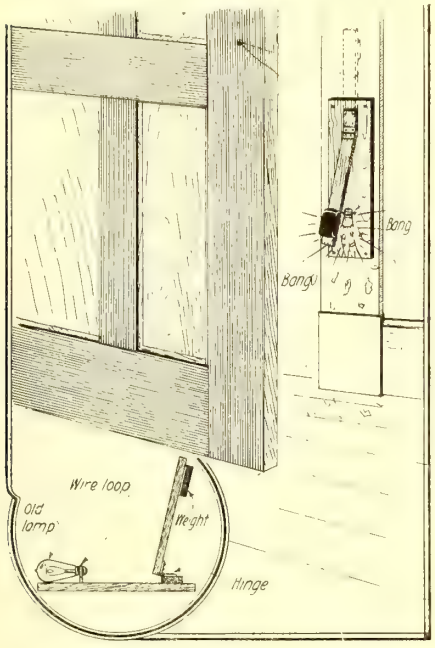


Fig. 4. Scaring "Burgulars" to a Quick Horrible Death by Means of an Old Burnt-out Lamp Bulb Is Not Such a Horrible Idea as It "Sounds."

dash a drop of water against the heated part where the cord was previously, and as a rule a clean cut will result.

Fig. 4 shows an improvised burglar alarm of the writer's, and it goes without saying that the very nature of this makes it impossible to use it more than once, but the writer guarantees that it will give a bad scare to any burglar who would attempt to open a door thus "protected." The idea simply consists of a board on which the lamp bulb is mounted by means of a wire loop. Of course, the bulb should still have its vacuum. Another piece of wood is secured by means of an ordinary hinge, and this piece of wood at the lower end is weighted by means of a piece of metal or stone or anything else that comes in handy. The entire outfit is now hung at the door frame while a thread is attached to the hinged part carrying the weight. It is apparent that as soon as the thread is broken, while opening the door, the weight will smash the bulb with a loud report. The thread itself is fastened by means of a special staple or tack to the door as shown in illustration. One or two feet of thread will do nicely. Of course, this alarm can be used again by putting another lamp in place.

Here is a medicated vaporizer or room fumigator that can be made by anyone at very little cost, Fig. 5. Take an ordinary lamp bulb and break off the tip, then cut off a small part at the top as shown. This you can do by means of a file or otherwise with a diamond. For that matter any glazier will do it for you for a few cents if you do not care to do it yourself. Break off all the filaments, leaving only the two lead wires exposed, as shown. Fill the bulb with either of the formulae as given below, all depending on the purpose for which you wish to use it. Fill the bulb as shown, and connect to your light supply. No resistance of any sort is required. Within a few seconds the water will begin to boil, while fumes will issue from the top of the bulb. Formula No. 1 has been prepared by a well-known physician and is excellent in case of colds, extensive coughing, cases of hooping cough, etc. Formula No. 2 will fumigate any room very quickly. The writer recommends both formulae. The beauty of this device is that *it works entirely automatic* for the simple reason that as soon as the liquid has evaporated below the level of the two lead wires, the current is turned off automatically, and no more fumes are generated. It is therefore entirely safe to leave this device run once it is started. It will stop at once as soon *as enough liquid has evaporated.*

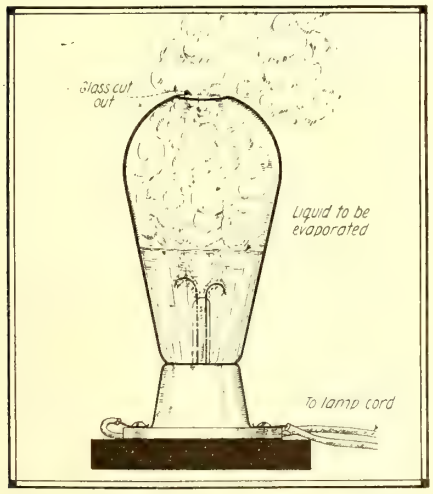


Fig. 5. Whoever Heard of Curing a Cold or Croup, or Disinfecting the House, With a Burnt-out Bulb? No, You Don't Eat the Bulb —But You Vaporize the Medicated Liquid!

FORMULA No. 1.

For Colds, Coughs and Croup.

Oil of Eucalyptus..... 60 drops
Menthol ..... 60 grains
Tincture of Benzoin compound
(enough to make 2 ounces)

Of the above, use 1 teaspoonful floated upon water in vaporizer. Add a pinch of salt to make solution conductive.

FORMULA No. 2.

For Fumigating and Disinfecting.

Have druggist make a 40% solution of formaldehyde. Add a pinch of salt to make solution conductive. Use without diluting in vaporizer. This solution is excellent for killing flies and mosquitoes, and is to be operated in closed rooms without any people being in the room at the time of the fumigation.

Nearly every student wishes a cheap as well as good instrument to demonstrate

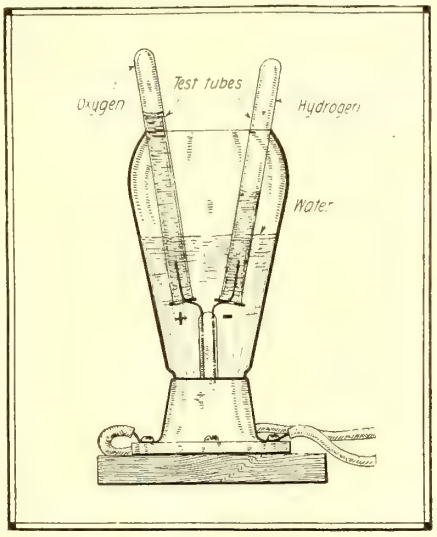


Fig. 6. This Shows How You Can Make at Practically No Cost a Very Efficient Apparatus for the Decomposition of Water—Electrolysis.

electrolysis—decomposition of water. These instruments are more or less expensive in the market, and as a rule a student does not wish to bother by buying one of them, as they sell in the neighborhood of three to five dollars each. In Fig. 6 the writer has shown how one of these instruments can be made for practically nothing. All we require is a burnt-out electric lamp bulb. Any size will do. Proceed as explained in the preceding article of the vaporizer, as far as cutting off the top of the bulb is concerned. Leave the two lead wires exposed as shown. Fill the bulb with diluted sulfuric acid, five parts of water to one part of sulfuric acid. Over each one of the wires place a narrow diameter test tube, which test tube must be full of electrolyte, which can be done readily by filling them first, and while holding a finger over the open part insert in the bulb filled with the diluted acid. This will keep all the liquid in the test tubes, which is quite necessary. Both test tubes of course should be full. Now that everything is ready, connect the apparatus to a source of current, such as a six-volt storage battery or six good dry cells. It is understood that the bulb thus prepared is screwed in a porcelain receptacle as shown. As soon as the current is turned on you will see gas bubbles arise in each one of the test tubes, and you will observe that the gas accumulates twice as fast in one tube as in the other. The first tube, which contains the most gas, will con-

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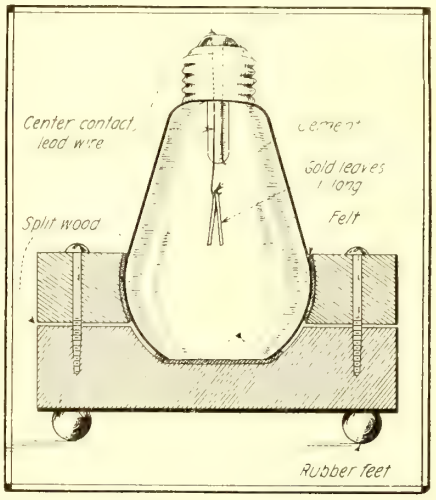


Fig. 7. A Student's Electroscope from an Old Burnt-out Lamp Bulb? Why Not? Very Simple if You Know How.

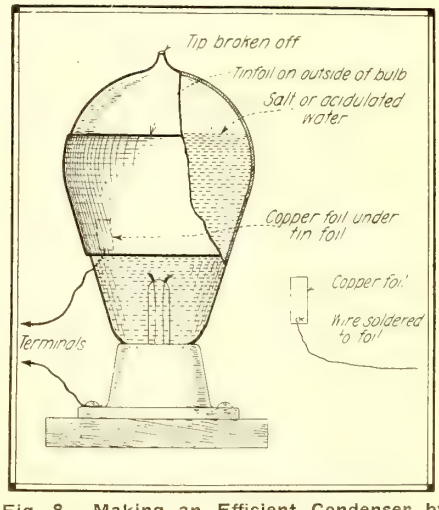


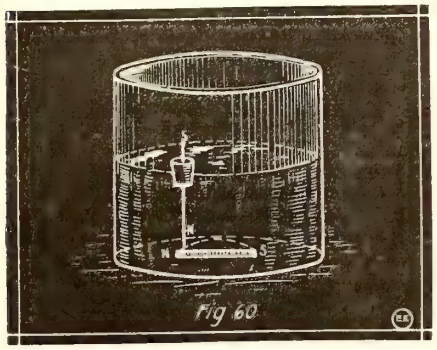
Fig. 8. Making an Efficient Condenser by Means of an Old Lamp Bulb is Quite a Simple Matter.

EXPERIMENTAL PHYSICS

By John J. Furia, A. B., M. A. (Columbia University)

LESSON 12.
Magnetism.

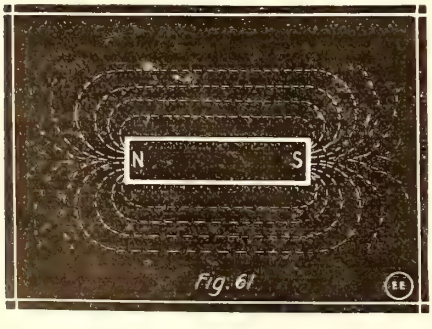
A CERTAIN kind of iron ore has the power of attracting iron (and cobalt and nickel somewhat). When a piece of it is suspended so as to swing freely it will come to rest in a north-south direction. This



An Interesting Experiment With a "Floating Magnet"—A Magnetized Sewing Needle Thrust Thru a Cork. "Like" Poles Repel, Hence the Needle Will Float Over to the "S" End of the Bar Magnet.

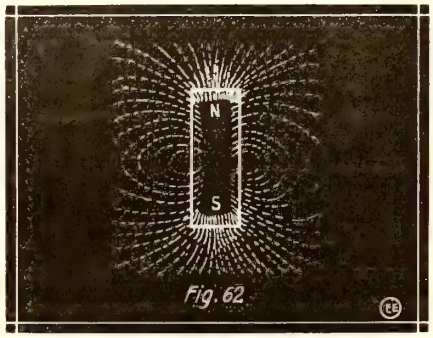
ore, called *lodestone, iron oxid* or *magnetite,* from Magnesia (not citrat, but a town in Asia Minor, where it was first discovered), is also known as the *natural magnet* to distinguish it from the *artificial magnet.* If an ordinary steel needle is brought near some iron filings it will not have any attraction for them; and if it be suspended freely it will not, in general, assume a north-south direction. If, however, this needle is gently stroked over a natural magnet (a bar or horshoe magnet will do) from the middle toward the point, it will now attract iron filings and assume a north-south position when suspended so as to swing freely; i. e., it has become an *artificial magnet.* If, instead of a steel needle, a piece of soft iron is used we find that it does not become a permanet magnet, but if the bar or horseshoe magnet is held over it or in contact with it the soft iron does become a magnet (temporarily, while the magnet is held near). Hence pieces of soft iron can be made to act as *temporary magnets,* while pieces of hard steel retain their magnetism to a great degree and can hence be made into *permanent magnets.*

It has been agreed to call the end of a magnet which, when swinging freely, points to the north the + or *north-seeking* pole, or more simply the *north* pole of the magnet, and the other end the — or *south-seeking,* or *south* pole. The ordinary compass is a small light bar magnet (needle) balanced upon a sharp pivot



Representation of a Few of the "Lines of Force" Existing About a Steel Bar Magnet.

EXPERIMENT 66—Magnetize a needle by stroking it a few times with a bar or horseshoe magnet. Bring the needle up to a small compass. One end of the compass will be attracted to the needle. Turn the needle around and bring it up to the compass again. Now the other end of the compass is attracted. By suspending our magnetized needle, we can determine which end is + or north and which is — or south. We find that the + end of the needle attracts the — end of the compass, and vice versa; i. e., *unlike poles attract.* If now we bring the + end of the needle near the north pole of the compass or the — end of the needle near the south pole of the compass, we find that they *repel* each other, i. e., *like poles repel.*



Fully Developed Magnetic Field of Force Around a Bar Magnet. The Greatest Strength of Field is Manifested at the Ends of the Bar, Where the Flux is Most Dense.

EXPERIMENT 67—Place a compass so that its needle points to its north (N) point and then place the + end of a bar magnet one inch from the "W" point of the compass and note the deflection of the compass needle. Now move the bar magnet so that the + pole is two inches away. The deflection is found to be only *one-fourth* as much as before. If we move the bar

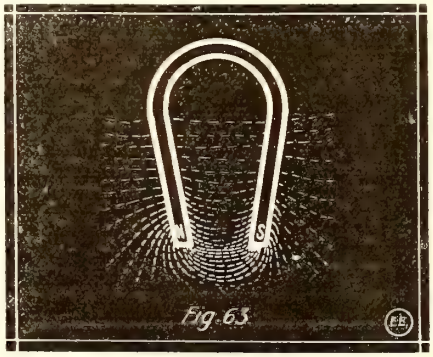
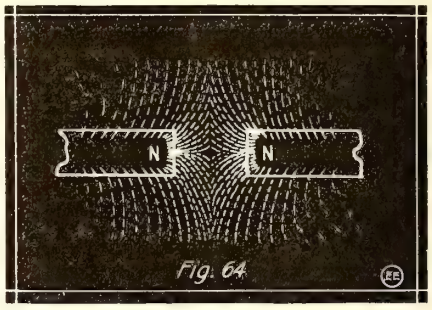


Chart of the "Lines of Force" About the Poles (and Between Them Also) of a Horse-Shoe Magnet. The Leakage Flux Between the Legs of the Magnet is Clearly Shown.

magnet to three inches from the compass "W" point, we find the deflection of the compass needle *one-ninth* as much as the first reading. If, while at any one of these positions, we add another magnet (same pole) the deflection is doubled, and if two are added the deflection is tripled, etc. This illustrates the *law of attraction (or repulsion),* i. e., *the force varies directly with the strength of the magnets and inversely as the square of the distance between them.* (In this experiment we increased the strength by adding more magnets.)

EXPERIMENT 68—Magnetize a long, thin needle and stick it thru a cork. Place the cork in a wide jar (or fish globe) filled with water. Place the jar over a bar mag-

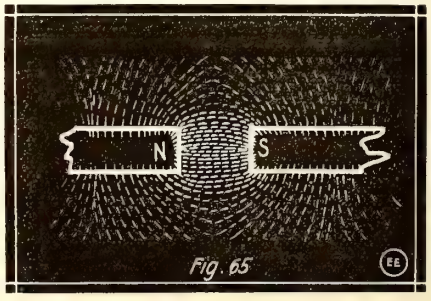


Showing the Field of Magnetic Force Resulting from Approaching Two "Like" (N) Poles Together. One Pole Neutralizes the Flux of the Other Pole and "Repulsion" Results.

net (see Fig. 60). When the N pole of the needle is placed over the N pole of the magnet it will be found to travel over to the S pole in a curved path. On starting the cork from different positions it will repeat as above, following different paths. The path which a free N pole travels over, when placed over the N pole of a magnet, is called a *line of force.* Obviously there are an infinite number of such lines, and these as a whole are called *fields of force.* From what we have said so far it is apparent that a free N pole cannot exist, but recalling that force of attraction (or repulsion) varies inversely with the square of the distance, we see that the long needle acts as a free pole (its other pole being so much further away from the bar magnet). Fig. 61 shows several *lines* in a *field of force.* A good way to obtain a field of force is to place a magnet under a sheet of paper and sprinkling iron filings over it. The filings arrange themselves along the lines of force. A permanent record of a field of force can be obtained by using photographic paper (working in a darkroom), sprinkling the filings, tapping the paper, lighting a match about a foot above the paper and then developing as one would a photographic print. (See Figs. 62, 63, 64, 65 for some typical fields of force.)

EXPERIMENT 69—Suspend an unmagnetized needle by a thread so that it hangs horizontally. Now magnetize it. It will be

(*Continued on page* 876)



The Couplet of Magnetic Power — When Two "Unlike" Poles (N and S) Are Brought Together, "Attraction" Results. The Two Magnets Are Drawn Toward Each Other. Compare With Fig. 64.

Editor's Mail Bag

Under this heading are publisht communications from our readers of general interest to all concerned. In order that letters shall receive proper attention, we earnestly request you to make them as short and concise as possible. This is essential and on account of the great amount of mail received daily.

No attention can be paid to unsigned communications, but on request we will withhold the correspondent's name.

A CURIOUS EXPERIMENT.

Editor Electrical Experimenter:

I read the "E.E." and like it. I believe the more one knows about the "game", the better he likes it.

Here is a little experiment or rather an experience, that may occasion a smile, but laugh as you please, it *is* a fact.

I was moping around the house, after an illness of several weeks. My attention was attracted by the beautiful colors of the spectrum which were playing on the white kitchen wall. I soon discerned the cause. An August sun was streaming thru a window and the rays impinged on a bevel edged mirror that had once ornamented the top of a ladies' work box. At last tired of the color effects I took the glass and went to the rear porch and amused myself with the old boyhood trick of "shooting" distant objects, with the sunlight "gun." Now, it so happened, that a neighbor's tow-headed urchin was in the back end of their lot "shooting" chickens with the spotlight from an 8" x 10" glass. It suddenly occurred to this boy to "shoot" me, and if there is anything in the transference of thought, I aimed at him. My flash struck his glass, his head glowing like an arc lamp. His ray struck my mirror, and it flew from my hand as I received a shock which I can only liken to the effect of the discharge of a Leyden jar, which once I took thru my body and occasioned my classmates a hearty laugh. That was many years ago, when they made electricity with a glass wheel, turned with a crank and by a *crank* and nothing was known of the art as we know it today.

To return to the battery of glasses. The boy received no shock. His mirror was incased in a wood frame. There was no frame on the glass I held and my fingers were in contact with the metal foil on the back. I stood on a wooden porch six feet above the ground and he stood on the ground, we were distant about 100 feet.

This theory has, so far, satisfied my mind, and I have given it some thought: The effect was due to an electric charge, generated by the rays of light traveling in opposite directions. The boy's focused rays impinged upon mine. Friction and velocity of the rays of matter (and sunlight is matter) produced the electricity which tried to convert my body into a condenser of considerable capacity.

In my general practice I have found that heat is a conductor.

While this letter may be of little interest or importance, it may encourage some experimenter to solve the problem of generating current from sunlight.

FULTON GARDNER.

Chicago, Ill.

[*A very interesting phenomenon. We tried to duplicate the experiment but with negative results. Perhaps some of our readers may have better luck. In that case we hope to hear from them. Mr. Gardner's theory is plausible enough to explain the phenomenon, which, we admit, was new to us.—Editor.*]

A COLLEGE STUDENT'S RECOMMENDATION.

Editor Electrical Experimenter:

Several years ago, while attending High School, I purchased two copies of your magazine. Ever since then I have bought every issue of your invaluable publication and have read and actually studied them. I always keep them handy for reference, and have almost every issue, from that of June, 1915, to the present issue. The few that I lack, I loaned to several friends upon request, and evidently they liked them so much, they forgot to return them.

I have found your magazine invaluable to me in my studies, clearing many problems, both in physics, chemistry, and the many courses in wood and metal working during the four years which I attended Stuyvesant High School. I may add, that I consider the ELECTRICAL EXPERIMENTER very instrumental in securing for me *a rating of* 100% *in a Regents' Physics Examination.*

The principal thing that I like about your magazine is its clearness. In fact, I firmly believe that it ought to be used as outside reading matter in conjunction with the regular text-books in technical schools. It is all very well to study the standard textbooks of science, but still, one must keep abreast of the times, and to all such, I earnestly recommend your publication.

The only criticism I have to make (I admit that adverse criticisms are hard to find) is that Mr. Gernsback indulges in too much fantastical theories. The readers would very much appreciate other opinions of leading men in science. The only other fault I have to find, is that when I buy a copy of the magazine, I cannot stop until I have finished it, and then I am sorry that there is not more, which leaves me for another month with plenty of food for thought.

By the way, I forgot to tell you how I was prompted to write this letter. In the current issue (January, 1918), I read with keen satisfaction an explanation of a trench-telegraph system operated upon the induction plan. I am at present a student in the College of the City of New York. At the College, there are usually several companies of Signal Corps officers stationed there, who use the College Radio Station for instruction purposes. One day, I watched with keen interest several of the officers operate a mysterious instrument in the field. To this instrument were attached two wires, running along the ground for a short distance. Several hundred feet away was a duplicate of this apparatus, with the wires stretched parallel to the first. Both men wore wireless receivers attached to headbands. As the men were deeply engrost in their work, I refrained from asking questions.

Since then I have tried to satisfy my curiosity concerning the instruments they used, and received a grateful surprise when I read your exceptionally clear explanation in the current issue of the ELECTRICAL EXPERIMENTER.

But there is one thing lacking. Try as hard as I can, there are a great many things in science that I cannot obtain a satisfactory explanation for, such as the induction motor, induction furnace, Audion bulbs, etc. If I obtain an explanation, it is so surrounded with high sounding technical terms that I obtain a very faint, hazy idea of "how the thing works." I would suggest that you start such a department in your publication, using as little technical language as possible. One more thing before I forget, why not introduce more stories, anecdotes, jokes, etc., based on "scientific plots?" I am sure that your magazine will become more interesting and popular.

I hope that the ELECTRICAL EXPERIMENTER will continue in its good and useful work.

J. H. GANCOVITZ.

New York City.

[*We like letters of this sort, they are the sort that make for a better magazine. We will shortly have articles on the induction motor, as well as induction furnace. As for the Audion we publisht several exceptional articles as for instance in our August,* 1916, *as well as in our May,* 1917, *issues.—Editor.*]

MR. RUSK'S ARTICLES.

Editor Electrical Experimenter:

You have asked so often for the ideas of your readers concerning the contents of your magazine that I feel obligated to write you.

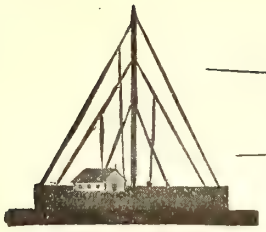
To begin, I wish to congratulate you on your loyalty to the cause of "Semi-Technical Electricity." Other publishers have drifted toward the so-called popular side of science. That field, I suppose, *does* interest more people than the "Semi-Technical," but I am sure you will find at all times an enthusiastic support from those who regard Electricity with more of the serious interest than of mere curiosity, if you continue in your present course.

There is next to nothing I can say in criticism of what you now publish. I can only offer a few suggestions as to what you might give us from time to time in the future. These must necessarily be somewhat specific, for, as I have just said, your general course is above criticism.

I like to read the ideas of America's greatest scientists and engineers who live in the *present* and the *future;* articles written by them personally, unalloyed by the views taken by some presumptious editor or reporter, who knows pretty nearly nothing about the subject. I am very fond of the articles which give the imagination exercise; which transcend what is commonplace; which are likely to form the stimulus for more deep and concentrated thought on the part of us "Bugs." Who knows but one or several of us may step later into the rôle of those men who wrote the articles for our benefit and whom we will succeed in their great work? Continue the picture supplements, please, as long as there are any celebrities to take pictures of. I am anxious to see another series of articles on "Modern Physics," now that Mr. Rusk's has been concluded. Personally, I should be interested greatly in much closer details than he has given us as well as facts and laws of the quantitative side of such subjects as photo-electricity, wave motions, radioactivity, electronic phenomena, etc. In a copy of *Motor Age,* I read an article, a sentence or two of which was devoted to a new form of gas battery, in practical use, so it seems, on German motor trucks employing platinum powder as a catalyzing agent and hydrogen and oxygen as its active elements. Can you publish further details about it? RAYMOND C. FISHER.

Tacoma, Wash.

[*We are pleased to state that with this issue Mr. Rusk is back once more. We had many similar requests to the one above. Sorry, but we could find out nothing about the alleged new German gas battery. Many new German devices must necessarily remain unknown till after the war.—Editor.*]



RADIO DEPARTMENT



Notice to All Radio Readers

As most of our radio readers are undoubtedly aware, the U. S. Government has decided that all Amateur Wireless Stations, whether licensed or unlicensed, or equipt for receiving or transmitting, shall be closed.

This is a very important consideration, especially to those who are readers of THE ELECTRICAL EXPERIMENTER, *for the reason that we desire to continue to publish valuable articles on the wireless art from time to time, and which may treat on both transmitting and receiving apparatus. In the first place, there are a great many students among our readers who will demand and expect a continuation of the usual class of Radio subjects, which we have publisht in the past four years, and secondly, there will be hundreds and even thousands of new radio pupils in the various naval and civilian schools thruout the country, who will be benefited by up-to-date wireless articles treating on both the transmitting as well as receiving equipment. Remember that you must not connect up radio apparatus to any form of antenna.—The Editors.*

Intensive Training for the Signal Corps

By A. C. LIETZ

THE men selected for commissions in the signal corps must, in the first place, possess some special qualification and be experts in some particular line such as telegraph, telephone, aeroplane, gas engine, balloons, radio telegraphy, photography, or be graduates in some allied technical branch. It remains, therefore, to give them a working knowledge of those branches with which they are not already familiar and to teach them those things not generally taught in the schools, namely: military maneuvers, visual signaling, military customs and regulations, court-martial procedure and the application of their technical knowledge to the science of warfare.

Before the entrance of this country into the war there were but two ways to secure a commission in the corps. One of these was by enlisting in the corps and passing an examination for a first lieutenancy. This was next to impossible as will be seen later, altho it has been done. The usual way was to take a special course at the Fort Leavenworth School after having been commissioned as second lieutenant in the line, that is, infantry, cavalry or artillery. This took about five years, including the four years at West Point. From this it will be seen that it is necessary to crowd five years' hard work into approximately three months, utilizing seventeen hours out of twenty-four.

First and foremost it is necessary to give the newly commissioned reserve officer a soldierly bearing. To this end he is given physical exercises to develop the muscles of his body uniformly, remove any superfluous flesh and increase his lung capacity. This is supplemented by infantry drill. He is taught not only to execute the movements properly himself but is given frequent opportunities to command units of various sizes, these being composed of officers undergoing the same course and who may then be termed the awkward squad and he must consider them as such. He must consider that he is in regular command of that unit and that it is composed entirely of raw recruits, explaining each movement before giving the command of execution, all under the watchful eye of the instructor. In this way he puts into practise what he has learned from studying the drill manual.

Several hours each day are devoted to conferences to discuss the lessons assigned and studied the night before. This covers "the soldier's bible," Army Regulations, also Signal Corps Drill Regulations, Field Service Regulations, and Manual of Court Martial. A part of the period assigned is devoted to a discussion and explanation of the subject and a part to answering questions of the student officers. These discussions form a very important part of the course, as they bring up many things not written in books. The naval and military service has a code of unwritten laws known as "customs and usages of the service." Some of these customs are as old as military history itself, and, are as interesting. They cover the personal conduct of the officer and his social conduct towards his fellow officers and towards the enlisted men. The students are taught what the older and experienced officers have learned from a study of the enlisted man.



Signal Corps Reserve Officers in Training, Listening to "Arlington" on an Experimental Radio Receiving Set, "Somewhere in the United States."

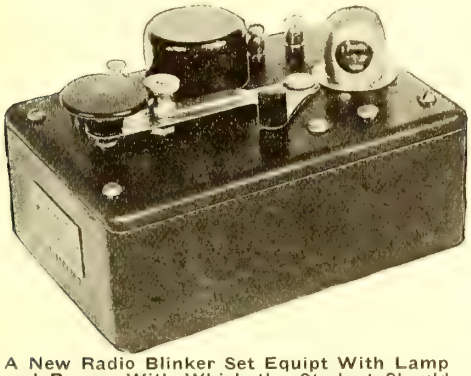
In order that he may secure the most efficient service from his men and equipment he must learn the operation, care and maintenance of the various instruments and means used for communication and also their limitations. It is not necessary that he be an expert in the use of all of them, but he should learn enough to be able to use them in emergencies and to be able to intelligently supervise the instruction of the men of his command by such of their number as may be expert. He should be able to use the semaphore and wig-wag flags, heliograph, acetylene lantern, telegraph wire.

(*Continued on page* 861)

A RADIO BLINKER SET FOR TEACHING CODE.

The cut herewith shows a new radio blinker signal set for teaching the code. This is self-contained in a cabinet, with sending key and a very sensitive, high pitched, high frequency buzzer.

The equipment comprises a buzzer and a lamp which may be operated separately by means of self-contained battery or outside current supply, in connection with two-



A New Radio Blinker Set Equipt With Lamp and Buzzer With Which the Student Should Learn the Code Quickly.

way switch and sending key. It is one of the most compact and most efficient devices available for purposes of practise and instruction by students in learning audible or visual signal codes.

It has not only been adopted by the Navy Department but is used in many branches of the Government service and by the best technical and radio schools for instructing aviators for both army and navy. It weighs about 1 lb. 6 oz. complete.

A HANDY RADIO CRYSTAL SET.

No more hunting around for that piece of crystal when the signals are not coming in strongly, no more soiled and broken crystals lying around in drawer's corner.

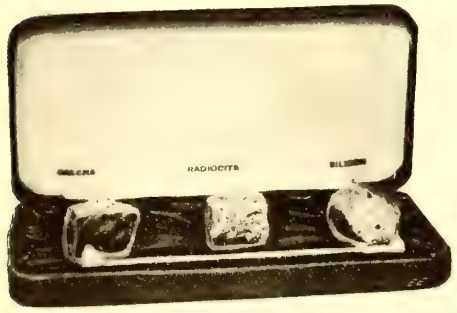
This new radio "De Luxe" crystal set not only obviates this, but the high class minerals furnished with the outfit will prove a boon for every operator.

The outfit consists of a water- and dust-proof, air-tight box of special construction, as shown in illustration herewith. The box can be carried easily in the pocket on account of its flat and neat shape.

It contains: One piece of Radiocite; one piece of Galena; one piece of Silicon, all tested.

Besides there is included one 18 Karat Gold Catwhisker and two phosphor bronze catwhiskers of different shapes.

The minerals should be handled only with pincers, never with bare fingers. The makers recommend strongly the use of the



At Last A Vest Pocket Radio Mineral Set. Contains Tested Rediocite, Galena and Silicon Crystals, Also Gold and Phosphor Bronze "Cat-Whiskers."

Gold Catwhisker with the Radiocite crystal. It is especially invaluable on board ships, as the gold cannot rust and no oxidation can set in between the catwhisker and the mineral.

CORRECTION!!

Editor of THE ELECTRICAL EXPERIMENTER:

Dear Sir:—Will you kindly publish this statement that the "graphic sign" (aA, Bbbb, etc.) referred to in leading up to my remarks on code-learning, in a recent issue of the EXPERIMENTER, *as one of the systems already in use, was invented and copyrighted, as I am advised, by Mr. F. S. Winger, of the Winger Electric & Mfg. Co., Chicago, Ill.*

Had I known who the inventor of the system was, I should have been only too glad to give him credit for it in my article, as I consider it by far the best method now in use for representing the characters of the telegraphic code.

THOMAS REED.

NEW WIRELESS COURSE IS STARTED AT CORNELL.

A special course in wireless work, designed to prepare men for service in the signal corps of the U. S. Army, has been instituted in the electrical engineering department at Cornell this term. The course is being given at the request of the government in order to fill some of the urgent needs of this arm of the service. It is offered to second term seniors only of whom about 17 have registered to date. Only students here will be enrolled so far as present plans go. The government has sent some special apparatus for the work which will be in charge of the regular staff of the department.

RADIO WRITERS — ATTENTION ! ! !

Can you write radio articles dealing with the practical problems of wireless operating? We can use some good papers on such subjects as "the tuning of radio transmitters"; "the use of the wave meter, including its application to measuring the frequency, wave length and decrement"; "operation of commercial transmitting and receiving sets"; "the operation of army truck sets"; "improved ways of receiving undamped wave signals," also new ideas and short-cuts for learning the codes. We pay well for all articles accepted. Help yourself, your magazine and your country.

RADIO COURSE OPENED AT SYRACUSE UNIVERSITY.

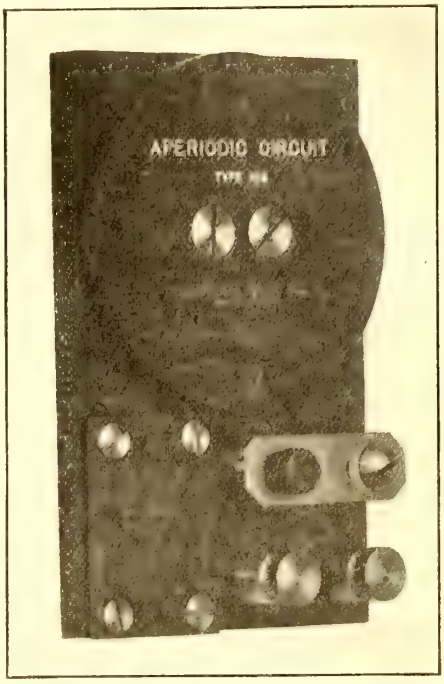
Announcement was made recently that Syracuse University, Syracuse, N. Y., has opened its first Government course of instruction to fit graduates from the College of Applied Science for radio service in the Signal Corps.

The teaching of this course of instruction will be conducted with the greatest of secrecy, Dean William P. Graham announces. Every student entering for the course, is required to take an oath that he will not reveal any of the instructions given him.

NEW PHANTOM ANTENNA AND APERIODIC CIRCUIT.

When radio engineers wish to test out a radio transmitting set, it is not always permissible or advisable to connect it up to a regular aerial. Hence this has resulted in the development of a localized antenna; i. e., a form of *lumped* capacity and inductance of the correct oscillating proportions, and so designed as to permit of passing thru or into it the same amount of energy in watts as would be sent into the actual antenna under working conditions. It's the same as hooking up a water-rheostat to a dynamo under a load test.

This phantom antenna comprises a mica condenser of .0004 M.F., capacity connected in series with a resistance of 4 ohms. It approximately duplicates the average *trailing wire* aeroplane antenna, and has a carrying capacity of 1.5 amperes, as indicated by a hot-wire ammeter. It will stand nor-



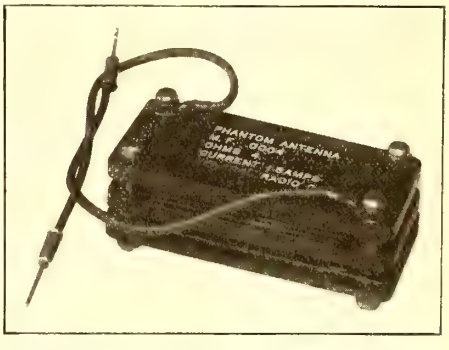
A New Radio Measuring Instrument. The "Aperiodic Circuit" Can be Used to Great Advantage in Determining the Point of Resonance in Damped Oscillating Systems.

mally a breakdown potential of 7,000 to 8,000 volts, and is very useful for tuning and testing aeroplane or other radio transmitters on the ground.

Aperiodic Circuit:

This instrument comprises a small inductance and large capacity in series with a crystal detector, with binding posts provided for connecting a set of head telephones. It is extremely useful as a tone tester for observing the quality of tone of a transmitter, but its greatest utility is found in its use in determining the point of resonance in oscillating circuits which are being excited by a damped wave.

For example: In measuring the natural period of an antenna the aperiodic circuit may be coupled loosely to the grounded antenna, a buzzer-excited wave-meter being also coupled to the antenna at a point slightly removed from the aperiodic circuit. When the wave-meter is then varied a loud response will be heard in the aperi-



A "Phantom Antenna" Useful in Testing Aeroplane Radio Transmitters Without "Flying" the Apparatus. It Saves Much Time in Any Such Testing.

odic circuit when the wave-meter is in resonance with the natural period of the antenna. This is by far the quickest way to get the natural period of an antenna.

An Oil Antenna Switch for High Powers

By M. M. Valentine, Engineer

The drawing herewith, together with the following description, will enable the reader to construct an oil switch from any S.P.S.T., S.P.D.T., D.P.S.T., or D.P.D.T. switch; for that reason no dimensions are given for the construction of this switch, altho the one from which the drawings are made was an E. I. Co. D.P.D.T. switch. This oil switch will carry a much heavier load than heretofore and it is much easier and quicker to manipulate. The last reason makes it extremely valuable for wireless stations when changing instruments from sending to receiving or vice versa.

The box "B" in Fig. 1 is made from wood, the joints of which should be made as tight fitting as possible. It is more than likely that it will leak at first but the oil will soon swell the joints and prevent this.

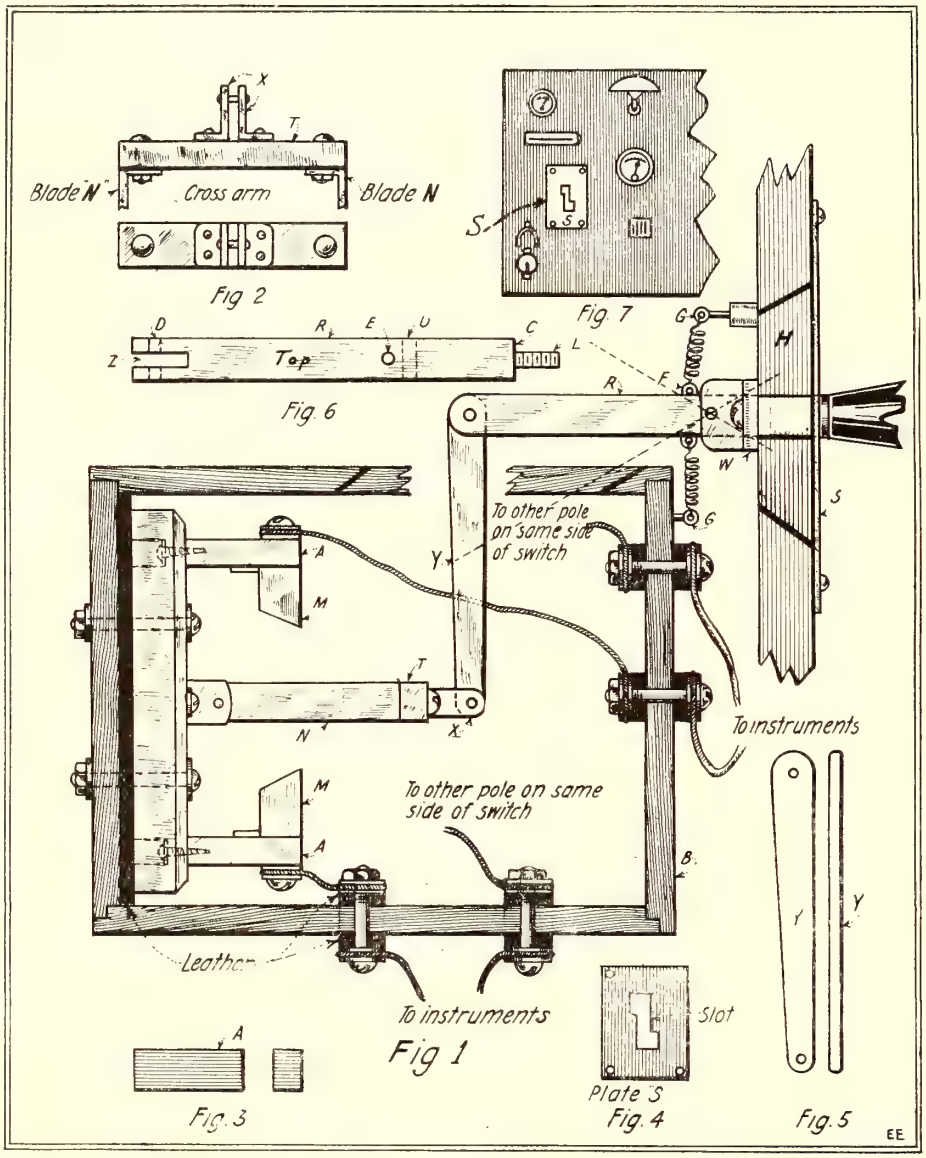
Referring to the diagram, it will be noticed that the jaw posts "M" (previously attached on the base) are set on uprights "A" which are made of wood, shaped as in Fig. 3. They are screwed to the base in positions from where the jaw posts "M" were removed. "Y" is made from sheet brass or iron and constructed as in Fig. 5. It is fastened to the cross-bar "T," by means of hinge posts "X" which are also of brass and constructed as shown in Fig. 2, leaving about one-eighth inch play between uprights.

The lever arm (R) is made from brass or iron, patterned as in Fig. 6. The slot "Z" is cut to admit "Y" as shown in Fig. 1. The hole "U" is drilled about ⅔ the length of the arm from the hole "D." At "C" a thread is tapt to admit threaded rod "L," which is ⅛ or 3/32 inches in diameter, depending upon the type of handle used. The hole "E" is drilled and small screw-eyes soldered in as in Fig. 1. "R" is fastened to switch-board "H" by means of the hinge posts "W" which are constructed the same as hinge posts "X," Fig. 2. About ⅛ inch side play is left, the reason for this will soon be shown.

The binding posts are fastened to box as shown in Fig. 1. The black-shaded portions being oil-soaked leather washers. The switch base also has a piece of oil-soaked leather, which is one-half inch longer and one-half inch wider than the base. The two bolts used for fastening base to box are also provided with leather washers.

The plate "S" as shown in Fig. 4 is made from sheet brass and is cut as shown. The notches in the slot are used to hold the lever arm "R" in down or up position, which in turn throws switch blades from one side of switch to other side or vice versa. This is the reason for the play left in hinge posts "X" and "W" as previously mentioned.

The switch is now ready for assembling. The parts are put together, connections made and box filled with transformer oil about one-half inch above top jaw posts. The cover is then fastened on by means of a set of hinges. Two springs of equal tension are fastened to screw eyes "F" and "G." These springs hold the switch in neutral position when not caught by slots in switch plate "S," on front of switch-board. The entire switch is mounted on brackets which are fastened to back of switch board.



The Illustration Shows a Well Designed Antenna Transfer Switch of the Oil Immersed Type. It Is Suitable for Panel or Other Style Radio Transmitting Sets and Possesses Several Desirable Features, Including Small Space Occupied, High Insulating Value and Small Corona Loss.

ETHERIC MEMORIES.

-.-./- -.-/-.-/.-/ Those were the days, you bet, four nice, stiff, resisting galvanized iron wires towering twenty full feet above the old back shed, the roof porous with leaks and twenty-four slates missing, of course used for insulators and all the fences in the neighborhood shy of wire.

Yes, don't you remember of calling all the neighborhood in to hear the local 50 KW station in full blast, and just as you are about to push out your chest the blamed outfit refused to work, of course you loomed up as the largest fake in the country right there and then. Yes, and all Grandma's needles disappearing and the front door bell refused to work because you took out the carbons for that supersensitive carbon detector. And wasn't it remarkable when one thinks about it, that every time you struck the table you could hear all kinds of signals and only wished that you knew the code for it must have been China, Germany, or Japan, it could have been old Teddy Roosevelt down in the jungles cornered by wild tigers calling for help. S.O.S. Same old stuff—and then, it could have been old Johnny Barleycorn calling C.Q.D.—Can't quit drinking, S.O.S. Same old souse.

Well, I struck the idea of connecting my sounder in series with the carbon detector and batteries, the result was really astonishing, honestly, it sounded like a real telegraph office in full blast, it worked scrumptuously. Yes, Sir, after months of nerve racking and a thoro course in swearing, don't you remember how easily you acquired the habit, why I could easily swear 2,000 times without repeating the same word, and that in a very few months, some of the words were really radio like, and I am sure they could only be interpreted by another oscillating fool.

Next on the market came Silicon, Ah! that silvery mineral, which I tried to melt for key contacts, the procedure was something like this: After burning about fourteen sacks of charcoal and melting the bottom out of five or six pots I gave it up as a hopeless case, but my troubles did not stop there, I had greatly depreciated the value of the kitchen outfit, in fact Mother had to cook in an old cracker box until Dad could get to town, not to mention the number of barrel staves he broke, using the place where I sit down for that purpose, before he left.

Then came the news of the famous loose coupler; even tho I did not succeed in making a good one I can inform you that my decrement was very low when I did

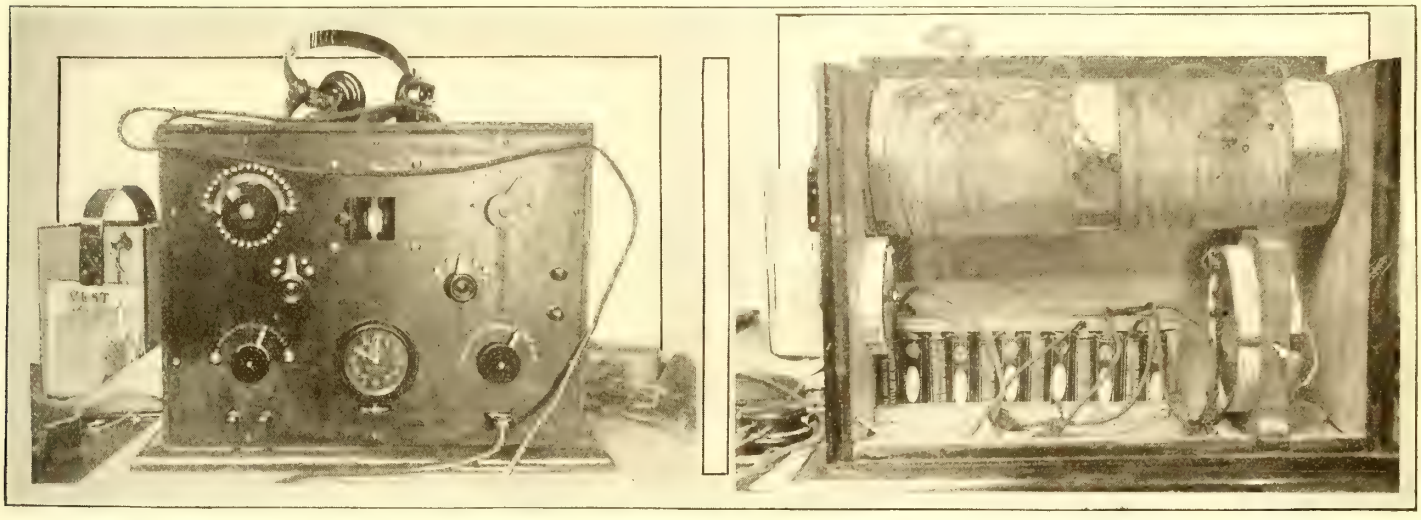
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A Motor-Boat Radio Receptor

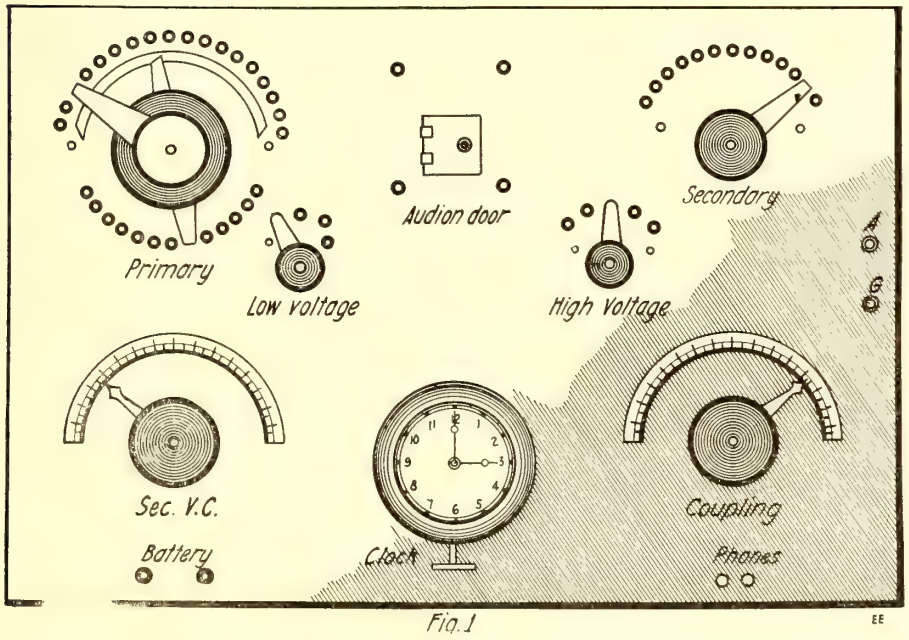
By F. MacMurphy

I HAVE here attempted to present a design of a Radio Receptor for motor-boat and yacht service. Ih ave aimed to produce a novel type of receiver, paying special attention to both mechanical and electrical efficiency.

The panel design is shown in Fig. 1.



Front and Rear Views of Compact, Well Designed Radio Receiving Se t for Motor-boat, Scout and Sub-Chaser Service. Adaptable for Use With Damped and Undamped Signals.



General Layout of Radio Receiving Panel Set. Tubular Audion is Enclosed in Cabinet and Covered by a Small Door as Shown. A Special Coupling Transformer is Employed.

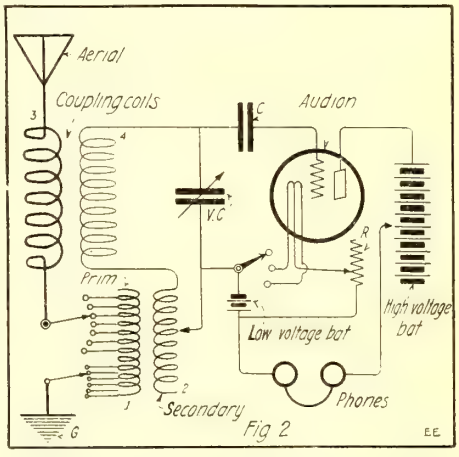
This panel, which is of Bakelite, is 15½ inches long by 11½ inches wide, with a thickness of 3/16 inch. Special attention is directed to the arrangement of the different adjustments on the panel. Beginning at the top we find the primary knob at the left, while the inductance control knob of the secondary is found at the right. At the center of the panel we have the Audion switch on the left, with the high voltage battery switch at the right. At the bottom of the panel we find the secondary condenser knob on the left and the coupling ment. The upper binding post A, at the right of the panel, is to be connected to the antenna, while the lower post, G, connects with the ground lead.

The coils Nos. 1 and 2, as given in the wiring diagram of Fig. 2, are constant in coupling, the coupling variation being given thru the coils Nos. 3 and 4. The former are mounted as shown in the cut. This cut also gives the arrangement of the other coils as well as the high voltage batteries. Every part of the set is made as rigid as possible.

The battery rheostat is adjusted by means of a handle at the left side of the cabinet. tion with the panel. The two binding posts at the bottom of the panel connect with the battery used to light the Audion filaradium paint. Details for the coil windings and condensers will be found in another article by the author which appeared in the February, 1918, issue of this journal page 686, under the title "Detail Construction of a Damped and Undamped Wave Receptor."

The various difficulties encountered in the proper installation and adaption to motor-boat and yacht "radio" have been overcome in this receptor.

Where space is at a premium and short compact aerials a necessity, the equipment must be of the best to give really good service. Not only as a convenience, but capable of rendering its true value in case of dire necessity, and thus it is that a well built radio set is really appreciated.



Hook-up for Radio Receiving Set for Motor-boat Service, Showing Tuning Transformer, Also "Coupling" Coils, Audion, et cetera.

RADIO REACHES U. S. FROM NORWAY.

A new wireless station just erected at Stavanger, Norway, has succeeded in communicating easily with American stations during trial. Regular transatlantic service between Norway and the United States will be started soon.

The Design and Use of the Wave-Meter

PART 2

By Morton W. Sterns

IN the last installment we discust the underlying principles of wave-meter design and how the various ratios of inductance to capacity are determined. This paper will deal more generally with inductances and capacities, and it is well to note that the same principles underlying receiver design also concern wave-meter design, and that, moreover, the sharp tuning values of inductance and capacity used in wave-meter design are more than welcome in radio receiver work.

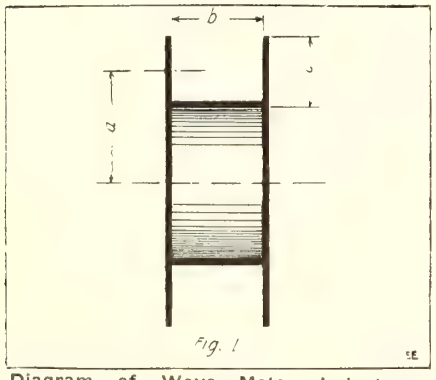


Diagram of Wave-Meter Inductance Form, Showing the Geometrical Dimensions Used in Computing the Inductance Value in Electrical Units.

To return to our particular design, we will calculate the size and number of turns per coil by means of Perry's formula, which is very easy to handle, and has been checked in any number of cases to be relied on to give values within 1 per cent. to 2 per cent., and in extreme cases to within 5 per cent. This formula is only of use in calculating the inductance of pancake coils and transmitter spirals and becomes inaccurate when b/c becomes large with respect to a L cms. =

$$\frac{4\pi\ n^2 a^2}{0.23a + 0.44b + 0.39c} \quad \text{or} \quad \frac{31.9 n^2 a^2}{0.23a + 0.44b + 0.39c} \quad (4)$$

Where:

L = inductance in centimeters.
n = number of turns.
a = mean radius.
b = axial length of coil (not wire).
c = radial depth.

If all dimensions are in centimeters the first formula is used, Fig. 1; but if all dimensions are in inches the factor 31.9 is introduced to care for the change in unit.

By experiment it has been found that the most efficient coils, viz., the ones having the least losses, have a mean diameter of six inches. And since we have selected as our conductor 3x16xNo. 38 *"Litzendraht"* (stranded insulated cable) which has an outside diameter of 0.052-inch, occupying approximately the same space as No. 16 B. & S. solid wire, we have enough data to calculate our coils.

We will start with the largest coil and make all our coil forms of the same size.

Coil 4 will have 1,310,000 cms., and assuming "a" as 3 inches, "c" as 1 inch and "b" as .2 we have:

Substituting in equation (4)

$$1{,}310{,}000 = \frac{31.9(n)^2\ (3)^2}{.23(3) + .44(.2) + .39(1)}$$

$$31.9 \times 9\ n^2 = 1{,}530{,}000.$$

$$n^2 = 5450.$$

$$n = 74 \text{ turns.}$$

Now, since the winding space is 1 inch deep and there are 74 turns, they will have to lay four wide. Therefore, the width, b, must equal 4x.05-inch, or .2-inch, so our assumptions as to winding space are correct, and we need not try another combination of "b" and "c," which would have been necessary if we had been unable to accommodate the required turns in our assumed winding space.

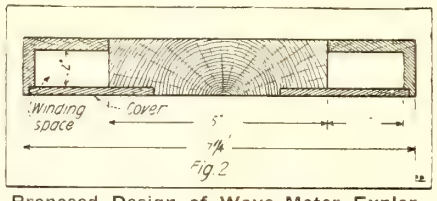
The next step is to make four forms of this size, and the other coils can be calculated as in the example and placed in the forms; as each will have fewer turns than the coil calculated.

Some form of plug should be fitted to the flexible cord of the wave-meter in order that it may fit into the sockets of any one of the four coils desired. The exact details of the design of the plug and socket connection is left to the builder's ingenuity.

The sketch (Fig. 2) shows a rather nice form of coil that will house all of our coils and will look very well if made of Bakelite.

A point to be remembered in designing wave-meter and receiver inductances is to keep the coil as narrow as possible, and if many turns are necessary to make the coil up on a form having several parallel slots, each of which is narrow.

We will now look into the various types of condensers in use. The most convenient form; the one most in use being the ordinary semi-circular plate type, familiar to all radio students. In order to make the plates remain in any position the movable plates are sometimes placed half on one side of the shaft and half on the other;



Proposed Design of Wave-Meter Exploring Coil, to Be Made of Mahogany or Other Hard Wood. The Coil Is Entirely Enclosed, as Shown.

thereby balancing the movable unit. Of course, these movable plates interleave with two sets of stationary plates set 180° off from each other. Naturally both sets of stationary plates are connected, and since both sets of movable plates are connected on the same shaft they are of one polarity. The following sketch (Fig. 3) shows roughly the above principle.

The Marconi Co. have what they call their "double" condenser, which has several advantages, namely, compactness, ruggedness and *double capacity variation per degree of scale.* This condenser, due to its connections, requires a box only one-half the depth of the ordinary type condenser box of the same capacity, and due to its rugged construction and the use of heavy castings it is extremely permanent in its calibration. A curve showing the relation of the capacity to the degrees on the scale of a condenser of this type between the limits of 10° and 170° on the scale is an extremely straight line variation.

Fig. 4 shows the Marconi "double" condenser diagramatically. Here A and B are the stationary plates, insulated from each other and forming the condenser terminals. A^1 and B^1 are the movable plates turning with shaft S, but insulated from it and each other. Plates A and A^1 are connected together and plates B and B^1 are connected together. Now, when the condenser is in the position shown with each set of movable plates interleaving its own set of stationary plates, it is evident that the capacity will be zero. However, if the shaft S is rotated 180°, so that plates A^1 interleave plates B, and plates B^1 interleave plates A, is it evident that we have maximum capacity.

In all wave-meter work where calibration must remain constant, the condenser must be made along certain lines to assure permanency. All bearings should be large and rugged and capable of taking up wear. Plates should be of large diameter and of at least 1/32-inch material to provide stiffness and fredom from temperature changes. Fairly large spacings and more plates is the preferable construction. Under no circumstances should insulating bushings be used, as they introduce hysteresis losses and also allow warping. The better construction makes use of the entire end pieces of insulation such as Bakelite.

There has lately been put on the market a new type of meter known as the *Kolster decremeter,* which incorporates several novel features, among which is the direct-reading scales for wave-length and decrement.

The meaning of *logarithmic decrement* was fully explained in the preceding article and with this in mind we will try to show how it is measured and how the Kolster Decremeter varies from other meters of its type. Let it be understood here that there are any number of wave-meters and decremeters on the market at present, and that they differ only in the respect that the Kolster Decremeter incorporates special features that allow direct reading decrement and wave-length scales to be attached. What these special features are will become evident during the course of the paper.

Bjerkness has shown that for two loosely coupled circuits the following relations exist:

$$\delta_1 + \delta_2 = \pi\ \frac{C_r - C}{C}\ \sqrt{\frac{I^2}{I_r^2 - I^2}} \quad \ldots\ldots\ldots (5)$$

Where

δ_1 = Decrement of primary circuit.
δ_2 = Decrement of secondary circuit.
C_r = capacity at resonance giving current I_r.
C = Capacity a slight degree off resonance giving a current I.

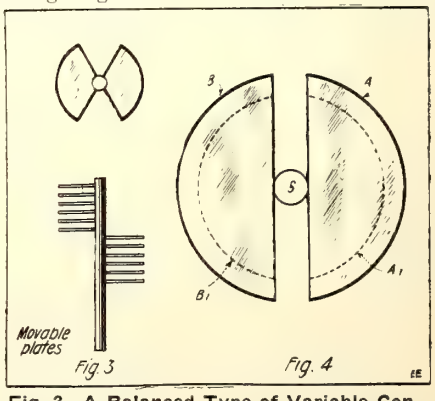


Fig. 3—A Balanced Type of Variable Condenser. Fig. 4—The Marconi "Double" Variable Condenser, in Which Two Sets of Fixt Plates and Two Sets of Rotary Plates Are Used, Resulting in Less Volume and Double Capacity Variation per Scale Degree.

The conditions under which this formula may be applied with sufficient accuracy are:

1. That $\delta_1 + \delta_2$ be small compared with 2π.
2. That $\frac{C_r - C}{C}$ be small as compared with unity.
3. That the degree of coupling between the two circuits be small.

Equation No. 5 immediately suggests a simple and generally used method of calibrating a decremeter. Suppose the primary consists of a circuit embodying some form of oscillating vacuum tube, such as the Pliotron, emmitting sinuosoidal waves of constant amplitude, or undamped waves; then it is evident that δ_1, the decrement of the primary circuit, is zero and any decrement measured is the *meter decrement.*

Let us assume that it is desired to measure the logarithmic decrement of the oscillations in the antenna circuit of a radio transmitter, as shown in Fig. 5.

A circuit containing inductance L, a calibrated condenser C and a sensitive low-resistance, hot-wire instrument H, is very loosely coupled to the antenna circuit A. Readings of the hot-wire instrument H, which are proportional to the square of the current flowing in the circuit, are taken for several values of capacity C on both sides of the resonant value C_r. Plotting these readings against capacity, a resonance curve as in Fig. 6 is obtained and from one of the following folmulæ the sum of the logarithmic decrements may be obtained:

$$(6)\quad \delta_1 + \delta_2 = \pi \frac{C_r - C_1}{C_1} \sqrt{\frac{I_1^2}{I_r^2 - I_1^2}}$$

$$(7)\quad \delta_1 + \delta_2 = \pi \frac{C_2 - C_r}{C_2} \sqrt{\frac{I_2^2}{I_r^2 - I_2^2}}$$

$$(8)\quad \delta_1 + \delta_2 = \pi \frac{C_2 - C_1}{C_2 + C_1} \sqrt{\frac{I^2}{I_r^2 - I^2}}$$

If the decrement δ_2 of the measuring circuit or decremeter has been previously found, the decrement δ_1, of the antenna circuit under test is at once obtained by subtracting the meter decrement from the measured value.

In practice it is found permissible to make the change in capacity from C_r to C_1, or from C_r to C_2, such that I^2 becomes $\frac{1}{2} I_r^2$, thus making the expression under the radical sign equal to unity.

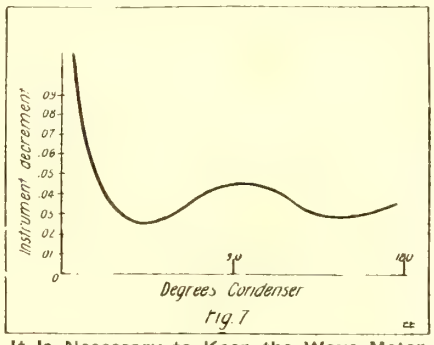
In practice a handle about 18 inches in length is fastened to the movable plates of the variable condenser so as to be able to control the fine movements more accurately, as a small movement of the condenser in degrees makes a relatively large movement on the scale of the hot wire instrument in the vicinity of the resonance point. Below is tabulated a set of experimental data taken from the antenna circuit of a quenched spark transmitter and plotted in the graph shown in Fig. 6.

Wattmeter Reading or I^2	Wavemeter Capacities in Mf.
.008	0.00125
.011	0.00124
.016	0.00123
.022	0.00122
.028	0.00121
.035	0.00120
.038 resonance	0.001195
.036	0.00119
.026	0.00118
.016	0.00117
.011	0.00116
.007	0.00115

Of course, the reader understands that the above data accurately combines two sets of data in one. The usual procedure is to plot the watt-meter readings against degrees on the scale, and then to look up the condenser calibration, which is furnished with every wave-meter, and which shows the capacities of the condenser for various scale readings in degrees.

From the plot in Fig. 6 it is seen that at resonance I_r^2 is 0.038, corresponding to 0.001195 mF.; I_1^2 equal to $\frac{1}{2} I_r^2$, corresponding to 0.001173mf. at 0.019 on the wattmeter scale. I_2^2 equal $\frac{1}{2} I_r^2$, or 0.019 watts at 0.001225mf.

Since I_1^2 or I_2^2 is equal to I_r^2 then the quantity under the radical sign becomes



It Is Necessary to Keep the Wave-Meter Decrement Low if We Wish to Measure Small Decrements. An Average Value of Decrement for Each Inductance Is Generally Used, as It Varies From Point to Point, as Illustrated Above.

$$\sqrt{\frac{I_1^2}{I_r^2 - I_1^2}} = \sqrt{\frac{.019}{.038 - .019}}$$ or equal to one;

therefore, it may be omitted in our calculations.

From equation (6):

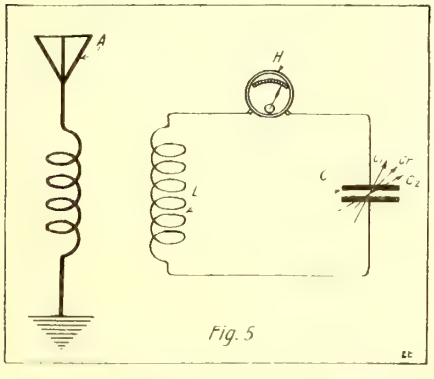
$$\delta_1 + \delta_2 = \pi \frac{C_r - C_1}{C_1} = 3.14 \times \frac{.001195 - .001173}{.001173} = .057$$

Similarly from equation (7)

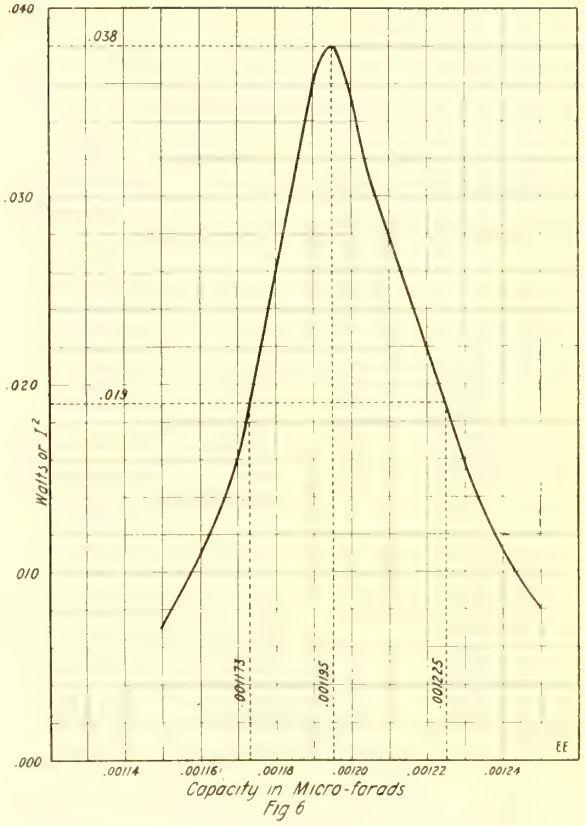
$$\delta_1 + \delta_2 = \pi \frac{C_2 - C_r}{C_2} = 3.14 \times \frac{.001225 - .001195}{.001225} = .0769$$

Average, $\delta_1 + \delta_2 = .0669$.

The value of δ_2 is given with the decrementer and is equal to .016. Therefore .0669 — .016 = .0509, which is the logarithmic decrement δ_1 per complete oscillation.



Arrangement of Apparatus for Measuring the Logarithmic Decrement of a Radio Transmitter Aerial Circuit. A Hot-Wire Meter Is Connected in Series with the Wave-Meter Inductance and Variable Capacity. Readings Are Taken for Different Positions of the Variable Condenser.



The "Resonance Curve" Obtained from Tests on a Quenched Spark Radio Transmitter. It Is Plotted by Observing Successive Readings as Obtained by a Hot-Wire Ammeter and a Wave-Meter, Fig. 5. A Radio Expert Can Compute the Logarithmic Decrement from Such a "Curve," and Besides, He Can Tell at a Glance Just How Efficiently Tuned a Certain Transmitter Is. This Is Explained in the Accompanying Test.

In order to show the value of the resonance curve let us look a little closer into what the curve actually represents. The breadth and height of the curve show graphically the sharpness of tuning and amplitude of the oscillations.

The addition of resistance into the circuit has the effect of broadening the curve and at the same time lowering the height of the *hump* or peak. If the coupling of the transmitter is too close, the curve will decrease in height, broaden out and show two distinct resonance humps, which, of course, indicates that the energy is not being emitted all on one wave-length. Therefore, by merely looking at a well-plotted resonance curve a well-grounded radio man can tell at a glance if the transmitter is working at maximum efficiency, and if not, he generally can determine the reason.

Now, it also becomes evident that it is necessary to keep the meter decrement low if we wish to measure small decrements, because the meter decrement is always incorporated in the value read. An average value of decrement for each coil is generally used, as δ_1 varies from point to point as shown in Fig. 7.

The necessity of a low resistance wattmeter and the use of *Litzendraht* wire on the inductances also become apparent.

Now, the above readings necessary to measure decrement seem fairly easy to take, but without laboratory appliances at hand it is not as simple as it seems. So in order to make it easy for the radio inspectors of the Bureau of Navigation to make these measurements on shipboard Mr. Frederick A. Kolster designed his *direct-reading decremeter,* which we shall study in the next installment of this series.

(To be continued)

THE CONSTRUCTOR



A Synchronous Motor Made From An Iron Pulley

By Raymond V. Wilson

THE motor here described will run on single phase alternating current of 60 cycles. The iron parts for the motor are secured from an ordinary six-spoke cast iron pulley wheel of about 3 inches diameter. The wheel is removed from its bearings and the spokes sawed off with a hack saw at about the white marks as shown. The rim is used for the field or *stator,* and the inner part is used for the armature or *rotor.*

The space between the projecting pole-pieces on the stator is wound with wire. The direction of winding is reversed on the adjacent sections so that when a current flows thru the wire, the projecting poles will be alternately North and South. Before winding the stator, it should be given two or three coats of strong shellac solution, for insulating purposes, allowing each coat to dry hard before applying the next coat. This drying may be hastened by placing it in a warm but well ventilated place.

It is not necessary to wind the rotor poles for any of the experiments here mentioned, as the rotor will run synchronously without any winding, text books to the contrary notwithstanding. One is shown wound and equipt with slip rings, however, and it can be fed with a direct current from a battery to slightly increase the power of the motor. The windings of the rotor poles are alternated in direction so as to produce poles of alternate polarity the same as the stator.

The rotor is fitted with a shaft and mounted on bearings as shown. If the spokes have not been sawed off accurately so as to be of equal length, they must be filed or ground down so that the rotor will turn without scraping the poles of the stator. The shaft of the rotor should protrude somewhat thru the bearings as the motor is not self-starting and must be started by twirling the end of the shaft between the fingers after the current is applied. One does not always succeed the first time, as the rotor must be spun until it is near synchronous speed before the current will take hold and continue the rotation. Two or three volts alternating current applied to the stator winding from a toy step-down transformer will run this motor very quietly and smoothly and without overheating, but the bearings must be smooth, well made and well oiled.

The wire used on this particular motor is No. 21 B. & S. double cotton covered, but other sizes will answer as well providing that the transformer has other voltages which will run but not overheat the motor.

The speed (S) or number of revolutions per second of any synchronous motor may be found by dividing the frequency of the applied current (F) by the number of *pairs* of poles (N). This motor, having three *pairs* of poles and being fed by alternating current of 60 cycles, will revolve at a speed of 20 revolutions per second. Also

$$F = SN;\ S = \frac{F}{N} \text{ and } N = \frac{F}{S}.$$

Apply the low voltage alternating current to the stator winding and give the shaft a twist. If it stops, try it again or try giving it a twist and then apply the current quickly. After a few trials it should continue running by itself if the machine has been properly made.

Alternating current flows first in one direction in the wire and then in the opposite direction, dying out to zero or no current between each pulsation or flow of current. See Fig. 1.

Alternating current of 60 cycles means that there are 120 of these pulsations every second.

Now to show that the motor is running *synchronously:* Take a cane or small stick and wave it rapidly back and forth in a darkened room illuminated by a single 10 watt (or even a 25 watt) incandescent lamp fed by alternating current. The cane or stick will appear like the blades on a fan. The filament of the lamp is heated red hot by these pulsations and the lamp gives the appearance of a continual glow of light, flickering not being noticed by the eye, as

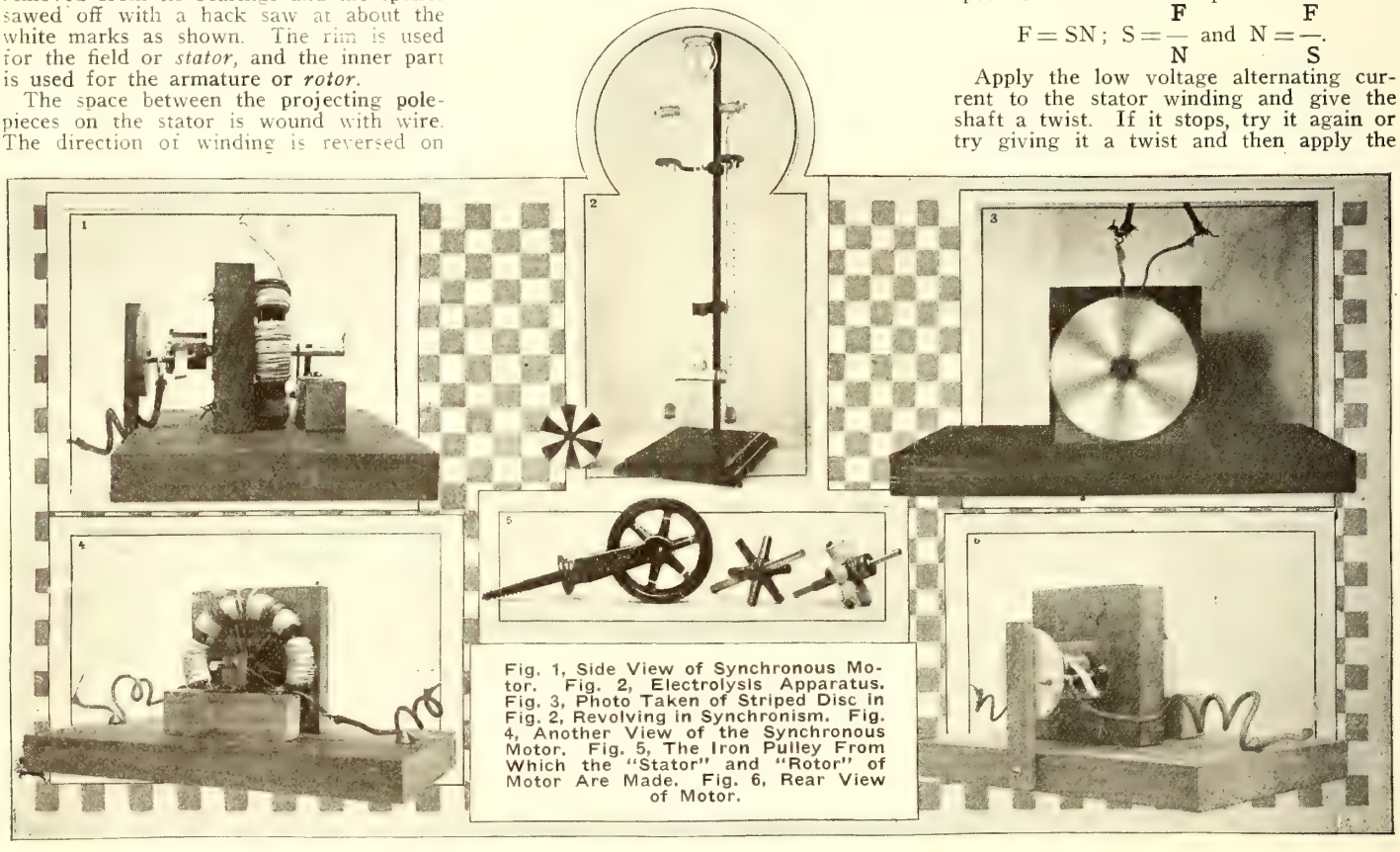


Fig. 1, Side View of Synchronous Motor. Fig. 2, Electrolysis Apparatus. Fig. 3, Photo Taken of Striped Disc in Fig. 2, Revolving in Synchronism. Fig. 4, Another View of the Synchronous Motor. Fig. 5, The Iron Pulley From Which the "Stator" and "Rotor" of Motor Are Made. Fig. 6, Rear View of Motor.

the current pulsations are far too rapid. It is a similar effect to that of the moving pictures where a succession of pictures are thrown on a screen. They come so rapidly

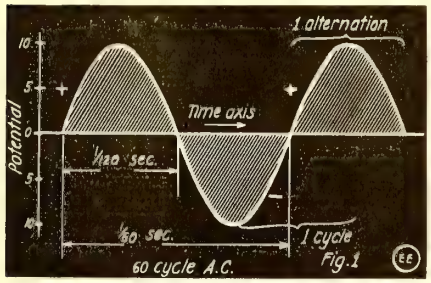


Diagram Showing How an Alternating Current Cycle Is Composed of Two "Alternations"—One a Positive Loop and the Other a Negative Loop.

that, with a good machine, the eye is not able to detect any flickering, altho *only sixteen* different pictures are shown per second when the machine is being run normally.

The filament of the ten watt lamp is very thin and fine and has a chance to cool off between pulsations of current, and 120 *times per second you are in the dark*, when the current is at zero and not flowing in the lamp. This is what causes the fan blade effect of the waving stick, as you do not see the stick at all during the dark periods.

A circular disc is cut out of a piece of card-board and marked into twelve equal segments, and these are alternately painted black and white as shown. This is affixt to the end of the rotor shaft with a bit of sealing wax. Now if the disc is illuminated only by a ten watt lamp, fed by 60 cycle alternating current, it will receive 120 flashes of light per second. If the motor is running and in *synchronism* (i. e., 20 revolutions per second), it is evident that the disc will be illuminated by six flashes of light during one revolution of the motor, and we will get six views of the disc every revolution. This is exactly what happens and in consequence the disc with its six black spokes *appears to be standing still*, altho revolving at the rate of 20 revolutions per second.

A photograph of several seconds exposure is shown, taken of the motor and disc while running in synchronism. The photo was taken by the light of a ten watt lamp, fed by the same alternating current of 60 cycles. It shows distinctly the six black sectors of the disc as if standing still. The edges of the sectors are not sharp for the simple reason that the current and consequent light pulsations are not abrupt, but undulating like waves on the ocean. (See **Fig. 3.**)

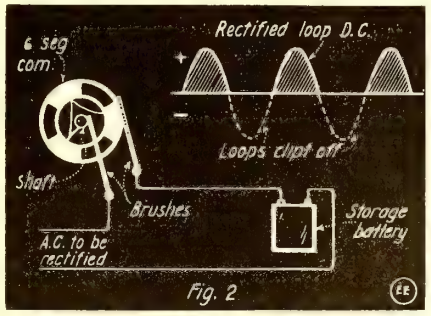
A similar effect is sometimes seen in moving pictures of a wagon which is moving but the wheels seem to be standing still. In this case it just happened that the wheel of the wagon *was turning in synchronism with the moving picture machine*. Each spoke of the wheel moving into the same relative position as the one before it as the pictures are taken.

Text-books state that the phenomenon of "hunting" is one of the defects of synchronous motors when used with a commutator for rectifying alternating current, and this motor is not entirely exempt. It may sometimes be noticed that the revolving disc illuminated by the lamp seems to waver or swing slowly forward and back., This is the phenomenon of "hunting" and is caused by the poles of the rotor sometimes revolving just a little beyond their corresponding poles on the stator. In trying to get back in their correct position in relation to the current pulsations, they swing back a little too far and slightly lag behind their correct position. This often occurs especially just after starting the motor, but usually it soon dies out and the spokes on the disc gradually appear to be standing perfectly still. In large machines when rectifying heavy currents this would cause trouble with the rectifying commutator, but with small currents it may be neglected.

As a *synchronous rotary spark gap* is most efficient for wireless work when using a closed core high voltage transformer, this motor can be used for that purpose. A wheel with six points (similar to the rotor of the motor) should be mounted on the shaft but thoroly insulated from it. The two stationary spark points must be placed at a certain position, to be determined by experiment, in order to get the most efficient spark thru the wheel.

If the motor is to be used as a *rectifier*, it must be supplied with a six segment commutator and mounted on the shaft as shown. This commutator had best be purchased or taken from a small toy motor.

Three alternate segments are connected together and in turn connected to the shaft of the motor. The other three segments are left dead. This arrangement will rectify *only one-half* of the alternate current waves. One brush bears on the com-



Circuits Used for Rectifying A. C. (One Set of Alternations) With 6 Segment Commutator Fitted to Synchronous Motor Here Described.

mutator and the other brush bears on the opposite end of the motor shaft as shown. It is to these brushes that the alternating current to be rectified is applied, together with a storage cell or other apparatus connected up in series. See Fig. 2.

The commutator brush is made adjustable both as regards its tension and its position on the commutator. The brush should be placed at a point on the commutator where there is little or no sparking when it is running. There will be found six such points; three of them rectifying in one direction and the alternate three will rectify in the opposite direction. These points represent the *zero* when the current pulsations are reversing direction.

It is quite essential that the brush be placed exactly at the zero point on the commutator, as otherwise the current picked off will not be purely rectified but will have some flowing in the opposite direction, which would be fatal if it were being used for charging an expensive storage battery, as the battery would be ruined. In fact, this motor rectifier as described can be recommended only for experimental purposes, as sometimes the motor will stop for no apparent reason, and if a "live" segment of commutator happens to come to rest under the brush, pure alternating current will flow thru it. Experiments in charging a storage cell are best made with one constructed of two small lead plates dipping into a glass filled with electrolyte. If alternating current is past thru it by mistake it will only cause a white deposit to form on the plates (called sulfating) which in this case can easily be scraped off or it will sometimes fall off by itself.

In fact, such a cell is of assistance in finding the correct place for the brush on the commutator. If in the wrong place the plates will sulfate, while if in the correct place one plate will turn a chocolate color and the other will retain its original lead color, and the cell will be "charging."

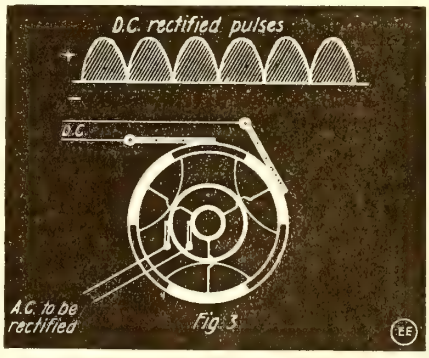
A small compass galvanometer is convenient for determining the direction of flow of the rectified current, as the motor will not necessarily rectify in the same direction after each starting, altho the position of the brush may be unchanged.

Such a galvanometer may be constructed from an ordinary compass by wrapping a few turns of insulated wire around it and connecting it in series with the current to be rectified. The compass is placed so that the turns of wire are parallel to the needle. If a direct current is past thru the wire in one direction, it will cause the needle to deflect to the right, and if the current passes thru it in the other direction the needle will deflect to the left. The needle is not quick enough, however, to follow the changing directions of a 60 cycle alternating current and it often demagnetizes the needle, as will also too strong a direct current, should there be too many turns of wire around the compass. The needle may easily be re-magnetized by passing the poles of a horseshoe magnet over the needle. If then the South end points to the North, it has been magnetized in the wrong direction and the opposite poles of the magnet must be past over the needle.

A compass galvanometer will not show whether or not a pure rectified current is flowing thru the circuit. The glass *Electrolysis Apparatus* shown in the photo Fig. 2, will do this, however. Advantage is taken of the fact that a current of electricity will decompose acidulated water into hydrogen and oxygen. With direct current, *oxygen* will be given off from one electrode and *hydrogen* from the other, in the proportion of one volume of oxygen to two volumes of hydrogen (H_2O). These gases rise in their respective graduated tubes and their volume can be read off directly. With alternating current the volume of the gases in the tubes will be equal and will consist of mixed oxygen and hydrogen. If the rectified alternating current is past thru the apparatus and the gases given off are not in the proportion of 1 to 2, it may safely be assumed that it is not a pure rectified current. Evidently the brush is not in its correct place on the commutator, or the rotor may be "hunting" excessively.

An electrolysis apparatus may be constructed from a tin pan. Two pieces of

(*Continued on page* 866)



Showing How It is Possible to Rectify Both Pulses of A. C. With Two Slip Rings Fitted to Six Segment Commutator on Synchronous Motor Described.

Electro-Static Experiments

By Frederick von Lichtenow

PART II (Conclusion)

SEVERAL years ago I happened upon the instructive and interesting little work entitled, "Simple Experiments in Static Electricity," by Percival G. Bull. Experiment No. 9, Chapter IV, of this book, dealing with spectacular condenser discharges, imprest me very much; in fact, to the extent that I couldn't help but give it the due tryout. The "bronze" or "metal" paper referred to and needed in the experiment seems, as I faintly remember, to be an uncertain article on the local market. There is something entirely wrong with it. Either the demand for it is so brisk that stocks are early exhausted, or there is no call for it at all, and, consequently, nobody bothers with it. I was for a time inclined to think the latter way, until finally, after a prolonged and fruitless search among the various stationery stores, I was shown at some small place what looked to be the remnant of a once glorious pile. Whether I purchased the real, honest-to-goodness "metal" paper or not has been an open question with me to this day, since it was not sold to me under that somewhat mysterious sounding name. At any rate, it works.

I mention this little incident only as an example of the handicaps, which at times confront the experimenter even in big cities, and which are only too frequently responsible for the fact that many otherwise highly instructive and fascinating experiments are left untried. Needless to say, I have had several real disappointments of this nature since, not only "close calls" like the above.

My aim in this article is to put down the results obtained with, and various spark effects noted on, three different grades of "bronze" or "metal" paper—the only number I was able to secure—which are not given in the aforementioned book. Following in the order of their relative resistance capacity they are "silver" paper, the "copper-bronze" paper and the "brass-bronze" paper, the latter being the poorest conductor of the three. They measure each, as cut by me, 19½ inches in length (the original width of the paper) by 8¼ inches wide, an ample size for the accommodation of even the largest Leyden jars ordinarily used.

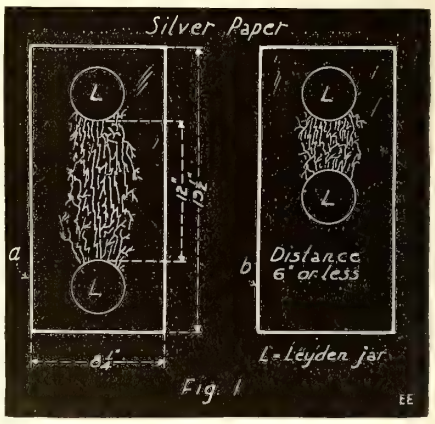
I employed in these experiments two very finely made static Leyden jars of one pint size each in connection with the always dependable little "Electro" Wimshurst static machine. According to the book in reference the jars are to be placed one at each end of the paper and connected with their inner coatings to the respective poles of the machine. I have placed them in various positions, these latter depending on the spark effect desired, as well as necessitated by the nature of the paper itself.

The following illustrations and short descriptions give the results of my tests (Fig. 1).

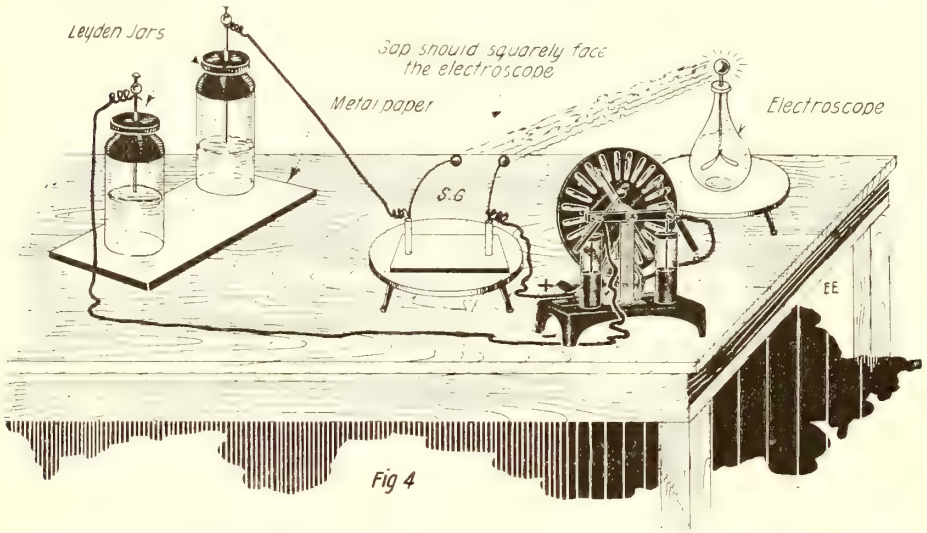
Characteristic of this paper is that the sparks always show a strong tendency toward branching out over its surface, whether the distance between the jars be a few inches or a foot, or even more. Their color is a beautiful bluish-white. With the jars separated by only a few inches, and up to six inches or so, the discharge manifests itself in thousands of bright little stars hanging together by shiny threads. These very striking effects are due to the relatively high conducting quality of the metal particles covering this paper.

The paper illustrated in Fig. 2, offering a somewhat higher resistance to the condenser discharge than the former, limits the distance between the jars to ¾ of a foot. At or near that distance the sparks are very pronounced and appear concentrated in the form of miniature lightning bolts of a clear white color. They hit around in curves and are accompanied by a loud report. If the jars are approached to within 4 inches or less, as indicated in "b," the sparks will dart in spray fashion across the intervening space, lighting up in a vivid emerald green. (Fig. 3.) As I have stated before, this paper is a poor conductor, and, consequently, permits only a separation of a few inches between the Leyden jars. Set at that distance, the spark effect is very similar to the one noticed on the "copper-bronze" paper, Fig. 2-b; however, it is not quite so distinct. The color shade of the sparks runs more into a dull yellowish green, not unlike that or oxidized brass.

The above spark-and-color effects are those as observed in an artificially (moderately) lighted room. The papers may be placed in triple or quadruple layers, thus insuring a better insulation for the Leyden jars, in addition to which an oilcloth covering on the table may be advisable. Care must be taken that the discharge balls of the machine are first to be separated *beyond* sparking distance while charging the jars, and not set "a few inches apart," as prescribed by the text book, which may be misunderstood, since the small Wimshurst machine I used in these tests delivers a three-inch spark alone, when in a healthy condition, not to speak of the many larger static machines with their correspondingly greater output. After thus charging the jars for a short while the electrodes are gradually and slowly approached toward each other, when upon reaching the stress limit the resulting spark will be accompanied by the condenser discharge across the paper.



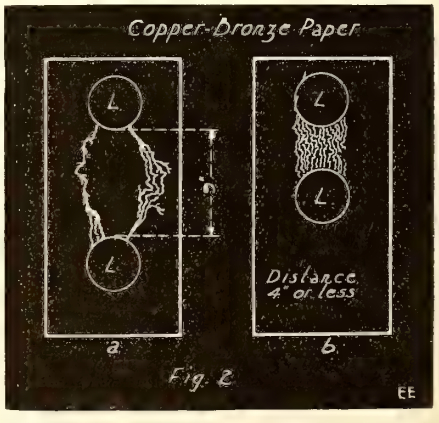
Spectacular Condenser Discharges Can Be Arranged With Metalized Paper, a Pair of Leyden Jars and a Small 3" Static Machine. This is a "Silver Paper" Experiment.



A Novel and out-of-the-ordinary Static Experiment Which the Author Discovered. The Insulated Electroscope Responded to the Unipolar Oscillatory Waves Set Up by a Silent Discharge in the Spark Gap, Owing to Its Ball Being in Line With Those on the Spark Gap.

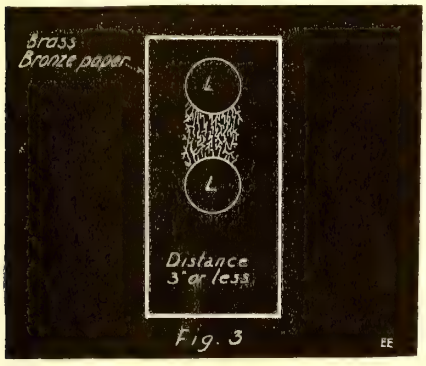
Following the above tests I was led to another experiment, terminating in the following discovery—if I may call it such—which I will give here for what it is worth:

In order to ascertain the conducting value of these metal papers as a circuit link, I had included a separate gap (spark gap) into the former set-up. With the conductors of the machine set wide apart I was testing the spark across this new gap under various



Different Forms of Discharge Effected Between Leyden Jars Set at Various Distances Apart on Copper-Bronze Paper.

adjustments, when, happening to glance around while turning the crank, I noticed my gold leaf electroscope, standing some



Peculiar Form of High Tension Discharge Obtained Between Two Leyden Jars Set on Brass-Bronze Paper.

distance away, near the further end of the table, under the influence of a strong charge. I discharged it and tried again with the same result, then looked at the gap, where only a silent discharge was taking place, caused by being set at the spark limit. Without disturbing anything I studied their respective positions and found the knob of the electroscope to be at exactly the same elevation as the busy end of the gap, with the latter squarely facing the former. Therein rested the secret, evidently. The oscillatory waves set up by the spark were in this way forced upon and recorded by the very sensitive instrument, which latter fact proves that a strong, unipolar element predominated in the charge (Fig. 4).

While the metal paper could by no means be clast as a conductor, this experiment demonstrates that it possesses sufficient conducting elements, however small, as to sustain a certain form of circuit; but it is, on the other hand, its feeble conducting value that makes the experiment at all possible.

The discharge rods of the spark gap, being in a vertical position, are curved in order to be capable of a wide range of adjustments. They consist of heavy, polished brass wire and terminate in 1-inch solid brass balls, well polished, as all the terminals on static instruments should be. All in all, the spark gap is a "concoction" of my own, brought about by the dire need for just such a gap (Fig. 5). No sparks will occur between the Leyden jars in this connection.

Success in static experiments depends a great deal on the nature of the connections employed. Chains or wires used for this purpose must terminate in balls or rings, respectively, with the links of the chains preferably soldered. Open ends and sharp edges are certainly to be avoided, while earth-connected or other objects not needed in the experiments are to be kept at a respectable distance from the instruments in operation.

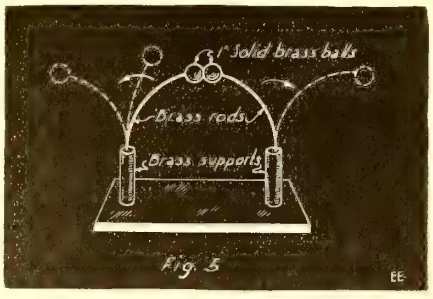
AUTHORS!!!

All matter intended for publication—not only by us, but by any other magazine or newspaper as well—should be written on one side of the paper only and in ink. If it isn't, somebody else must copy part of it off on another sheet before it is given to the printer.

CHEMICAL NAMES.

Many drugs and other chemicals have names of astonishing length, although these are generally used only by experimental chemists, shorter names being employed in the trade. Phenacetin, a popular remedy for headache, is known to chemists as acetaminophenetol. Antipyrine, which is equally popular as a headache cure, is phenylmethylpyrazolone. A few years ago a new drug was introduced as a remedy for acute rheumatism, the full name of which is sodium phenylmethylpyrazolonaminomethan - sulphonate. Everyone has heard of nicotine, even if they do not happen to be smokers. Pinner, who investigated the properties and structure of pure nicotine, called it α-pyridyl-β-tetrahydro-N-methylpyrol. Some of the aniline and azo dyes and their parent substances have quite extraordinary names Thus, the well-known dyestuff, malachite green, is prepared from a basic substance known as tetromethyldianinotriphenylmethane.

Contributed by H. J. GRAY.



Simple, Yet Extremely Flexible Form of Static Spark Gap Used by the Author in the Electro-Static Experiments Here Described.

The Chemistry of Selenium*

By Albert W. Wilsdon

History

SELENIUM was first discovered in 1817 by Berzelius, the noted Swedish chemist, as an elementary body in the deposits of Sulfuric acid chambers at Gripsholm, Sweden, where the Fahlun pyrites had been used experimentally to produce the acid, which had been previously prepared exclusively from Brimestone (Sulfur). Thus the discovery of selenium was occasioned by the independent production of Sulfuric Acid.

It is a non-metallic element, occupying the intermediate space between Tellurium and Sulfur. It may be of interest to the reader to give an explanation of how the suffix *-um* was applied to Selenium.

It has been the custom in modern times to distinguish *metals* from *non-metals* by applying to the former names ending in -um, and consequently such metals as are of more recent discovery all have names with this termination. Seleni*um* was at the time of its discovery thought to be a metal, and it consequently received a name with the terminal -um. This substance strongly resembles a metal in many of its physical properties, but its chemical relation is so closely similar to the non-metal Sulfur, that it is by general consent clast among the non-metals; it is an example of those elements which are distinguished as *metalloids*. On this account many chemists advocate the term *Selenion*.

Occurrence and Distribution:

Tho not very abundant in nature, it enters into the composition of many minerals, and has been found in the free state in certain parts of Mexico.

In combination it is found as:

1. Sulfur selenid or Selensulfur, also known as Selenic-sulfur, found at Volcano, Lipari Islands, also at Kilanea, Hawaii.

2. In Clausthalit, or Selenid of Lead (PbSe), found at Clausthal, in the Harz Mountains in Germany. Its composition is said to be: Selenium, 27.59-31.42; Lead, 63.92-71.81; Cobalt, 0-3.14; Iron, 0-.45.

3. In Lehrbachit, or Selenid of Mercury and Lead (PbSe+HgSe), found at Lahrbach and Tilkerode in the Harz Mountains. Its composition is: Selenid of Mercury and Lead represented by the formula PbSe+HgSe.

4. In Onofrit, the composition of which is: Selenium, 6.49; Sulfur, 10.30; Mercury, 81.63-98.12; which corresponds to the formula $HgSe+4HgS$.

5. In Berzelianit, a mineral placed by Dana in his Galena group. Its composition is: Selenium, 38.4-40; Copper, 61.6-64. It is a selenid of copper, occurring in Sweden, and in the Harz Mountains.

6. In Eucairit, derived from the Greek name Eukairos, meaning "Seasonable," Eu meaning "good," and Kairos meaning "the right point of time" so named by Berzelius, because he found it opportunely soon after the discovery of selenium. It is found in Sweden and Chile, and has the composition: Selenium, 31.6; Copper, 25.3; Silver, 43.1. It is a selenid of copper and silver, corresponding to the formula, Cu_2Se+Ag_2Se.

7. In Crooksit, the composition of which is: Selenium, 33.28; Copper, 45.76; Thallium, 17.25; Silver, 2.71; which corresponds to the formula, (CuTlAg)Se. It occurs in Norway and Sweden.

Selenium is also found in very small quantities in meteoric iron, in some varieties of coal, and in many other minerals, especially in certain iron-pyrites, and copper-pyrites, and where these are used in the manufacture of Sulfuric acid, a red deposit containing selenium being found in the flues and chambers.

It is found in small quantities associated with sulfur, in the sulfids of Iron, Copper, Silver, etc., and more rarely in selenides, as Lead selenid (PbSe), Mercury selenid (HgSe), Copper selenid (Cu_2Se), and Silver selenid (Ag_2Se).

Preparation:

Selenium is most conveniently prepared from lead-chamber deposits. The crude material is mixed with equal parts of sulfuric acid and water to make a paste, heated to the boiling point, and treated with nitric acid or potassium chlorat from time to time until the red color disappears. This solu-

(*Continued on page* 867)

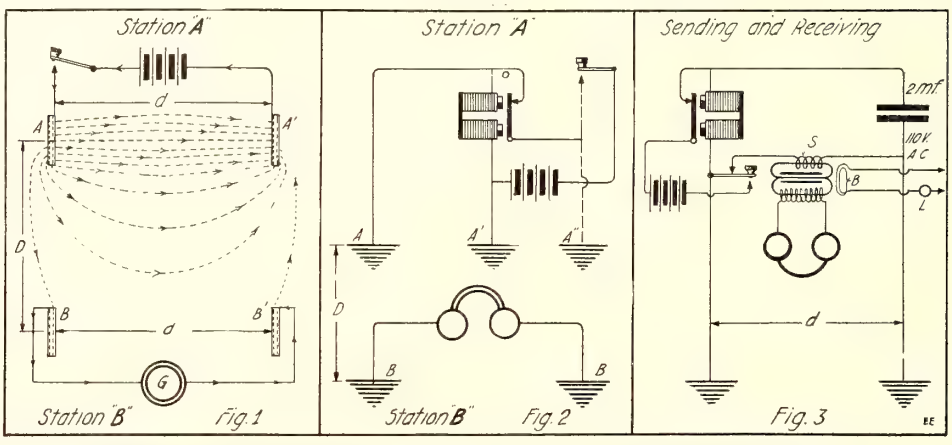
* Copyright 1917 by Albert W. Wilsdon. If any part of this article is copied and republished, full credit must be given the ELECTRICAL EXPERIMENTER as well as the author.

Telegraphing Thru the Earth

By Roy T. Griffith

THIS article describes a system of non-radio wireless telegraphy utilizing earth currents, which is entirely practical over short distances.

The principle is shown in Fig. 1. At Station A a battery is connected thru a key to two pipes, A and A^1, driven into the ground a few feet apart. At Station B two similar pipes are connected to a galvanometer, G. Now, when the key is deprest at Station A, the galvanometer at Station B will indicate a current in the wire connecting B and B^1. The reason is found when we trace the course of the battery current thru the ground from A to A^1. Obviously the greatest part of the current will flow directly from A to A^1, as indicated by the broken lines, spreading out but slightly in the ground. But small parts of the current will spread out over the longer curved paths shown, and some small fraction of the total current will spread far enough to reach Station B and flow from B to B^1 thru the galvanometer circuit instead of thru the ground between them. Altho this received current is very small compared with the transmititng current, it will suffice to transmit telegraphic signals between the stations without the use of conecting wires.



Some New Ideas in "Ground Telegraphy" Are Shown in the Present Diagrams and Discussion, Which Will Undoubtedly Be of Interest to the "Closed Up" Radio-bugs.

To get strong indications at the receiving station for a given distance between stations, D, we should have the distances d, our "base lines," as great as possible, a powerful transmitting battery, grounds of low resistance, and a sensitive indicating instrument.

Since the telephone receiver is very cheap and is marvelously sensitive to pulsating currents, it is desirable to use a pair of phones for receiving, and a battery and buzzer to excite the transmitting grounds. This gives the hook-up shown in Fig. 2, which makes use of the relatively high emf of self-induction developed in the buzzer coils. The grounds may be connected either across the buzzer windings ($A\text{-}A^1$), or the buzzer contacts ($A\text{-}A^{11}$) with identical results. When the grounds are good ones, connecting across the contacts usually prevents the buzzer's operation, but connecting across the windings is not so likely to do so. If difficulty is experienced from this cause, connect either a sufficient resistance or a 2 mfd. telephone condenser in one of the ground leads. The condenser will not cut down signal strength at all, but will stop sparking at the buzzer's contacts and improve its tone. The absence of sparking allows us to use much more power without injuring the buzzer. The buzzer should be arranged to give a clear high tone by soldering the contact spring rigidly to the armature and adjusting carefully. "Radiotone" buzzer will be found most excellent for this work, and its beautiful tone can be easily read thru the QRM of stray ground currents. Usually a medical coil or a small spark coil will not be found as satisfactory as a buzzer, because of their high resistance, which limits the transmitting current, and 60 cycle A. C. is undesirable because of its tone. The buzzer is ideal because it combines a low resistance with a high emf, and a good tone with ability to operate on almost any available source of current.

The phones should be of very low resistance, the lower the better. Wireless phones will give very poor results if connected directly to the grounds but are excellent if connected to the secondary of a step-up coil, the primary being put in place of the phones in the diagram.

My experiments indicate that the grounds need not be very elaborate. A pipe driven a few feet into the ground gives very good results. The two grounds should be as widely separated as conditions allow, and the base lines AA^1 and BB^1 should be parallel. It should be remembered that separating A and A^1 will practically not increase the resistance of the transmitting ground circuit, since almost all the resistance is at the surface between the pipes and the ground, but making the ratio d/D large will very much increase the ratio of the received current to the transmitted current. If the gas and water mains come into the building well apart, and are not connected in any way inside the house, they may be used as the pair of grounds, but it is usually better to use at least one separate ground. It must not be expected that using gas and water pipes at *both* stations will give improved results, for the pipes are probably connected directly together at almost every house by water heaters, etc., so that the current does not follow the pipes, but spreads out from their points of entering the ground.

Fig. 3 shows a very simple hook-up using a 6 volt storage battery, double contact key, buzzer, telephone condenser, wireless phones with step-up coil, and a "balancing coil" B. The key with the back contact is used to make the arrangement a break-in system, and to cut out the phones while sending, preventing waste of current and fractured ear drums. When the phones are connected across the grounds for receiving, a hum, sometimes very loud, will usually be heard, due to stray alternating currents. This QRM will greatly interfere with the reception of signals, but if the hum is due to 60 cycle current, and 60 cycle lighting current is available, it may be completely balanced out by placing near the step-up coil S a coil B, consisting of several turns of wire and carrying the current for a 25 watt lamp L. The position of this coil should be adjusted until perfect silence is obtained. An outfit like this employing parallel base lines of 50 to 100 feet may be expected to give good signals over a distance of half a mile. Larger powers, longer base lines, and more delicate receiving instruments will give correspondingly better results.

I think it should be clear from the above explanation that loose couplers, variable condensers, unilateral connections, and crystal detectors are very much out of place in such a system. But the experimenter will find that greatly enhanced results can be secured by the use of a regenerative Audion on the received signals, and by using a definite transmitting frequency, tuning the transmitting and receiving circuits to this frequency by properly designed iron core inductances and paper-and-tinfoil condensers.

TELEPHONE RECEIVER WORKS WITHOUT DIAFRAM.

It will be of great interest to the readers of the ELECTRICAL EXPERIMENTER to know of a way of using telephone receivers in conjunction with a high frequency buzzer connected directly across the contacts without the use of a condenser, and to still obtain the much desired high pitch but not too loud. This is done by removing the diaframs entirely from the receivers and connecting the 'phones across the contacts of the buzzer.

This will seem impossible at first, perhaps, but when tried it works admirably well, and is best explained as follows:

All telephone receivers are constructed with a permanent magnet and a soft iron core electro-magnet. When the telephone has the diafram on, in the usual way, it is attracted by the varying intensity of the magnetic field produced about the poles of the soft iron cores of the electro-magnets of the receiver. It is therefore evident, since there is always some iron left in the receiver, that this iron will be acted on to some extent, therefore manifesting itself in this case as the high pitch sound of the same frequency as the note of the buzzer. The action is usually due to the fact that the iron molecules are set into vibration by the fluctuating currents surrounding the core. It is sometimes due to loose cores or magnet laminations, screws, etc. Some years ago an account was given of a similar phenomena in the "Modern Electrics" magazine, in which case it was found possible to make a 5 h. p. motor "talk." The iron mass of the magnet frame was set into molecular vibration by varying the current thru the field coils by means of a microphone.

This also explains the reason for the "hum" produced by the core of a choke coil when connected to an alternating current. The wires as well as the molecules of the iron core are in a constant state of vibration. Contributed by E. DUSKIS.

RADIO EXPERTS WANTED!

To write up your new ideas and apparatus which have proven efficient and practical. Send us a short, clear write-up with sketches and photographs when possible. We pay good rates for all articles accepted. Address the Editor "Radio Department."

The Construction of an Experimental Electric Furnace

By Ralph H. Muller

IN response to the editor's appeal for practical electrical and scientific articles, I submit herewith photograph, sketch, and description of an electric furnace which I designed and constructed with the aid of a fellow experimenter. The furnace was a source of instruction and entertainment and with it the writer made many interesting experiments such as reducing refractory oxides, making alloys, etc.

The furnace can be made by anyone having access to a few tools, only one part requiring any lathe work. The sketch shows the most important details. The box in which the clay lining is placed is made of common sheet iron cut to the shape shown in Fig. 1. The larger one at the left is the lower box, the one to the right the lid or cover. The small holes for rivets, should be drilled with a No. 28 twist drill, and the box bent to shape and riveted. Little angles of sheet iron are fastened to the lower box to hold it to the base. It will be noticed that the lid or cover is provided with tabs which are bent over to keep the clay from slipping out when the cover is inverted. The upper box or cover is provided with a handle, the dimensions of which are optional. The semi-circular cut at the ends of both boxes form a hole 5/8" in diameter when the boxes are put together, and coincide with the 5/8" hole in the asbestos board shields shown at Fig. 2.

Two of these shields are required. They are cut from 1/4" asbestos board to the shape shown. A 5/8" hole is drilled equidistant from the sides and 2 5/8" from the bottom. Four holes must be drilled for 8-32 machine screws and they must coincide exactly with 4 similar holes drilled in the ends of the lower box.

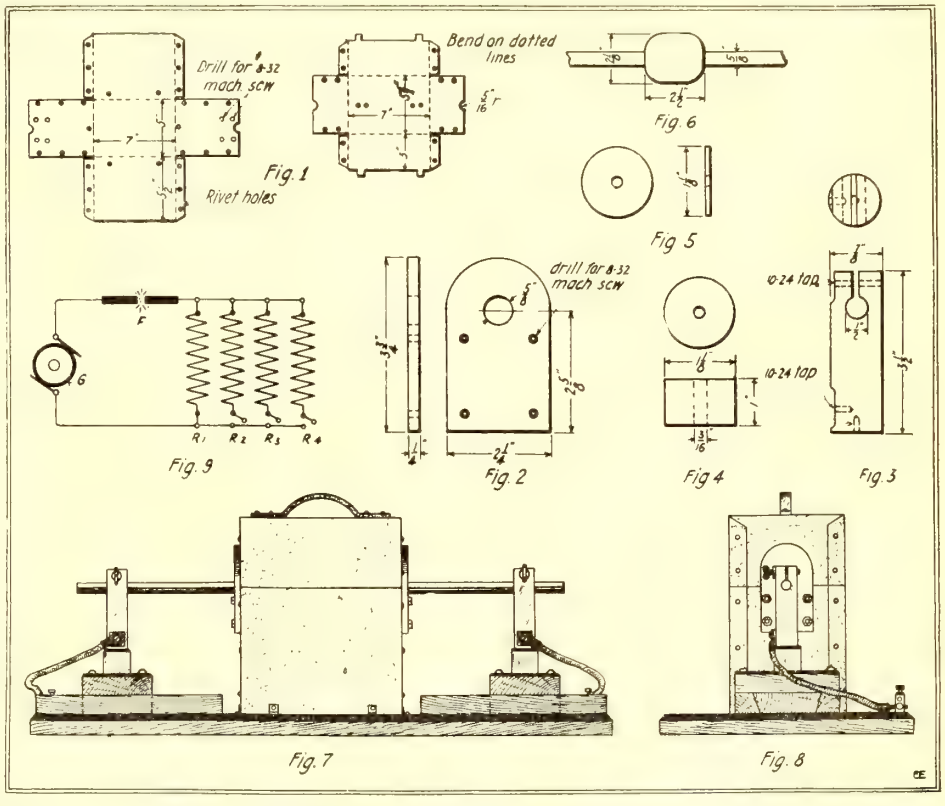
The carbon holders, Fig. 3, are made of steel turned in a lathe to dimensions shown. The 1/2" hole is drilled exactly 2 1/8" from the bottom of the piece. A slot is now sawed from the top of the piece to the hole, and a hole drilled at right angle to the slot, tapt for a 10-24 machine screw. A wing screw is used to clamp the carbon holder tight. As shown in the drawing these standards are filed flat where the machine screws are placed. The holes at the bottom are also drilled and tapt for No. 10-24 screws, the one serving to clamp the cable to it and the other to hold the standard to the slide block. Fig. 4 shows the dimensions of a fiber pillar on which the carbon holder stands; Fig. 5 shows a copper washer 1/8" thick placed between the holder and pillar.



Photograph of Finished Electric Furnace Which the Author Has Successfully Employed In Reducing Refractory Oxides, Making Alloys, Etc.

The base of the furnace is made of well-seasoned oak 25" x 11" x 7/8", and is beveled for the sake of appearances. Two slides 8" long and 3" wide at the top, having the sides beveled at 15° as shown in Figs. 7 and 8, are cut from 7/8" oak and are fastened equidistant from the sides of the base by means of flat head, wood screws, countersunk to give an unobstructed passage for the slide blocks.

These slide blocks are also made from 7/8" oak and the top pieces are cut to 4 1/2" x 3". To these are fastened, by means of round-head wood screws, two cleats 3" long 7/8" high and with sides beveled at 15°.



Many of the World's Scientific Secrets Undoubtedly Lie, as Yet Unrevealed, In the Fiery Heat of the "Electric Furnace." Moissan, the French Savant, Produced the First Synthetic Diamond In the Electric Furnace. To It Also We are Thankful for "Carborundum" and Other Abrasives. Here Is One Any Experimenter Can Make.

A 2 1/4" flat-head 10-24 machine screw is past up thru a hole drilled in each slide block, past thru the fiber pillar, copper washer, into the hole of the steel carbon holder. Leads are now provided and should be made of stranded cable, equivalent to a No. 4 wire, or even larger, and should be well insulated; preferably with an asbestos or other slow-burning insulation. The ends should be soldered to lugs, one of which is clamped to the carbon holder by means of a machine screw, the other to a binding post fastened to the base.

The next operation is to make the arc chamber. The lower box is screwed in position by wood screws passing thru the angle strips riveted to the box, and the asbestos shields are held in place by 3/8" 8-32 brass machine screws, the nuts being placed on the outside. A wooden form is turned up according to dimensions given in Fig. 6. The form is past thru the holes in the asbestos shields and clamped at both ends in the carbon holders. The extreme ends of this form will have to be trimmed down with a penknife to fit the 1/2 holes. After the ball-shaped part of the form is located in the exact center of the box, a mixture of fire-clay and water, about the consistency of dough, is packed in tightly. After it is filled, the form is carefully taken out, which operation may necessitate the removal of one of the shields. The top box or cover is then filled using the same form. After both boxes are filled and the lower one removed from the base, they are both placed in an oven (a moulder's core print oven serves admirably) and slowly baked out.

After all the moisture has been driven out, the apparatus may be reassembled. Half inch arc-lamp carbons are clamped in the carbon holders and past thru the holes in the asbestos board shields.

The furnace is then connected in a D. C. circuit as shown in Fig. 9. The writer used iron wire resistances such as are used with stereoptican lanterns. After placing suitable fuses in the circuit, close one switch and start the arc by shifting the slide blocks, then slowly close the remaining switches. The carbons require very little adjustment, for in the confined space the one carbon builds up the other and the only loss is the monoxide (CO) and dioxide (CO_2) of carbon driven off. When connected to the starting panel of a forge blower, it was possible to draw 80 amperes thru this furnace. This created a terrific roar and the clay decomposed into a glassy silicate and the writer was amused when, after ten minutes, he raised the cover and saw the arc chamber one mass of white hot bubbles of glass. A more refractory crucible for the substance is grafite, magnesite, etc.

HOW TO MAKE IT

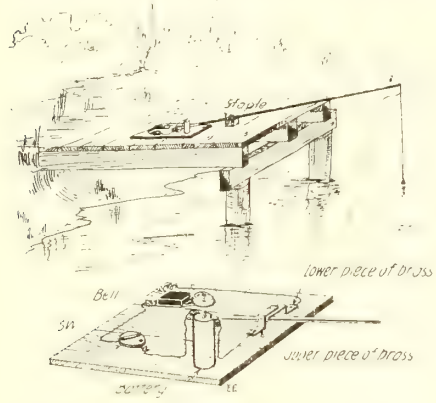


This department will award the following monthly prizes: **First Prize, $3.00; Second Prize, $2.00; Third Prize, $1.00.**
The purpose of this department is to stimulate experimenters towards accomplishing new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best idea submitted a prize of $3.00 is awarded; for the second best idea a $2.00 prize, and for the third best prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings. Use only one side of sheet. Make sketches on separate sheets.

FIRST PRIZE, $3.00

WHEN THE FISH BITES THIS BELL RINGS.

The accompanying sketch illustrates a device I have used while fishing at night. It may be readily adapted for fishing thru holes in the ice also. One or two dry cells, an ordinary vibrating bell, a switch and a specially made contact device into which the fish pole fits, constitute the outfit. These parts are mounted on a board, as shown. The brass springs under which the pole rests, should be of fairly light stock, so that the unlucky victim will not have the



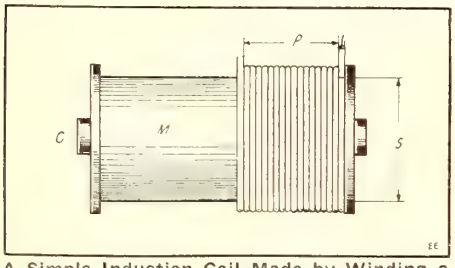
Fishing Time is Coming, Boys! Here's an Electric Alarm That Can be Rigged up to Ring a Bell or Pull Your Toe While You Doze Off on the Bank.

pleasure of pulling the line in half before the bell rings.

Contributed by
RAYMOND MURRAY.

AN EASILY MADE INDUCTION COIL.

A small induction coil may be very easily made with a high-resistance electro-mag-



A Simple Induction Coil Made by Winding a Layer of coarse Wire Over a Magnet Spool.

net (20 ohms or more) by simply winding two or three layers of coarse wire (No. 18-22) on the outside as a primary. Use the terminals of the electro-magnet as secondary leads.

A battery current sent intermittently thru the outer coil causes a magnetic field in and surrounding the magnet core. At the same time an induced current is caused in the fine wire of the inner coil.

I find this type useful as a telephone coil and with an interrupter it makes a very good medical coil. A 75 ohm magnet or one wound with seven or eight layers of No. 30 wire do about equally well.

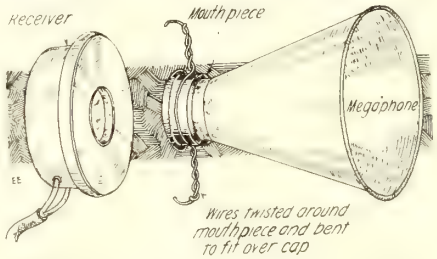
The sketch shows a part-wound diagram of my own coil, where M—Magnet (8 layers No. 30); P—Primary (2 layers No. 22); S—Secondary leads, and C—Core.

Contributed by E. BASIL LAUFER.

SECOND PRIZE, $2.00

FITTING MEGAPHONE TO RECEIVERS.

Many experimenters desire to increase the distance at which signals can be heard



An Easy Way to Attach Megaphone Horn to Telephone Receiver.

from a telephone or radio receiver by means of a megaphone. Their chief difficulty is in fastening the megaphone to the recever properly. The accompanying illustration shows a satisfactory method of overcoming this difficulty without the use of glue.

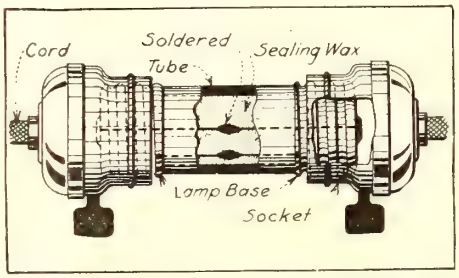
Contibuted by F. WESLEY MEYER.

EXPERIMENTERS!!!

Don't forget to write up that little "stunt." It may win a prize. Address all manuscripts to the Editor, Electrical Experimenter, 233 Fulton Street, New York City.

PLUG TO CONNECT TWO SOCKETS.

This is a plug for connecting two sockets. It is constructed from 2 brass lamp base caps. The wires are connected together and soldered as shown, a card-board or



Take Two Old Screw Lamp Bases, Solder the Lead Wires as Shown, Seal up in Fiber Tube and You Have a Handy Socket Connector.

fiber tube being placed in position first. The inside of the tube is filled with sealing wax. It may be used to connect two sockets together, et cetera.

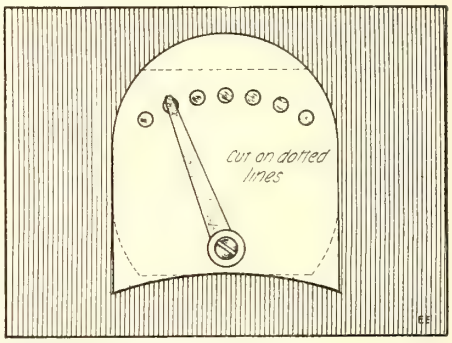
Contributed by LOUIS DROTAR.

THIRD PRIZE, $1.00

HELP! SWITCHES MADE FROM RUBBER HEELS.

Do you wear rubber heels on your shoes? Well and good—here's a fine use for electrical experimenters' old rubber heels—but not too old, mind you. Carve out a switch base as shown by the dotted lines by means of your favorite jack knife. Next—drill the proper number of holes to accommodate the switch points and blade stud. Rubber is a good insulator as we all know—besides it's a good "shock" absorber—what? Say, Brother Ohm, how 'dye get that way?

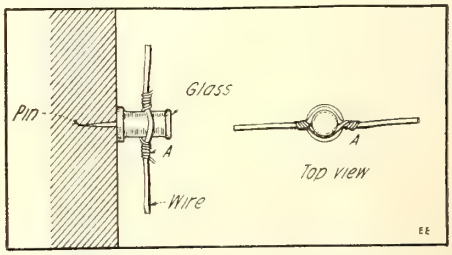
Contributed by RUDOLPH BOSSEN.



Rudolph's the Boy!! Yep, You've Guest It. A Switch Made from an Old Rubber Heel..

A CHEAP AND ATTRACTIVE INSULATOR.

A great many experimenters have big, unsightly, split knob or cleat insulators around on the walls of their rooms to support a measly No. 18 wire. Instead of this, I use "Moore" glass push-pins, which can be purchased at any book store. I used them as illustrated herewith. The live wire is held by a smaller wire "A." A small

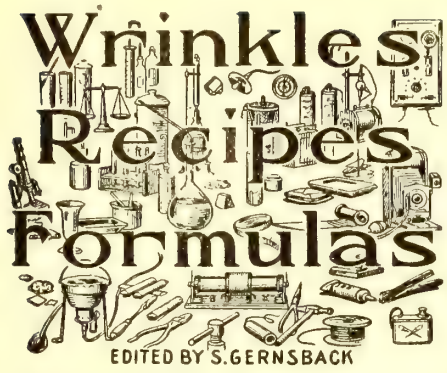


The Glass "Push Pin" Finds a New Field of Usefulness Serving as Insulators for Low Voltage Wires.

wire will slip thru the hole in the split knob and cleat insulators and look baggy, but not so with this kind of insulator. These push-pins are easily and quickly put up and if taken down do not leave a large gaping hole in the wall.

Contributed by S. T. MAUNDER.

To clean soldering iron tips badly blackened, rub the hot tip in sal-ammoniac on a brick. If corroded file smooth first.



Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

Experimenter's Aphorisms

In the following, we wish to give to the Experimenter some hints as to the use of the different ingredients and how to work them:

(1 Always bear in mind that exact working of a formula requires ACCURACY, CLEANLINESS, PATIENCE, and SKILL.

(2) Know what you are about, before you start to experiment.

(3) "THE HISTORY OF FAILURES IS THE HISTORY OF SUCCESS" goes an old adage, and it applies well to the experimenter.

(4) Many times impure, wrong or deteriorated raw materials, spell FAILURE instead of SUCCESS.

(5) A great many of the chemicals and ingredients required, cannot be obtained from drug stores; buy them at a reputable supply house.

(6) BEFORE CONDEMNING A FORMULA, be sure the fault does not lie with the manner of handling it, or the purity of the ingredients.

(7) Be sure to mix the materials comprising a certain formula in the proper sequence.

(8) When starting to prepare a mixture, especially one containing liquids, ask yourself: "IS THE SPECIFIC GRAVITY CORRECT, AS INDICATED BY A HYDROMETER? IS THE TEMPERATURE RIGHT? IS THE QUANTITY OR WEIGHT RIGHT?

(9) Acids and water, when mixed, should be manipulated in the proper manner, i. e., THE ACID SHOULD BE POURED INTO THE WATER, and not vice versa, as the solution is liable to be forcibly ejected from the containing vessel and into the mixer's face.

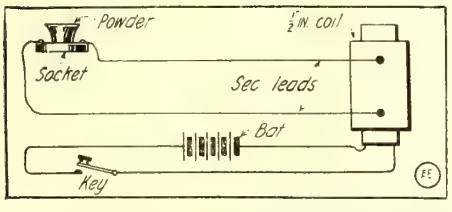
(10) For any kind of SYSTEMATIC WORK, a floating THERMOMETER and HYDROMETER, as well as measuring glasses and scales, should always be provided, as GUESSWORK is EXPENSIVE, and SOMETIMES FATAL.

(11) Put labels on ALL bottles, boxes and packages with FULL INSCRIPTION as to their contends, it will avoid troubles and mistakes.

(12) Remember that a beginner cannot expect to make articles AT FIRST, which will compare with regular manufactured products.—S. G.

USING TELEPHONE MOUTH-PIECE AS FLASH-POWDER HOLDER.

An ordinary telephone mouth-piece forms a handy container for flashlight powder which is to be ignited from an induction coil or 110 volt circuit. The mouth-piece is



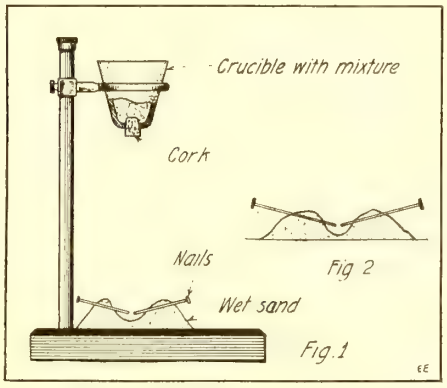
Make a Flash-Powder Holder Out of That Old Telephone Mouth-piece. A Spark Coil Ignites the Powder.

mounted upright on a block of wood with two wires attached to it in such a way that a small spark gap is left inside the mouth-piece. Over this the powder is placed. When the push button in the primary circuit is prest the induction coil spark jumps the gap, igniting the flash-powder safely and accurately. Keep your face at least 3 to 5 feet from the powder when igniting it, and don't let your hands get closer than this either, unless you want a nasty burn.

Contributed by an EXPERIMENTER.

AN EXPERIMENT WITH "THERMIT."

"Thermit" consists of a mixture of aluminum and the oxid of an element—usually



Do You Know What "Thermit" Is? This Experiment Will Get You Acquainted With It. One Use of It Is to Weld Street Car Rails.

a metal—to be reduced, as Fe_2O_3, MnO_2, SiO_2, etc. The aluminum has such intense affinity for oxygen that it reduces the oxides to their metals, giving a temperature of 3000 deg. or over.

The equation of the following is:

$$Fe_2O_3 + 2Al = Al_2O_3 + 2Fe$$

Mix equal quantities of iron oxid and aluminum and place in a clay or sand crucible, thru the bottom of which a ½ inch hole has been drilled, and the hole fitted with a cork. Support the crucible on a ring support or a ring stand, as shown in Fig. 1. Place some wet sand in a pan, and set about 6 inches under the crucible. A small hole is made in the sand with the finger and two nails placed in it as shown in Fig. 2. They should just touch each other. A piece of magnesium ribbon is placed in the mixture in the crucible and ignited. As soon as the ribbon is lighted the cork should be removed with a pair of pliers. This must be done *quickly*, and the operator should *step aside* and avoid being burned by the spattering which is quite considerable. The molten mass will now pour into the hole in the sand and weld the nails together.

Contributed by JOSEPH GRAHAM.

GLUE RECIPES.

Glue to Resist Moisture—One pound good flake glue, melted in two quarts of skimmed milk.

Glue-Cement to Resist Moisture—Four parts good glue, 4 parts black resin, 1 part red ochre; mix with least possible quantity of water.

Marine Glue—One part of India rubber, 12 parts of mineral naphtha or coal tar; heat gently, mix and add 20 parts of powdered shellac; pour out on a slab to cool. When used, it should be heated to about 250° Fah.

Contributed by FRED WILKINSON.

A SUBSTITUTE FOR WAX COMPOUND.

When wax compound has gone up from 20 to 40 cents a pound it is not easy for the "lean-pocketbook experimenter" to encase large high frequency coils in the same. Below is a thoroly tried out system which is guaranteed to work well.

Thoroly shellac the coil three times with orange shellac. Let each coat dry well, and when the last one is ready rub well with linseed oil, place in a snug box and pour a mixture of plaster of paris and water (thick) into the box, so that it is thoroly encased. When hard it may be left in a box or taken out and polished with oils and varnishes. This idea, if followed out correctly, makes a neat and compact and truly *invulnerable* coil.

Contributed by DEWELLYN P. COTTMAN.

HOW TO "SOLDER" CARBON.

Carbon may be soldered in the following manner: First clean the place to be soldered and then cover the rest of the article, which will necessarily be submerged in the solution, with vaseline. Now, place the article in a concentrated solution of copper sulfate for a few moments, then remove it and clean; repeat this till the plating becomes plainly visible. The joint may now be soldered in the usual manner with paste and soldering iron. It is best to make the joint on a projection, because it can be plated easier. This joint may be used for the pig-tails on carbon brushes, battery rheostats made of pieces of carbon connected to switch points and also to small battery carbons.

Contributed by E. S. COOKE.

CHEMICAL FIRE FORMULAS.

Put 9 drops of glycerol on a small piece of paper in an evaporating dish. Then cautiously place 6 measures of potassium permanganate on the glycerol. Keep your face away. It will burn brightly with a lilac color and carbon dioxid (CO^2) is evolved. The lilac color comes from the element potassium.

The Manufacture of Colored Fire: Mix thoroly on a piece of paper 4 parts of barium nitrate, 4 parts of potassium nitrate, ½ part of sulphur and 1 part of powdered charcoal. Pour this mixture in an evaporating dish. Apply match. The mass will take fire and burn with green fire.

Contributed by JOHN R. BROSNAN.

AN INTERESTING CHEMICAL EXPERIMENT.

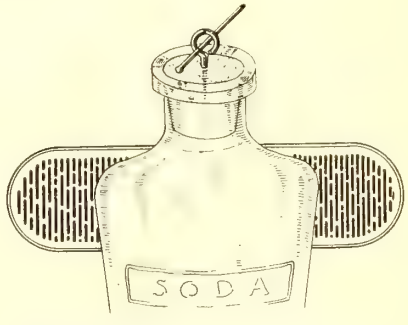
Dissolve a little cobalt chlorid in some aque regia (by heating). The mixture will be green. Add a few drops of water and it will turn red. Add three times as much water as mixture and use for invisible ink; when heated it will turn blue.

Another Invisible Ink: Dissolve equal parts of copper sulfate and ammonium chlorid in water until it becomes light green. When heated it will turn yellow.

Contributed by GEO. VAUGHAN.

EMERGENCY CORK SCREW.

Recently I had occasion to open a bottle and, not having a cork extractor, very simply accomplished my purpose by using an ordinary screw eye in combination with



A Cork Screw in a Jiffy—Simply a Nail and a Screw Eye Do the Trick.

a nail, as shown in the drawing. The use of the latter provided a better means both for turning the screw and pulling the cork out.

Contributed by JOHN T. DWYER.

Experimental Chemistry

By ALBERT W. WILSDON

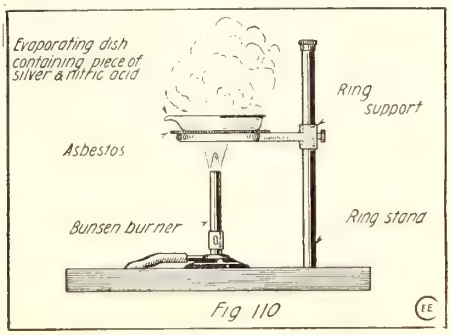
Twenty-Third Lesson

Experiment No. 113.

Silver and Copper With Nitric Acid.

PUT into an evaporating dish a piece of silver and pour over it 2 cc. (measured) of nitric acid. Place the dish on a ring stand over asbestos or iron gauze and apply heat until strong fumes begin to appear; then remove the lamp from beneath the dish and permit the action to continue as long as it will.

Mr. D. J. Thomson in the February issue

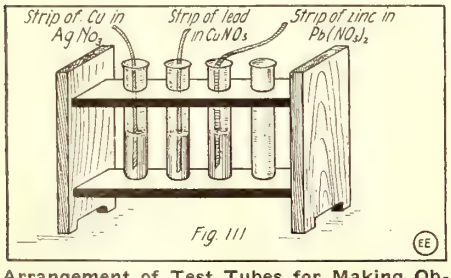


How Apparatus Is Arranged for the Preparation of Silver Nitrate.

of the ELECTRICAL EXPERIMENTER, page 699, described a method of preparing pure silver from a silver coin. The editorial note appended thereto should be read carefully.

For the purpose of illustrating the action which takes place upon the decomposition of a silver coin as described in the article above mentioned, let us mix 90 per cent of silver and 10 per cent of copper (which is approximately the composition of a 10-cent piece). Place these in an evaporating dish and add 2 cc. (measured) of nitric acid. What action do you notice first? What color has the liquid? Examine some silver nitrat and copper nitrat in solid form and in solution, and see if you can explain the color you obtained. Is the discoloration due to the copper or the silver? Are any crystals formed in your solution? If so, describe them as to shape, color, etc., and try and identify them. What does your solution apparently contain?

When the action wholly stops, remove any solid particles and add 10 or 15 cc. of water, stir it till any crystals dissolve; if the solution is not clear, filter it; pour it into a clean tube (saving a little in another tube for comparison), and suspend in the solution a copper wire (No. 9 or 10 B. & S.) made bright by running a piece of emery paper over it, or in place of the wire use a strip of copper. See Figs. 110 and 111. Note any immediate action; then allow the solution to stand, proceeding with other experiments.



Arrangement of Test Tubes for Making Observations of Actions of Different Metals on Various Solutions

At the end of half an hour or so examine the contents of the tube with care, noting the color, luster and shape of the deposit. To ascertain whether it is amorphous or crystallin, examine some of it under a microscope. Has the solution changed color? Compare with the previous solution. If so, state how, and account for it. Notice whether that part of the copper wire in the liquid has been reduced in size. Try and account for any change in the size of the wire.

Wash the deposit from the wire into a dish, return the wire, and wash the deposit several times by decantation, with stirring, and when every trace of copper nitrat solution is washed out, put away the silver in a vial and label it for future use, reserving a very little to dissolve in a few drops of nitric acid. The ionic equation for the action of nitric acid on silver is

$$3\ Ag + \overset{+}{4H} + \overset{-}{4NO_3} = 3\ \overset{+}{Ag} + \overset{-}{3NO_3} + 2H_2O + NO$$

In the above, 3 atoms of silver replace 3 hydrogen ions and become 3 silver ions; 4 hydrogen ions unite with 2 oxygen ions (thus breaking up one NO_3 ion), seizing upon enough oxygen to combine with it, forming two molecules of water and leaving a molecule of the gas-NO.

The ionic equation for copper acting on the solution of silver nitrat is:

$$Cu + \overset{+}{2Ag} + \overset{-}{2NO_3} = \overset{++}{Cu} + \overset{-}{2NO_3} + 2Ag$$

The common parts, $2NO_3$, may be cancelled. One copper atom forms a copper ion and deposits two atoms of silver. Atoms and ions thus change places.

Experiment No. 114.

Copper and Lead With Nitric Acid.

Place 2 grams of copper scraps in a dish and pour over them 2 cc. of nitric acid. If the acid is concentrated, no heat need be applied.

As in the previous experiment notice all the phenomena of the gaseous, liquid and solid products.

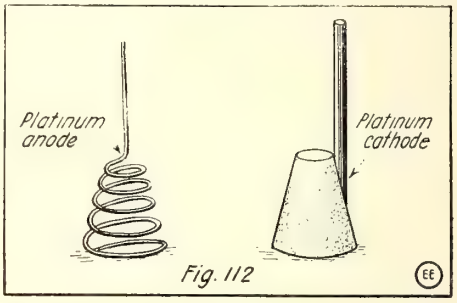
When chemical action has stopt, add 10 or 15 cc. of water and stir the mixture; then filter it (unless it is perfectly clear); save 2 or 3 cc. of it to compare as to color with that obtained by the next process. The remainder is to be poured into a narrow tube and a strip of sheet lead or a piece of lead wire (No. 9 or 10 B. & S.), made bright by filing or by sand-papering, hung in the liquid and extended to the bottom. If after a few minutes no deposit is noted, warm the tube and let it stand for half an hour, noting occasionally whether anything is depositing on the wire or at the bottom. If much free acid, due to adding an excess of nitric acid, is present, considerable effervescence will ensue. This is to be avoided by measuring the acid at the beginning of the experiment and making sure that all has reacted with the copper. If the deposit on the wire is small, it may be left for twenty-four hours.

Finally take out the wire, scrape off the deposit in a dish, and return the wire after noting the relative sizes now and at the beginning. Filter the liquid and compare its color with the sample taken earlier in the experiment. Try and account for any difference. Any deposit at the bottom of the tube should be put with that taken from the wire and washed several times by decantation, with stirring; then put it into a vial or tube and label it, except a little that should be placed in a dish and tested with a few drops of nitric acid. Think out carefully all the results obtained and make full notes, with an explanation of all phenomena and reactions; also try and reason out the two ionic equations.

Experiment No. 115.

Lead and Zinc With Nitric Acid.

Into a porcelain dish put about 2 grams of lead fiber or a piece of sheet lead, about a quarter of an inch square, and pour over

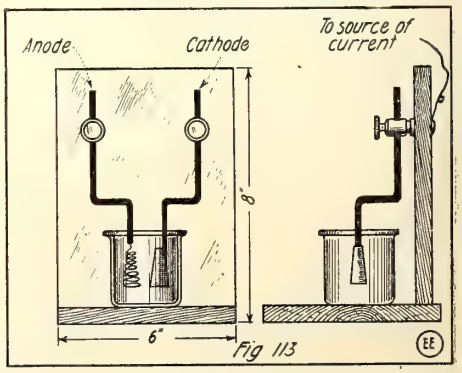


In Electrolytic Work, Electrodes of Platinum Should Be Employed Similar to the Ones Here Illustrated.

it 5 or 10 cc. of nitric acid which has been diluted with an equal volume of water. Heat the dish for five minutes; then as soon as the action stops add 10 cc. water, stir it, take out any excess of metal, and filter the solution unless it is clear. Hang in the narrow tube containing the filtrat a piece of zinc wire (No. 9 or 10 B. & S.) or a strip of zinc, leaving it for at least half an hour (or, better, for twenty-four hours). Then take out the wire, remove the residue to a dish, wash it by decantation several times, and put it into a vial and label it.

Make as close observations and take as full notes on all parts of this experiment as you did in the two previous ones. Examine specimens of lead nitrat and zinc nitrat both in solution and in the solid state. Of two elements, the one that drives the other out of solution is said to be *electropositive* to the one deposited or driven out. Of the nitrates in the last three experiments, namely, lead, silver and zinc, and hydrogen (nitric acid), arrange the elements according to their *electrochemical affinities,* placing the symbol of the *most positive* or the *plus* first, then in regular order to the *most negative* or *minus.* A negative ion is driven out of solution by a more positive ion, each ion replacing other ions according to its

(*Continued on page* 861)



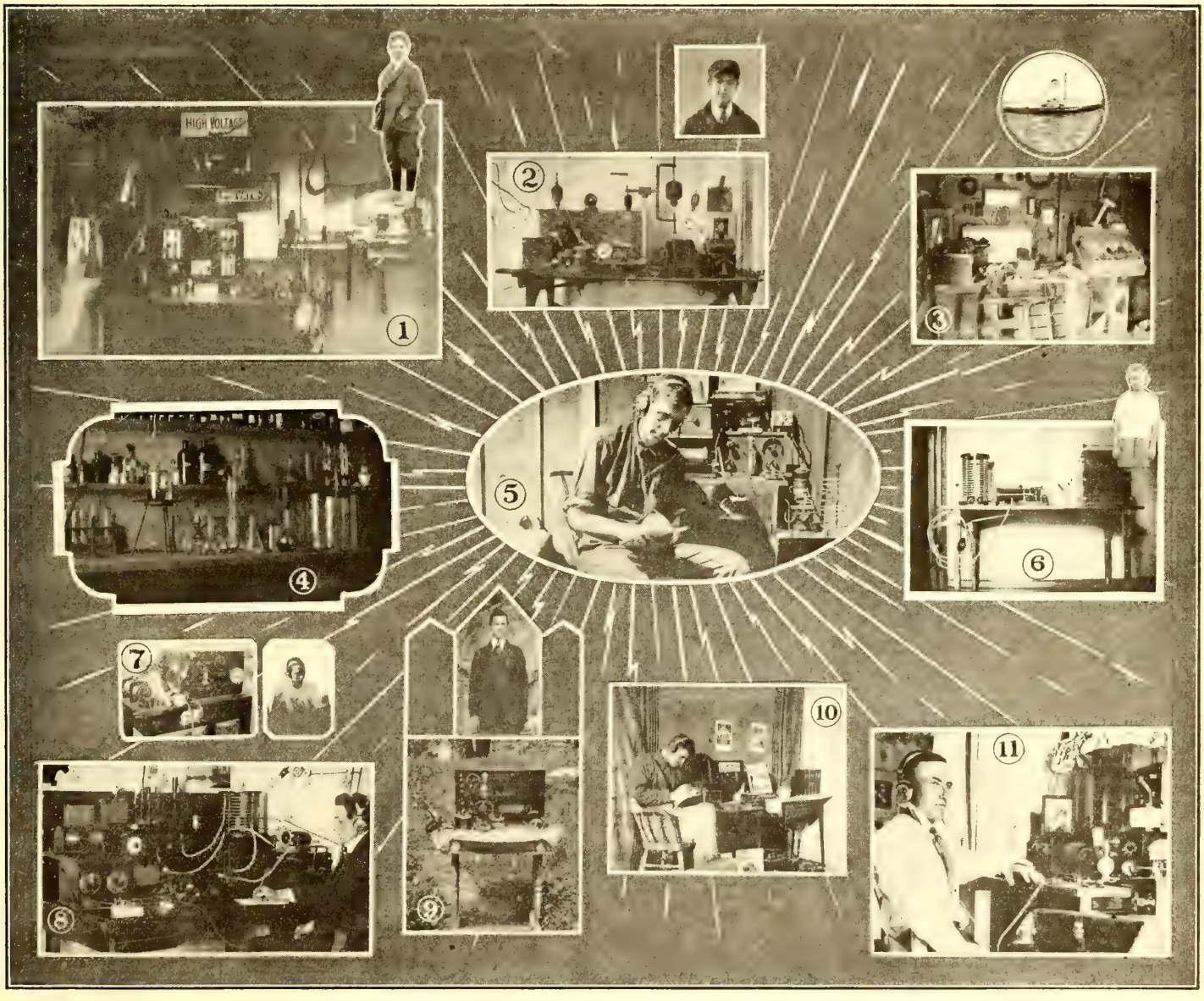
A Simple, Yet Rugged, Electrolytic Apparatus Which the Amateur Electro-Chemist Can Construct In a Few Minutes' Time and Which Is Adjustable for Different Size Bearers.

WITH THE AMATEURS

Our Amateur Laboratory Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of apparatus unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month **$3.00** prize for the best photo. Make your description brief and use only one side of the sheet. Address the Editor, "With the Amateurs" Dept.

"Electrical Laboratory" Contest

In the March issue we publisht an interesting story with a number of excellent photos, describing one Amateur Electrician's experimental laboratory. Now "Bugs"—we want to publish a similar articles each month. Here's our proposition: Why not write up your "Electrical Lab.," in not more than 500 words. Dress it up with several good, clear photographs. If we think it good enough we will publish the article in display style and pay you well for it. The remuneration for such articles will range from $5.00 to $10.00. And "Bugs"—don't forget to make your article interesting. Don't write—"I have a voltmeter, an anmeter, a switchboard," etc., *ad infinitum*. For the love of Pete put some punch in it! Tell us what you do with your instruments and apparatus. You don't mean to tell us that every Experimenter does exactly the same thing. "We" know different—but from the general run of such articles which we have received in the past, one would naturally think every "Lab.," exactly alike. Remember—send a photo of YOURSELF along. Typewritten articles preferred. Tell us the facts and don't send in photos smaller than 3¼" by 4¼". They must be sharp and clear—not veritable "picture puzzles." We can read—but we are not mind-readers. Address the Editor "With the Amateurs Prize Contest."



A GROUP OF REPRESENTATIVE AMERICAN AMATEUR LABORATORIES.

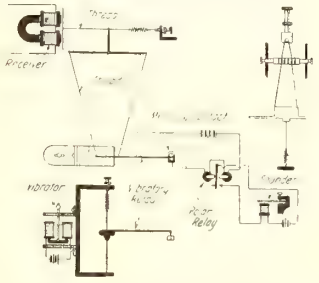
Electrical Laboratories of, 1—Gregg Toland, Los Angles, Cal. (Prize Winner); 2—Arthur Lott, Whiting, Ind.; 3—Jack Stranger, Spokane, Wash.; 4—Carroll Tobias, Bethlehem, Pa., Radio Stations of; 5—H. Gerky, Las Crosse, Wis.; 6—Earl Fraser, Denver, Colo.; 7—Fred Dickely, Brooklyn, N. Y.; 8—B. F. Wing, Idaho Falls, Idaho; 9—W. S. Wellington, Waltham, Mass.; 10—Edgar Lerew, Harrisburg, Pa.; 11—Carroll S. Miller.

LATEST PATENTS

Radio-telegraphic Recorder

(No. 1,251,473; issued to William M. Bruce, Jr.)

A system for effecting a permanent record of radio-telegraphic signals. A telephone or radio receiver has its diafram connected up mechanically with a vibratory relay member, by means of light threads as shown.

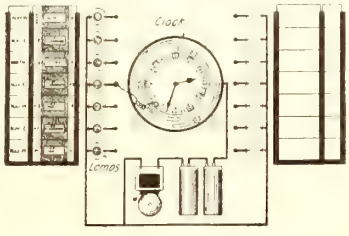


The vibratory relay is kept in the proper state of vibration by an electro-magnetic self-interrupting device. The vibratory relay armature closes a tape recorder or sounder local circuit thru a mercury cup contact. The inventor states that to obtain maximum results the vibratory relay armature should be turned so that its natural period coincides with the periodicity of the current actuating the receiver diafram.

Electric Zig-Zag Course Control

(No. 1,253,816; issued to Ernest E. Hall.)

This ingenious anti-submarine scheme for ships was described at length in the October, 1917, issue of this journal, together with later improvements whereby the device is caused to act automatically on the vessel's steering gear and thus zig-zag the ship over a predetermined course without the human element entering into the operation. In the

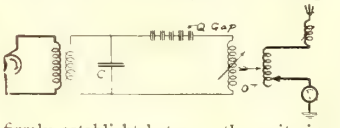


present patent the zig-zag course is plotted by the navigating officer, so that each leg of the course, consumes various increments of time. As each successive leg of the course is sailed, the helmsman removes the contact plug on the clock and sets it for the next lap. As each lap is run off, the alarm bell rings, notifying the helmsman to shift the clock contact a lap ahead and also to shift the rudder for the new direction.

Quenched Spark Gap

No. 1,1253,103; issued to Emil J. Simon.)

Quenched spark gap design for application in radio-telegraphy. The design embodies a system of building up the quenched gaps in units of say two gaps, as here shown. After assembly any number of units can be placed end to end in a common frame or holder, contact being

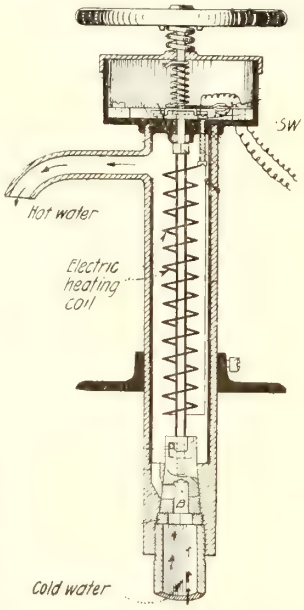


firmly establisht between the units in the manner apparent. The patentee prefers to make the gap plates of brass or other suitable material, having inset sparking surfaces of electrolytic copper. These surfaces are very close together, or about .01 inch apart. The plates of each gap unit are held together by insulating screw bushings. The plates are insulated from one another by mica or comprest paper rings.

Electric Hot-water Spigot

(No. 1,252,661; issued to Howard K. Clover.)

An instantanious electric hot-water spigot which can be attached to any pipe outlet. It may be connected with the nearest electric light socket, or floor receptacle. A turn of the handle at the top of the spigot is all that is required to turn on the water, close the electric circuit thru the heating coil (disposed vertically, as shown, in the chamber thru which the cold water passes on its way to the efflux nozzle) and get instant

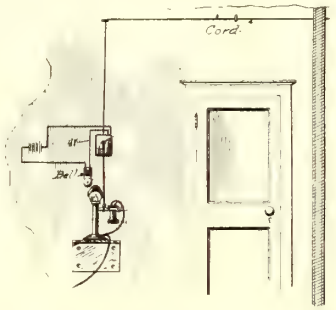


hot water. Another turn of the handle, and the water is shut off, as well as the electric current. By turning the handle a certain way, cold water may be drawn from the spigot.

Automatic Telephone Fire Alarm

(No. 1,252,665; issued to Lee A. Collins.)

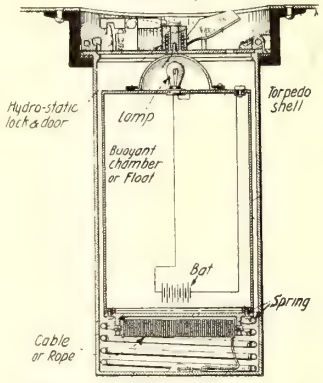
Why not transmit an alarm of fire directly over the telephone to "Central" thought this inventor, and this is what he actually does. It operates on the principle that we do not have to remove the receiver from the hook



to communicate speech or other sounds to Central. This being the case the inventor proposes to rig up a cord which, when burned or otherwise severed, causes a weight to fall —and wind up a drum which lifts the telephone hook with its receiver. Also an electric alarm bell circuit is closed; thus Central hears the bell.

Sunken Torpedo Indicator

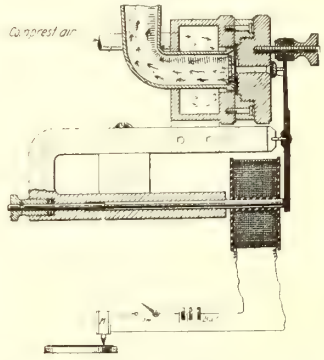
(No. 1,252,877; issued to John B. Barrett.)



Should the torpedo, as when used for practise, etc., sink to the bottom of the bay or river, a clever hydrostatic lock functions, due to the increased water pressure, opening the retaining door and liberating the "float." This is attached to the torpedo by a cable or rope; it also carries a signal lamp and battery so as to be readily seen when it reaches the surface of the water.

Electro-pneumatic Amplifier

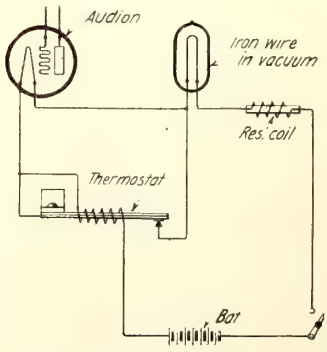
(No. 1,253,533; issued to Harrison W. Rogers.)



cuits. The voice waves from whichever source they may come, actuate a microphone or equivalent device, which is connected in circuit with a battery and the electric magnetic winding on one leg of the polarized reproducer, here illustrated. The voice fluctuations cause corresponding electric current fluctuations thru the magnet coil mentioned, these in turn acting on a balanced, pivoted armature bar. This bar controls a diafram air valve as the cut shows, causing rythmical puffs of comprest air to pass into a reproducing horn;

Audion Protective Circuit

(No. 1(252,502; issued to Herbert E. Shreeve.)

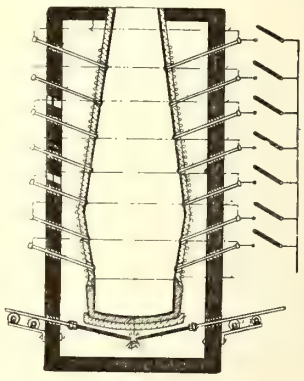


Connected in circuit with the filament and battery there is a thermostat of usual construction, also a ballast resistance element, as well as a retardation coil. The ballast is made of iron wire member in a vacuum chamber, containing hydrogen. This ballast acts to automatically regulate the current in the circuit in a well-known manner, once it is heated.

Electric Ore Furnace

(No. 1,252,635; issued to John A. Ward.)

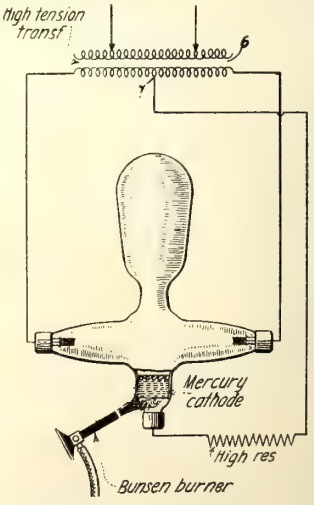
In this furnace the ore body itself is used as an electric heating element, and further, the heat generated by the controlling device is utilized, thus eliminating the usual source of waste. Conducting pencils are inserted in openings in the furnace wall at various heights as shown, any or all of which may be connected in circuit. The resistance coil (generating heat) is wrapt around the furnace. Below the crucible are the arc-forming contacts. The furnace is filled with ore from the top; it is started by closing the proper switches, springing the arc at the bottom, thence thru the resistance coil, and thru whatever electrodes above the arc that are connected in circuit.



Vacuum Regulation for Rectifiers

(No. 1,251,562; issued to H. A. Newcomb.)

This patent provides a means for regulating the degree of vacuum in mercury vapor rectifiers, and similar devices, employing a cathode of mercury or some other reconstructing, conducting material. The inventor first heats the cathode by a Bunsen burner for example; just sufficiently to vaporize a small portion of the mercury. By means of an adjustable high-potential transformer 6, a high-potential discharge of considerable



amperage is caused to flow between the anodes and thru the current-conducting bodies evolved from the heated cathode. This H. P. discharge causes intense local heating of the anodes, serving to set free occluded gases therefrom; thus lowering the vacuum.

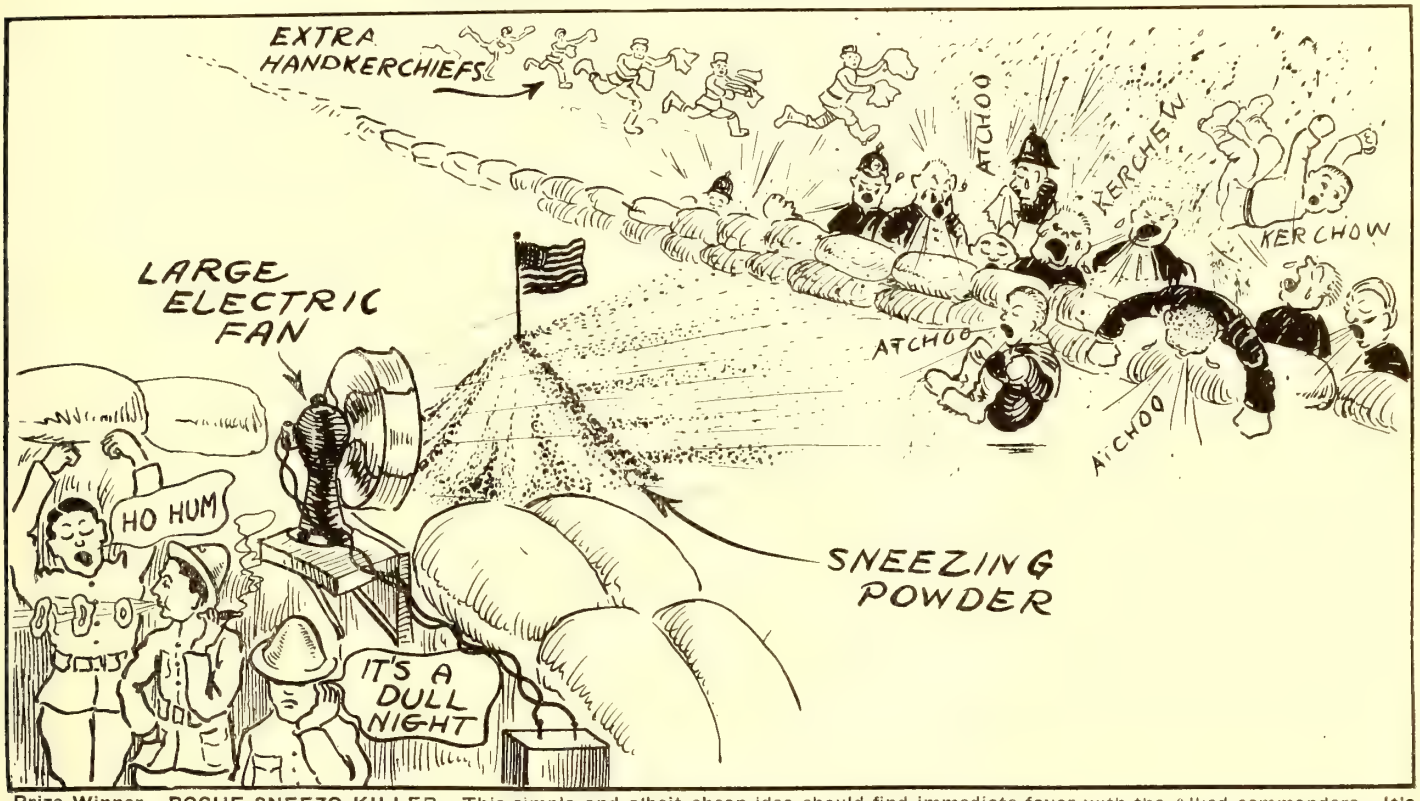
COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c EACH.

Phoney Patents

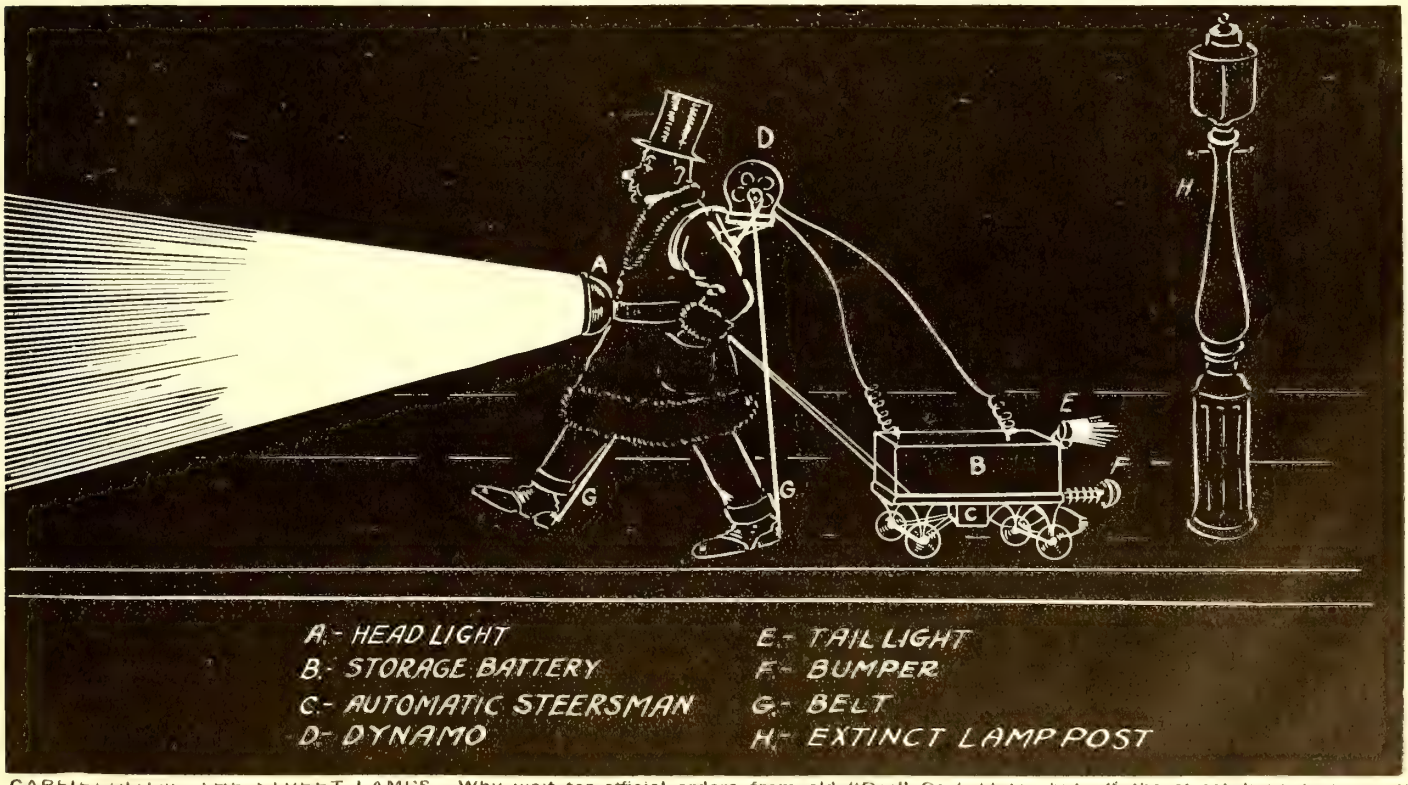
Under this heading are publisht electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for the entire universe.

We are revolutionizing the Patent business and OFFER YOU THREE DOLLARS ($3.00) FOR THE BEST PATENT. If you take your Phoney Patent to Washington, they charge you $20.00 for the initial fee and then you haven't a smell of the Patent yet. After they have allowed the Patent, you must pay another $20.00 as a final fee. That's $40.00! WE PAY YOU $3.00 and grant you a Phoney Patent in the bargain, so you have $43.00!! When sending in your Phoney Patent application, be sure that it is as daffy as a lovesick bat. The daffier, the better. Simple sketches and a short description will help our staff of Phoney Patent examiners to issue a Phoney Patent on your invention in a jiffy.

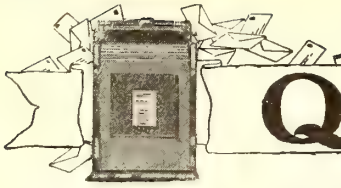
PHONEY PATENT OFFIZZ



Prize Winner. BOCHE SNEEZO KILLER. This simple and albeit cheap idea should find immediate favor with the Allied commanders. It's the only guaranteed, sure-fire modus operandi by which to break the Hindenburg line. On a nice dark night the Allied trench inmates deposit a fine, large heap of "sneezo" powder in no-man's land, at intervals of 100 feet. On top of the trench set a large 500 H. P. electric fan. Turn the switch. Oh! Gazuka! The Germany army sneezes itself to death—the "Reserves"—Oh! they're kept busy bringing up handkerchief reinforcements! Inventor, Paul F. Henning, Harrison, Pa.



GARFIELDIZING THE STREET LAMPS. Why wait for official orders from old "Doc" Garfield to shut off the street lights? Use my unpatented automatic, pedestrian-operated electric head-light. Its operation is simplicity itself. Every step counts, as it is geared up to spin the dynamo 50 Revs. per sec. The dynamo charges the storage battery; battery lights head-light as well as tail-light. You can't go wrong with this simple device. And it "burns no fuel"—neither does it use energy derived from fuel. We hear the "Doc" calling "James, the ice water," Inventor, Herbert N. F. Willcox, S. C. S., West Hoboken, N. J.



QUESTION BOX

This department is for the sole benefit of all electrical experimenters. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be publisht. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addrest to this department cannot be answered by mail free of charge.
4. If a quick answer is desired by mail, a nominal charge of 25 cents is made for each question. If the questions entail considerable research work or intricate calculations a special rate will be charged. Correspondents will be informed as to the fee before such questions are answered.

LEARNING ARMATURE WINDING TRADE.

(909.) H. M. Rodriguiz, Calif., writes:

Q. 1. Can I learn the trade of "Armature Winding" successfully from a correspondence school?

A. 1. Armature Winding is practically a trade by itself, and it is usually the best policy to acquire this trade in an electrical repair shop or manufacturing plant where such work is performed. It is rather difficult to learn all the practical details of the art just from books.

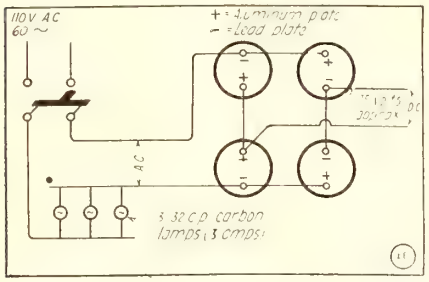
However, there is a large amount of technical detail connected with the understanding of armature winding which can be procured from a good correspondence school course, and we would strongly recommend that you get in touch with the correspondence schools advertising in THE ELECTRICAL EXPERIMENTER.

ELECTROLYTIC RECTIFIER.

(910.) W. A. Osborn, Cleveland, Ohio, wants to know:

Q. 1. How to make an electrolytic rectifier.

A. 1. The best home-made rectifier is constructed as follows: Procure four jars



Hook-Up for Four-Cell Electrolytic Rectifier Used to Convert A. C. to D. C., for Charging Storage Batteries, Etc.

having a diameter of four inches and about eight inches high, and make proper covers for these jars of wood dipt in hot paraffine. Fasten to these four pieces of wood an aluminum plate and a lead plate, the aluminum plate to be 4 x 6 inches while the lead plate should be 3 x 6 inches.

You should then proceed to fill the jars with an electrolyte made up by dissolving as much sodium phosfate as the solution will dissolve without a precipitate, when filled to one inch from the top with water. It will then be necessary to add a few drops of sulfuric acid to reduce the resistance of the electrolyte, depending upon the amount of current you wish to draw. Diagram of connections is given herewith for four-cell restifier, which rectifies both halves of the A. C. cycle.

MAGNETIC TEST FOR BRASS.

(911.) C. Robinson, Victoria, Australia, asks:

Q. 1. For a good test to determine things that are made of brass.

A. 1. One of the simplest methods of determining whether an article is made of brass or not is by means of a steel magnet. Of course, an article might look as if it were brass and be of some other alloy, but if the magnet does not exert any effect on it, it is always possible to determine in this way that the article is not iron or steel or any alloy containing a reasonable percentage of these metals.

THE USE OF "DUMMY ANTENNAE."

(912.) Harry E. Longmire, Missouri, inquires:

Q. 1. I want to know if the United States Government demands of us amateurs that we do away with our radio sets altogether, forbidding the use of "dummy antennae" and of doing radio research work.

A. 1. The U. S. Navy Department, who have charge of all radio communications and stations at the present time, do not allow any form of radio station to be put into operation with any kind of aerial, and also they do not permit the use of "dummy antennae" for the testing of apparatus, except in duly licensed research laboratories.

There are a number of articles explaining how to carry on radio communication over short distances in the September, 1917, issue, and which you will undoubtedly find very interesting.

ODD PHOTOS WANTED AT $1.00 EACH ! ! !

Now is the time to make your Kodak pay for itself in a real practical way. We are after interesting photographs of out-of-the-ordinary electrical, radio and scientific subjects and are willing to pay $1.00 *cash for every one we can use. Please bear in mind that for half-tone reproduction in a magazine, a photograph should be particularly sharp and clear. Of course, if a subject happens to interest us particularly well, we can have the photo retouched. For the general run of subjects, however, it does not pay to go to such expense. Therefore, please take pains to properly focus and expose your pictures. It often happens that a really mediocre subject well photographed wins approval over an excellent subject poorly photographed. And don't send us plate or film "negatives"; send unmounted or mounted "prints," perferably a light and a dark one.*

As to what to photograph: Well, that's hard for us to say. We leave that up to you, and every reader now has the opportunity to become a reporter of the latest things in the realm of Electricity, Radio and Science. But, please remember—it's the "odd, novel or practical stunts" that we are interested in. Every photo submitted should be accompanied by a brief description of 100 *to* 150 *words. Give the "facts"—don't worry about the style. We'll attend to that. Enclose stamps if photos are to be returned and place a piece of cardboard in the envelope with them to prevent mutilation. Look around your town and see what you can find that's interesting.*

Address photos to — Editor "Odd Photos," ELECTRICAL EXPERIMENTER, *233 Fulton Street, New York City.*

WHAT IS SPONGY PLATINUM?

(913.) Charles Honeywell, Gloversville, N. Y., asks:

Q. 1. What is spongy platinum and where can it be obtained, as well as its present cost?

A. 1. Spongy platinum is a form of platinum which is very sensitive to gases; i. e., when this metal is exposed to a gas it absorbs the gas considerably, causing a compression in the metal which manifests itself as heat or incandescence. Automatic cigar lighters, gas detectors, etcetera, make use of this unique property of spongy platinum.

The price of this platinum changes so often that we cannot give you its present cost, but we would refer you to any chemical supply house.

ELECTRIC MOTOR IN VACUUM.

(914.) W. R. Oliphant, Healdton, Okla., writes the "Question Box":

Q. 1. Can I run a motor in a vacuum or would it burn out?

A. 1. Relative to your question on the heating effects of an electric motor running in a vacuum, we believe that the motor could be regulated so as not to generate too much heat and thus cause destruction to itself.

In any case, if the motor did generate too much heat it would seem that it could be gotten rid of by proper cooling devices placed without the vacuum chamber, and also by providing proper means for the radiation and conduction of the heat produced.

Q. 2. Would the motor run efficiently?

A. 2. In answer to your second question, wherein you ask whether the motor might run more efficiently in a vacuum, we are certain it would not do so, and that such a system of running motors in a vacuum is impracticable, for under these conditions it would be necessary to maintain a constant vacuum by means of pumps which would have to work constantly.

From a purely academic point of view, there perhaps would be gained a little, due to the fact that the armature would run without air-resistance, but the gain is very slight.

ELECTROLYTIC INTERRUPTER QUERY.

(915.) P. Barabino, Chicago, Ill., writes:

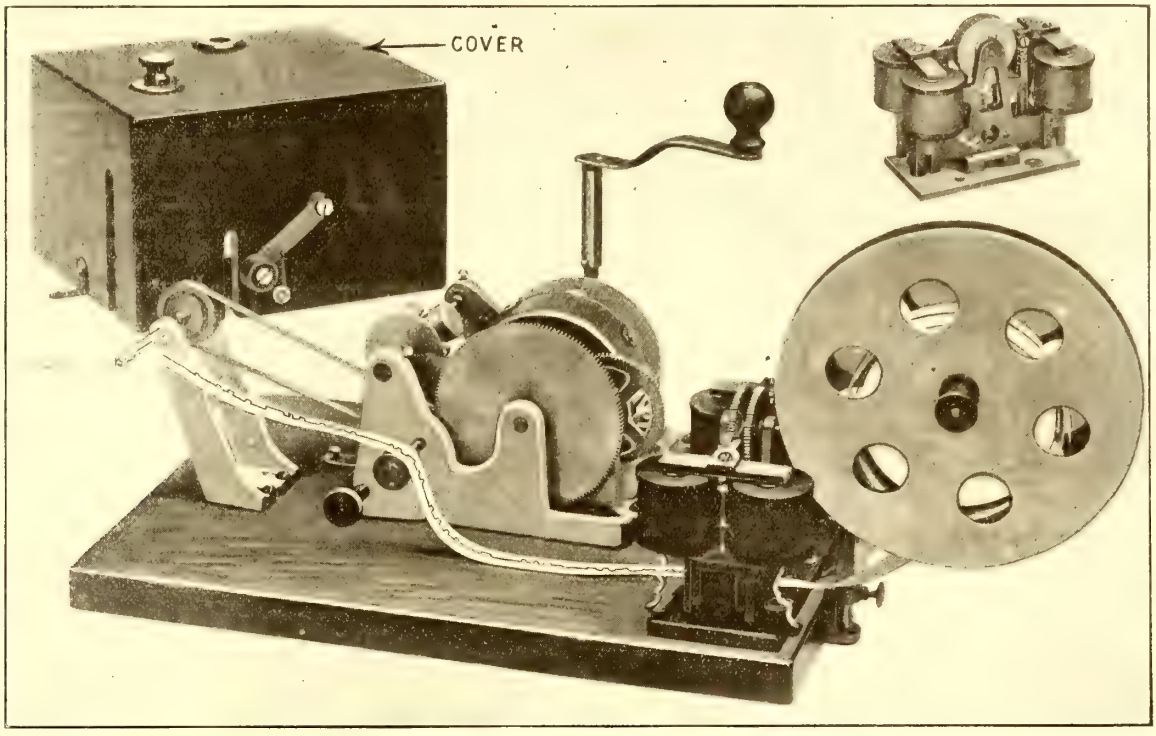
Q. 1. I am having trouble in operating a spark coil with an electrolytic interrupter. What would you advise?

A. 1. We believe the trouble to be with your electrolytic interrupter. A sure test for ascertaining this to be so is to connect

(*Continued on page* 856)

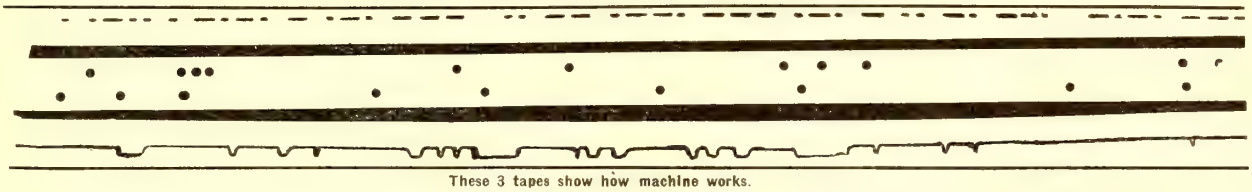
Amateurs! Experimenters!! Opportunity Extra-Ordinaire!

$70.00 for $15.00 !!



$70.00 for $15.00 !!

Size of machine 19½ x 9½ x 8½. Net weight 18 lbs.



These 3 tapes show how machine works.

STATEMENT BY MR. H. GERNSBACK, PRES'T:

"I have carefully read all the statements contained in this advertisement. Every word is true; nothing has been exaggerated. I believe this to be the greatest bargain,—the greatest value—that has ever been offered by my company to amateurs and experimenters, in its 14 years of existence." *ELECTRO IMPORTING CO., (Signed) H. Gernsback, President.*

HISTORY

The tape recording and perforating machine here illustrated and described is regularly manufactured by one of the largest electrical companies in the U. S. Some time ago a western telegraph company ordered a goodly quantity of these machines for their regular requirements. As we understand it, they paid over **$70.00** apiece for these recording machines. The machines were duly shipped West by Express, but the telegraph company having financial troubles could not pay the heavy express charges. Thereupon the machines were returned to New York **with added charges,** and were finally sold at auction by the express company to recover the transportation charges, as is customary. **We bought the entire lot of machines.**

DESCRIPTION

This is a standard commercial, large size, perforating, telegraph recorder. It is exactly the same machine as used by the Western Union and Commercial Telegraph Companies in their main offices. This machine requires a double contact (back stop) telegraph key and a few batteries. Pressing the key operates in turn the two sets of powerful electro-magnets, which on their part operate the two ratchet wheels. These then operate two plungers which punch the holes in the tape (see illustration of tape). By sending Morse code, the holes are punched in a certain manner. Then by feeding the tape back thru the machine and by arranging two brass contact fingers, the tape will spell out dots and dashes by means of a buzzer.

This machine has a truly wonderful spring motor. It is absolutely silent and has a centrifugal regulator speed-adjuster and stop arrangement. **At the highest speed the motor runs 18 minutes, at the slowest speed 65 minutes continuously.** Over all dimensions of machine are 19½ x 9½ x 8½. Diameter of holes punched 1/16". The width of paper tape is ½". Aluminum reel 6½" dia. The magnets measure 1½" dia. and are 1¼" high. **The net weight of the machine is 18 lbs.** Our illus. shows machine with cover removed to show motor. The small insert shows the beautiful tandem electro-magnet arrangement, the ratchet wheels and perforating equipment. All wood work is solid mahogany

USES

What you can do with this beautiful machine:

1ST—USE AS A PERFORATING MACHINE as already described. By means of a block of wood and a few bits of brass (or you can mount them on the base of the machine) you have a regular Morse sender and receiver. You can then ask a good operator to send you a long message and you can listen to the dots and dashes as often as you wish. The tape record thus prepared will last a very long time.

2ND—AS A REGULAR MORSE REGISTER. With instructions which we supply and by using only two magnets (instead of 4) and by making a few slight changes, **which any experimenter can do,** the machine will write regulation dots and dashes on the tape. A pencil lead is used to do this. **You can then hitch an omnigraph to the recorder, and you are now enabled to read the messages by sight.** Or you can send the message yourself with an ordinary key, etc., etc.

3RD—AS A SPECIAL REGISTER. By utilizing all four magnets a special type of dot and dash can be sent (as used in cable telegraphy). See sample of writing on the tape just leaving machine, above. This record can be read just as easy as regulation dot and dash (the dot is represented by the π sign). To send such signals a slight change is necessitated which can be made by any experimenter handy with tools.

4TH—AS A TELEGRAPHONE. Every experimenter has long wished for a real telegraphone, whereby the voice is recorded on a thin steel wire, and then reproduced over a cheap style 75 ohm pony telephone receiver. By means of this machine a very efficient telegraphone can be built by any experimenter handy with tools. No expensive extras are needed; a few bits of brass and steel will do the trick.

We furnish Blue Prints and full Directions to make all the above apparatus using the recorder. We also furnish 3 paper reel tapes, standard size.

Space does not permit listing all of the many good points of the recorder. Suffice it that the machine is the most expensive commercial type, with everything of the very best.

A similar machine is listed at **$100.00** in the catalog of the Western Electric Co. We bought these machines cheap thru auction, hence the ridiculously low price. **AND EVERY MACHINE IS BRAND NEW,** has never been used, and is in perfect working order—or money back.

We have not a very large quantity of these machines on hand and as we know that there exists a big demand for this recorder, we are almost certain that we will not run this "ad" again. This is your one chance,—grab it while the machines last—**you will never see such a bargain as long as you live**—we are quite certain of it.

The size of the machine being 19½ x 9½ x 8½, the net weight 18 lbs. (shipping weight 30 lbs.) make it necessary to ship it by express or freight. We guarantee immediate shipment within 24 hours after receipt of remittance. Order at once—today—so you won't regret. If you live far away you can make telegraphic reservation. In this case we will hold one or more machines awaiting your remittance.

Price as described complete

$15.00

THE ELECTRO IMPORTING CO.

231 FULTON ST., N. Y. C.

"Everything for the Experimenter"

See also our full page ad on page 809



2 Promotions --Pay Doubled

Mr. Victor C. Harvell, one of Uncle Sam's brave flying men, wrote us the other day as follows:

Aviation Field, Mineola, N. Y.

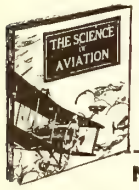
National Aero Institute, Chicago, Illinois

Gentlemen:—I have received two promotions due directly to your valuable lessons in conjunction with my training here in the United States Government Service. I have charge of a crew of men, a hangar and six airplanes. MY PAY HAS ALMOST DOUBLED. Sincerely,

VICTOR C. HARVELL,
23rd Aero Squadron,
Aviation Branch, United States Army.

Wanted--Men!

Yes, men who know the Science of Aviation. The United States Government plans to send 30,000 flying men to Europe and has appropriated $166,000,000 for new airplanes. The airplane companies need half a million men now. You can learn this science at home during your spare time. Your training will be under aeronautical experts—men like Walter Brock, the famous aviator that won the London to Paris race.



FREE BOOK!

Just put your name and address in the coupon and we will send you our free book about the Science of Aviation and our special limited offer on our complete Mail Course. Learn all about the great opportunities that are offered you in this new billion dollar industry. Tear out the coupon and mail at once. Do it NOW!

National Aero Institute,

Dept. 7444, Morton Building, Chicago, Illinois

Gentlemen:—Please send me absolutely free and prepaid your new book on the Science of Aviation; also particulars of your Mail Course in the Principles of Aviation and special limited offer.

Name . . . . . .

Address . . . . . .

MAKE YOUR OWN GENERATOR!

We have a complete line of sturdy efficient generators and alternators from 100 to 1000 watts. We furnish these complete, or parts furnished ready to assemble with wire and instructions to wind. Send for catalogue.

ALL AT FACTORY PRICES.

BERGMANN MOTOR WORKS, 1283 NIAGARA ST., BUFFALO, N. Y.

GOOD hand generators, 110 volt, closing out at bargain prices. Crank can be replaced by pulley if desired.

GENERATORS

These are not toys but well-made machines, built for service. While they last, $3.00 each. Order quick. No catalog. **CHEAP!**

Watson Electric Co., 867 Gas Bldg., Chicago

QUESTION BOX.

(*Continued from page* 854)

the coil across some batteries, and if it then works all right, naturally the trouble is in the interrupter.

The best way to remedy the trouble with the interrupter is to try different strengths of solution, and if this does not work, try an interrupter porcelain tube with a smaller hole. If it appears that your secondary is broken down, which you will find out by the dry battery test, then the primary voltage is too great; that is, the voltage when used in connection with the electrolytic interrupter breaks down the insulation of your spark coil.

SIMPSON MERCURY VALVE RADIO TRANSMITTER.

(916.) Walter R. Rathbun, Alaska, writes:

Q. 1. Where can I find information regarding the Simpson mercury valve radio transmitter?

A. 1. In reference to the Simpson mercury valve radio transmitter, this system was thoroly described in the February, 1917, issue of the ELECTRICAL EXPERIMENTER, page 729.

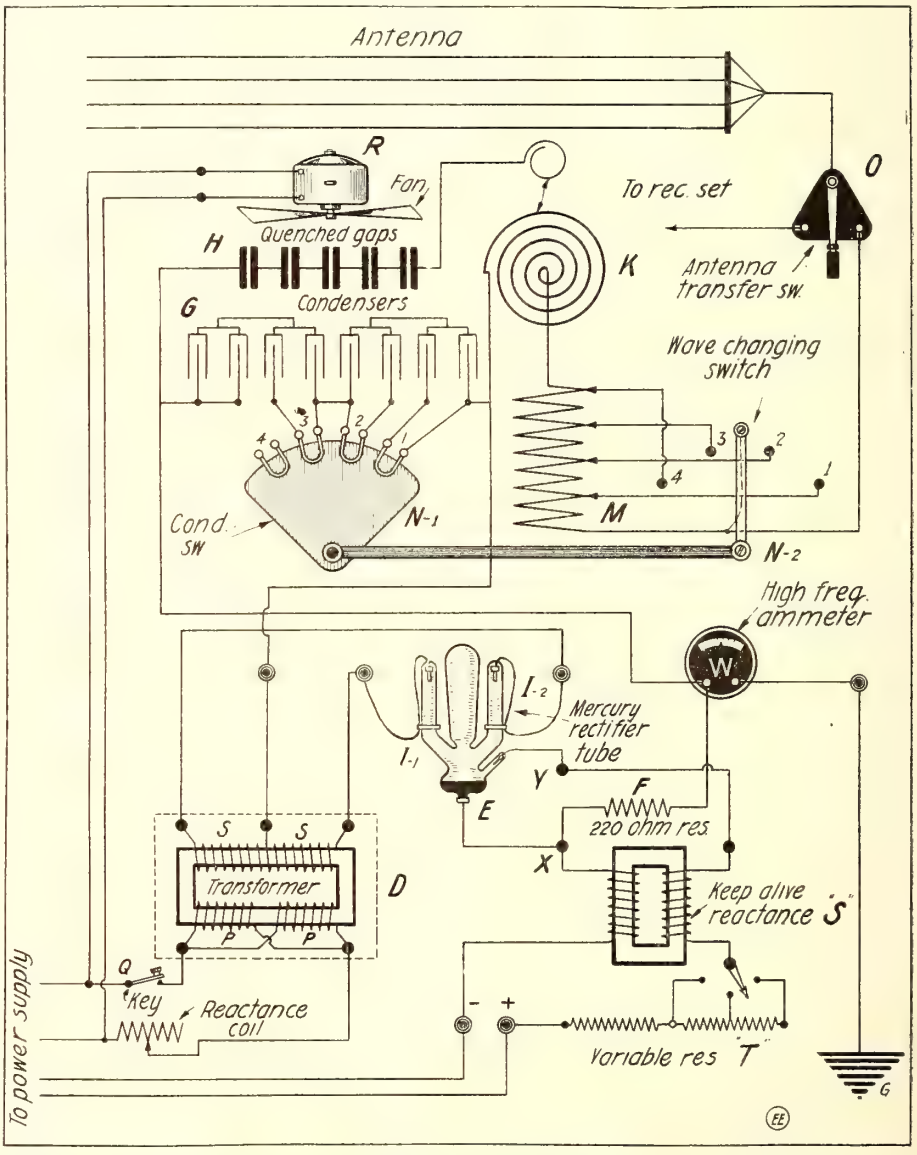
You would do well also to procure a copy of U. S. Patent No. 1,999,213, copy of which we can supply at ten cents prepaid, and in which there is considerable theory given of the Simpson Valve and its operation. We give official wiring diagram of the Simpson transmitter herewith.

DATA ON WATER FALL.

(917.) Edward Lecchis, New York, N. Y., asks for:

Q. 1. Data on water wheels, water falls, etc.

A. 1. We would advise that the formula to use in the computation of the horsepower given by a water fall, water wheels, etc., is contained in an extensive article dealing with such problems in the July and August, 1916, issues of the ELECTRICAL EXPERIMENTER, copy of which we can supply you at 20c each. This article also deals with the design and constructional details of practical water wheels of different sizes, suitable for driving dynamos, machinery, etc.



Official Wiring Diagram for "Simpson Mercury Valve" Radio Transmitting Set as Installed on Many Pacific Ocean Vessels and in Numerous Western Coast Land Stations. The Mercury Vapor Valve Acts to Transmit Only Rectified High Frequency Impulses, of Common Sign, to the Antenna.

SAYVILLE RADIO PLANT HAS NEW BUILDING.

Work was recently started on the erection of a building, 50 by 80 by 56 feet, of tile and stucco, at the big Government radio station at Sayville, L. I.

This will be used as a transmission building and connected with that will also be a similar building to be used as a machine shop and storage rooms.

MEANING OF "WIRE" AND "CONDUCTOR."

In the United States Bureau of Standards Publication No. 37 the following definitions for "wire," "conductor," "duplex" cable, and "twin" cable are given:

"A wire is a cylindrical rod or filament of drawn metal."

"A conductor is a wire or a combination of wires, not insulated from one another, suitable for carrying a single electric current."

"A duplex cable consists of two insulated single-conductor cables twisted together. They may or may not have a common insulating covering."

"A twin cable comprises two insulated single-conductor cables laid parallel, having a common covering."

And at that, we think they are still wrong, for Dr. Steinmetz says he believes that wires do not "carry" electric currents at all—they merely act as guides; the currents travel thru the ether surrounding the conductor—beg pardon—*wire.*

ELECTRICAL RESISTANCE OF THE HUMAN BODY.

Results obtained from measuring the resistance of the human body to electric currents vary from 500 ohms to 8,000 ohms and even more. According to a note by Dr. Nixdorf of Berlin, appearing originally in *Elektrizität* of that city, these enormous differences are due to the employment of defective methods. When an excessive continuous voltage is used muscular contractions and nervous excitations ensue which falsify conclusions. Experiments made by Dr. Nixdorf and Professor Brandenburg have brought consistent results. They used both direct and alternating current—in the first case at 1 millivolt, corresponding to the action of the heart; in the second case replacing the slide-wire of a Wheatstone bridge by a trough filled with a solution of sulphat of zinc, says *Revue Générale de l'Electricité.* The subject plunged his arms or his legs into salt water at the temperature of the human body and resistance was measured between the arms, between the legs and between one arm and one leg, the experiments being repeated after two weeks' time. The results are tabulated as follows:

	Resistance to Direct Current, Ohms		Resistance to Alternating Current, Ohms	
	Arm to Arm	Leg to Leg	Arm to Arm	Leg to Leg
Healthy countryman (59 years)..	1100	1400	233	350
Woman with nervous malady	1000	1200	255	455
Diabetic patient ...	1500	1700	284	434
Man (65 years) while in attack...	2000	3100	224	414
Man with softening of brain	1800	2800	299	414
Ditto	1400	1400	270	480

When the subject was apprehensive the resistance, measured with direct current, was found to be greater than when he was tranquil, 1,700 ohms from arm to arm and 1,500 ohms from leg to leg being recorded in the first state and 1,000 ohms from arm to arm and 1,200 ohms from leg to leg in the second state.

"EDISON PIONEERS"

(*Continued from page* 828)

many interesting reminiscences the gathering adjourned to meet at the Lawyers Club on Feb. 11, 1918, to celebrate Mr. Edison's 71st birthday by an informal luncheon. Over forty *"Edison Pioneers"* attended this luncheon on Feb. 11th, at which time the constitution and by-laws of the organization

How I Raised My Earnings from $30 to $1000 a week

The Story of a Young Man's Remarkable Rise as Told by Himself.

THREE YEARS AGO I was earning $30 per week. With a wife and two children to support it was a constant struggle to make both ends meet. We saved very little, and that only by sacrificing things we really needed. Today my earnings average a thousand dollars weekly. I own two automobiles. My children go to private schools. I have just purchased, for cash, a $25,000 home. I go hunting, fishing, motoring, traveling, whenever I care to, and I do less work than ever before.

What I have done, any one can do—for I am only an average man. I have never gone to college, my education is limited, and I am not "brilliant" by any means. I personally know at least a hundred men who are better business men than I, who are better educated, who are better informed on hundreds of subjects, and who have much better ideas than I ever had. Yet not one of them approaches my earnings. I mention this merely to show that earning capacity is not governed by the extent of a man's education and to convince my readers that there is only *one* reason for my success—a reason I will give *herein.*

One day, a few years ago, I began to "take stock" of myself. I found that, like most other men, I had energy, ambition, determination. Yet in spite of these assets for some reason or other I drifted along without getting anywhere. My lack of education bothered me, and I had thought seriously of making further sacrifices in order to better equip myself to earn more. Then I read somewhere that but few *millionaires* ever went to college. Edison, Rockefeller, Hill, Schwab, Carnegie—not one of them had any more schooling than I had.

One day something happened that woke me up to what was wrong with me. It was necessary for me to make a decision on a matter which was of little consequence. I knew in my heart what was the right thing to do, but something held me back. I said one thing, then another. I couldn't for the life of me make the decision I knew was right.

I lay awake most of that night thinking about the matter—not because it was of any great importance in itself, but because I was beginning to *discover* myself. Along towards dawn I resolved to try an experiment. I decided to cultivate my will power, believing that if I did this I would not hesitate about making decisions—that when I had an idea I would have sufficient confidence in myself to put it "over"—that I would not be "afraid" of myself or of things or of others.

With this new purpose in mind I applied myself to finding out something more about the will. I was sure that other men must have studied the subject, and the results of their experience would doubtless be of great value to me in understanding the workings of my own will power. So, with a directness of purpose that I had scarcely known before, I began my search.

The results at first were discouraging. While a good deal had been written about the memory and other faculties of the brain, I could find nothing that offered any help to me in acquiring the new power that I had hoped might be possible.

But a little later in my investigation I encountered the works of Prof. Frank Channing Haddock. To my amazement and delight I discovered that this eminent scientist, whose name ranks with James, Bergson and Royce, had just completed the most thorough and constructive study of will power ever made. I was astonished to read his statement, "The will is just as susceptible of development as the muscles of the body!" My question was answered! Eagerly I read further—how Dr. Haddock had devoted twenty years to this study—how he had so completely mastered it that he was actually able to set down the very exercises by which anyone could develop the will, making it a bigger, stronger force each day, simply through an easy, progressive course of training.

It is almost needless to say that I at once began to practice the simple exercises formulated by Dr. Haddock. And I need not recount the extraordinary results that I obtained almost from the first day. I have already indicated the success that my developed power of will has made for me.

I understand that Professor Haddock's lessons, rules and exercises in will training have recently been compiled and published in book form by the Pelton Publishing Co. of Meriden, Conn., and that any reader who cares to examine the book may do so without sending any money in advance. In other words, if after a week's reading you do not feel that this book is worth $3, the sum asked, return it and you will owe nothing. When you receive your copy for examination I suggest that you first read the articles on: the law of great thinking; how to develop analytical power; how to perfectly concentrate on any subject; how to guard against errors in thought; how to develop fearlessness; how to use the mind in sickness; how to acquire a dominating personality.

Some few doubters will scoff at the idea of will power being the fountainhead of wealth, position and everything we are striving for, and some may say that no mere book can teach the development of the will. But the great mass of intelligent men and women will at least investigate for themselves by sending for the book at the publishers' risk. I am sure that any book that has done for me—and for thousands of others—what "Power of Will" has done—is well worth investigating. It is interesting to note that among the 225,000 owners who have read, used and praised "Power of Will" are such prominent men as Supreme Court Justice Parker; Wu Ting Fang, ex-U. S. Chinese Ambassador; Lieut.-Gov. McKelvie, of Nebraska; Assistant Postmaster-General Britt; General Manager Christeson of Wells-Fargo Express Co.; E. St. Elmo Lewis; Governor Arthur Capper, of Kansas, and thousands of others.

As a first step in will training, I would suggest immediate action in this matter before you. It is not even necessary to write a letter. Use the form below, if you prefer, addressing it to the Pelton Publishing Company, 30-H Wilcox Block, Meriden, Conn., and the book will come by return mail. This one act may mean the turning point of your life, as it has meant to me and to so many others.

PELTON PUBLISHING COMPANY
30-H Wilcox Block, Meriden, Conn.

I will examine a copy of "Power of Will" at your risk. I agree to remit $3 or remail the book in 5 days.

Name .....

Address .....

.....

—"LEARNELECTRICS"—

DEPENDABLE KNAPP ELECTRIC SPECIALTIES

Ii basic truths and principles made clear and fully demonstrated.

Complete Electrical and Experimental Laboratory



A choice collection of instruments, materials and interchangeable parts with which numerous electrical machines may be constructed and a thousand experiments performed.

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If your dealer cannot supply you, order direct Write for free catalog of electrical motors and specialties from 10c up.

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BOYS YOU CAN EARN TEN DOLLARS

or more-easily and quickly-selling this wonderful automatic gas lighter-an indispensable household article-does away with dangerous and inconvenient matches-sells itself-bought on sight write for sample.

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Write Today for Our Free Blue Print Offer. Agents wanted for our ready built Choraleons

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BORE HOLES QUICKER



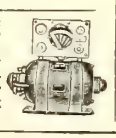
and with less elbow grease. Use the Rusby Extension Drill Brace. A perfect corner brace, extension chuck, and breast drill in one tool. Instantly adjusted to various lengths and speeds. Chuck holds round and square shank drills and bits. Often pays for itself in one job. **Special Price, $3.60 Prepaid Via Insured Parcel Post**

Thousands in use. Sold on money-back guarantee. Send check or money order for one TO-DAY. Start NOW to same time and strength—they're valuable.

HOWARD R. SMITH, 234 Harrison St., Nutley, N. J.

Learn Watchwork, Jewelrywork and Engraving. A fine trade commanding a good salary, and your services are always in demand. Address HOROLOGICAL Department, Bradley Institute, Peoria, Ill., for our latest catalog

Big Profits Charging Auto Storage Batteries HB Chargers bring owners $40 to $60 clear profit every month. This money-maker complete for $15 cash, balance in 8 monthly payments of $20 each. Money-back satisfaction guarantee. Mail this ad with name for full particulars. **HOBART BROS. CO., Box E-44, Troy, Ohio.**



were formally adopted and various steps taken to further the aims and objects of the *"Pioneers."* These steps among other things embraced the erection of a memorial on the Lincoln Highway where it is to pass Mr. Edison's old home and laboratory buildings at Menlo Park, N. J.; the coöperation with the Edison's Association of Illuminating Companies in the formation of an Edison Museum, the preparation of a Biographical and Historical Volume to be presented to each member and certain other important matters of which it is inadvisable to speak at the present time. It was also decided that the *"Edison Pioneers"* should be perpetuated by making the members' descendents eligible to membership. A birthday telegram of congratulations and hearty well wishes was sent to Mr. Edison, whose absence in Florida made it impossible for him to be present and after addresses by President Francis R. Upton and others, the party adjourned.

Among the men already identified with the *"Edison Pioneers"* are Francis R. Upton, Orange, N. J.; Sydney B. Paine and W. S. Andrews, Schenectady, N. Y.; F. B. Potter, Charles A. Benton, Fremont Wilson, William J. Hammer, Edwin W. Hammer, Frank S. Hastings, F. S. Smithers, Frank S. Hastings, F. A. Wardlaw, H. A. McLean, Charles S. Bradley, Peter Weber, C. Roch, Arthur S. Reves, A. C. Pointier, W. Pelzer, C. W. Kiddle, Alexander Mungle, W. A. Donshea, A. S. Campbell, Henry Stephenson, New York; Philip S. Dyer, Easton, Pa.; Geo. S. Grower, Ansonia, Conn.; E. G. Acheson, Niagara Falls; Charles Wirt, Philadelphia, Pa.; John W. Lieb, New Rochelle; A. O. Tate, Philip Klein, Montreal, Can.; John Ott, William Meadowcroft, C. N. Wurth, W. S. Gilmore, Orange, N. J.; Samuel D. Mott, Passaic, N. J.; Samuel Insull, Henry M Byllesby, Chicago, Ill.; P. B. Shaw, Williamsport, Pa.; William M. Brock, Paterson, N. J.; Wilson S. Howell, Pleasantville, N. J.; John W. Howell, George F. Morrison, Newark, N. J.; M. F. Moore, Roselle, N. J.; William Carman, Menlo Park, N. J.; Schuyler S. Wheeler, Ampere, N. J.

HEALTHFUL HEATING OF THE TISSUES BY ELECTRICITY.

(*Continued from page* 824)

In other words, a spark or series of crackling sparks, crash across the spark gap. The arrangement then is such that the Leyden jar is kept filled with electric stress equal to the force necessary to break down the distance of the spark gap. The wider the space, the greater the stress in the jar. The greater the voltage, the higher the amperage.

In the ordinary high frequency machine the patient is placed between the terminals of the gap. When a patient is so placed, he shares in the *oscillations* of the current. These, when strongest, are like a spring, which, when released, overshoots its mark. They are like a pendulum, strongest at the beginning and gradually come to rest.

Electric particles or *current-like* particles or *waves* of light, travel at about 186,000 miles a second. In 1/120 of a second the current covers 1,550 miles. The inside of a Leyden jar measure 3 inches from the center to the sides. The space is therefore covered several million times during each alteration of the primary current. Since the secondary alterations are at least ten times more, there may be millions upon millions of alterations a second.

Here you have a simple A. B. C. explanation of the high frequency electric current, which is successfully used to make heat and also to heal certain sorts of human ailments, such as arthritis of a particular type.

ETHERIC MEMORIES

(*Continued from page* 838)

get finished, in fact every thing in the line of pasteboard from oatmeal boxes to hat boxes disappeared, not to mention anything about the paint and varnish, the earmarks of which were evident almost everywhere. The door bell received another calling and said bell disappeared instantly, of course it was essential that the annunciator wire leads should also vacate, for without them I would have had no primary. Pop only discovered this after having to knock a few window panes in to let us know that he was trying to get into his own house. Next in line came the push button, last but not least, for it was put to very good use, having arranged a perfectly good test, (32 cp light in series with 110 AC). Of course, it made no difference whether the detector was adjusted or not, just so I had my hand on the frame of said button I could hear a loud click in the phones,—it was really a wonderfully designed detector, you see it never lost its adjustment and still I remember of sitting hours all through the local stations schedules without hearing a sound. I remember once of getting a slight click in the phones, just before one of my friends came running in and reported that a tree had been struck by lightning just two blocks north of the house.

By this time I had been reading considerable literature in regards radio and had been pronounced incurable by old Doc. Bugs from Bugland, who stated that he expected to see me one day as a very prominent leading engineer, owing to the fact that he was present the day I short circuited my detector in order to reduce the resistance in the closed circuit, thereby lowering the decrement; truly the tuning qualities must have been increased considerably, in fact it was so sharp that I was not able to get the blooming thing set on any particular tune, nor did I hear anyone during that entire long dreary month of agony, which time it took to complete these demented experiments. I decided to return to the old circuit, feeling perfectly satisfied to wait until I had mastered the art of tuning, before trying any more highbrowed stuff.

Hurrah! Hurrah! More experiments for kid bugs, AH then came the Potentiometer, well, in short, from the following you will find that it is advisable that the inventor's name should be kept MUM from my Dad. Taking a good squint at the specifications I began to lay my plans, immediately visited Papa's store and work shop, and quietly removed as much resistance wire as I could from the starting box, but the worst part of it was when the electricians told Pop that Damnable lie about motor trouble and they soaked him forty dollars for MOTOR repairs which I am quite sure consisted of a complete wiping off of the commutator and restoring the resistance in the starting box. Well did I feel like a thief? NAW, not at all. Forty cents of resistance wire, and I had moved the decimal point two places to the right for Dad.

Of course, after the above was accomplished it was essential that I have a sending set, and I did not lose any time getting this, for Father's shop was shy a few snap switches, fifty feet of No. 14 DBRC, a DPST switch and his desk fan which was used for my rotary. Now Dad never went to work at night, so I was quite sure that he would not discover these missing links, but, however, he did go one night and what

a night it must have been for him, but OH! what a night it WAS for me; well do I remember in trying to retreat from the razor strap with the phones still clamped tightly on my head. In my excitement I sat on the key with my right hand holding tightly on the spark gap reaching for the door with the left, at the same time busily engaged in studying the least path of resistance. Oh! yes, it is great to have been a pioneer; in fact it's the only way. It was only thru the *Modern Electrics* then, and the ELECTRICAL EXPERIMENTER NOW that got my start and which allowed me the above pleasures. Well, Bugs, I'll not keep you from your work any more, connect them in series or in parallel, I don't care, you know what you want. E. T. J.

UTILIZING BURNT-OUT LAMP BULBS.

(*Continued from page* 833)

tain pure hydrogen; the other, pure oxygen gas. The former is connected to the negative, the latter to the positive pole of the battery.

Nearly every experimenter wishes to possess a good electroscope. One can be readily made from a burnt-out lamp bulb as is shown in Fig. 7. Take an ordinary bulb and cut off the top as explained in the preceding articles. Leave one lead wire which *must* be the one going thru the central connection as shown in illustration. By means of a long pair of tweezers, bend this wire around to form a small hook. Now take a strip of gold leaf 2 inches long, ⅛ of an inch wide, and fold once. This gives us two strips joined at the center, each 1 inch long. (See illustration.) The writer, who has had quite a good deal of experience with gold leaf, has taken a peculiar dislike to the same, as it is nasty material to handle, adheres to the fingers and is a general nuisance all around. For some years past he has used a gold leaf substitute, which can be easily handled, and which works just as well if not better than gold leaf.* The substitute gold leaf can be readily fastened to the central lead wire, as, for instance, with a bit of thick shellac; or it may be simply hung loose; but we believe shellac to be the better method. Ordinary fish glue may also be used, and it proves quite satisfactory. In that case, simply apply a little of the glue by means of a wood splinter to the hooked lead wire. The gold leaf can then be hung on the little hook of the lead wire, and will adhere there readily. After all is finished, the bulb is secured to two wooden blocks as shown in the illustration, the lower block carrying a piece of felt to support the bulb, while the upper ring-like clamp simply holds the bulb in its upright position. Four pieces of felt may be placed between bulb and ring, so as not to crush the glass. Rubber feet at the bottom of the base complete the apparatus, which are quite necessary. If now, for instance, an ordinary rubber fountain pen be rubbed on the sleeve, thus electrifying it, and after it is brought near the metallic top of the lamp, the two gold leaves will diverge. The stronger the charge, the further the leaves will diverge. They can be made to diverge quite violently if an ordinary piece of blotting paper is taken and strongly rubbed over your knee. This strongly electrifies it, and the leaves will diverge violently; if they are long enough they will touch the wall of the bulb.

In the next idea is shown how the experimenter can make an efficient Leyden jar (condenser) by means of a discarded lamp bulb. Take a bulb and break off its tip under a solution of either strong salt water

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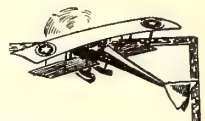
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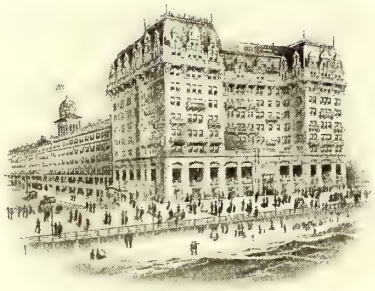
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or acidulated water, one part acid, four parts water. The solution will rush into the bulb as mentioned in the "barometer" experiment. It is, however, not necessary to quite fill the bulb. In other words, three-quarters full will be sufficient. As will be noted from the illustration, the two lead wires can remain after the filament has been broken off. Nothing further remains to be done except coating the outside of the bulb by means of tin foil which may be shellacked to the bulb. In order to make a good connection, our detail illustration shows how this can be accomplished. A piece of copper foil about 1 inch long and ¼ inch wide is soldered to a copper wire. This copper foil is shellacked against the glass of the bulb, and the tin foil is then wound around the bulb over the copper foil. No shellac should come between the copper foil and the tin foil. Otherwise a bad connection results. The tin foil should reach up as high as the solution goes, and should be on the level with the latter. It does not matter how far the tin foil reaches down, and this is up to the constructor. In our illustration we have only shown it three-quarters way down, but the tin foil could go still further down. Of course, in that case, the copper foil would be moved further down also.

In order to keep the wire from tearing out the tin foil, a stout rubber band may be slipt over the bulb (not shown in illustration). This rubber band will hold the wire in a satisfactory manner.

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INTENSIVE TRAINING FOR THE SIGNAL CORPS.

(*Continued from page* 836)

wireless and induction, telephone and buzzer. He must also learn to handle complete wire and radio companies with precision in various formations and also the means of transportation provided for each, motor truck, motor cycle, wagon or pack mule. Gas engines alone hold a prominent place in the course. Trucks and engines are taken entirely apart and replaced for instruction. It seems incongruous that the pack mule should, in this age of motors, come in for his share. He holds a place that it has been found cannot be filled as efficiently by machine. He has always had a warm place in the hearts of the old soldier, especially the cavalryman and even now the old packer and his mules are worth their weight in gold. Streams, mountain, roads or no roads, look alike to the patient mule. You may be sure that he will find his place even in extremely modern warfare. I cannot recall a more welcome sight than a pack mule, commanded by a catholic priest, loaded to the gun'ls with grub, making port in rear of the trenches on San Juan after a hard days work and nothing to eat or drink. In the signal corps he now carries a portable radio set consisting of a hand-power generator of about one quarter k.w., operating chest and sectional mast. The entire outfit can be unloaded, set up and placed in operation in about eight minutes and loaded again in less time. It is extremely useful in keeping a fast-moving cavalry or artillery outfit in touch with headquarters or communicating with other and detached outfits and across country where, owing to mountains or water, it is impracticable to string or lay wires. Much dependence cannot, however, be placed in radio as a means of communication on account of likelihood of "jamming" by the enemy in emergencies.

The greatest demand for our signal men will be in connection with the building maintenance and operation of more or less permanent telegraph and telephone lines between the base of operations and the extreme front and an intercommunicating system at the latter point. Also in the control of railway train movements in the zone of operations.

When the young officer is finally assigned to a company and is in the theater of military operations he will find himself confronted with problems on every hand, maintenance of communication, maintenance of health and discipline of the men and he must know his business thoroly.

Let us suppose that the commander of a division to which his company has been assigned calls him into a conference, at which a plan has been mapt out for a battle the following day, and says, "Captain, I am going to move a battery of field artillery to such a point, can you keep these headquarters in communication with it?" The impulse would be to take the risk and say "Yes." Possibly the success of the entire operation rests upon his being able to keep up such communication and his reply should be made after full consideration of the men and material under his control, of the country over which he is to work and every possible exigency which may arise and when making his reply to the commander should lay before him all his knowledge of the limitations so that he may know just what can be absolutely depended upon and when he goes to battle know just where his weakness lies, if this cannot be remedied, as well as his strength.

The signal corps, unlike any other branch of the military service permits of a great amount of initiative on the part of the officers, whatever their rank may be, and, if he is capable and wideawake and knows his business he will have unlimited opportunities to distinguish himself. Even a single enlisted man, crawling from shell hole to shell hole, unreeling his little buzzer wire may be the means of saving an entire detachment, which has gone far ahead and is cut off by a barrage from retreat and who need a protective fire in front until reinforcements can come up, from annihilation.

Study, practise and physical exercise makes them fit for the opportunity when it comes. It is wonderful to see how the students progress; their studies are new and interesting and their incentive puts life and snap in every movement so that in two or three months they compare favorably with regulars in everything but experience and in that terms are about even as the present war presents conditions that are new to all and feeling, if any exists between them will be laid aside on the other side for there will be room at the top for all.

EXPERIMENTAL CHEMISTRY.

(*Continued from page* 850)

valence. The valence of copper being 2, each copper atom displaces two silver atoms or ions. This is shown by the equations. A list of all the metals can be made showing their electrochemical affinities.

Experiment No. 116.

Into 5 cc. of water put 1 gram of copper bromid. Heat, if necessary, to dissolve it. Notice the color. Next add 5 cc. more of water and note any change of color. Then dilute the solution still further till you see a marked change of color. Try to explain the three results by the ionic theory.

Experiment No. 117.

Prepare a saturated solution of sodium chlorid (common table salt) by heating the salt in 10 cc. of water until no more will dissolve, then cooling and pouring the solution — having no precipitat — into another tube. Pour into the sodium chlorid solution 10 cc. of hydrochloric acid. Note result and try to find an explanation by means of the ionic theory. Also determine what stage of the experiment illustrates equilibrium. Do the same with sodium chlorid and barium chlorid. The ionic theory explains only part of the precipitat.

Experiment No. 118.

The Electrolysis of Hydrochloric Acid.

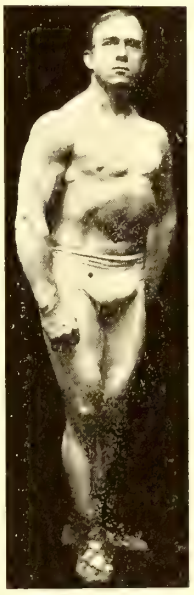
Obtain a concentrate solution of hydrochloric acid and electrolyze the acid by using the apparatus described in the ELECTRICAL EXPERIMENTER for October, 1916, Experimental Chemistry, Lesson 5, page 422, or Fig. 113. Note and account for the relative volumes of the two products.

Experiment No. 119.

Estimation of Copper.

Weigh about 1.5 gram of recrystallized copper sulfat into a beaker and dissolve in 200 cc. of water. About 2 cc. strong nitric acid is added (if the copper is to be separated from other metals, a larger quantity of nitric acid must be added) and the mixture gently stirred with the platinum wire which is to be employed as the anode; this is then left standing in the beaker. The platinum cone, which has been perfectly cleaned and carefully weighed, is then lowered into the beaker over the projecting end of the anode. In *electrolytic work,* and especially in *analysis,* it is of the utmost importance that the platinum cathodes which are used should be scrupulously clean, and free from *even the slightest trace of grease,* even to such an extent that would be *contracted by touching them with the fingers.* The two electrodes are then fastened to their respective supports, which may be similar to the apparatus shown in Fig. No. 113. They should not

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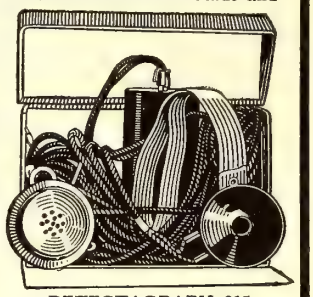
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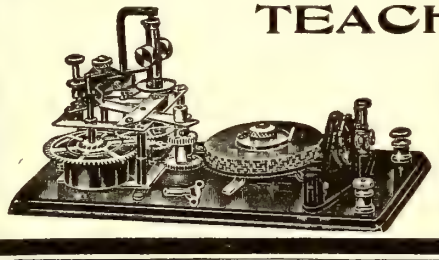
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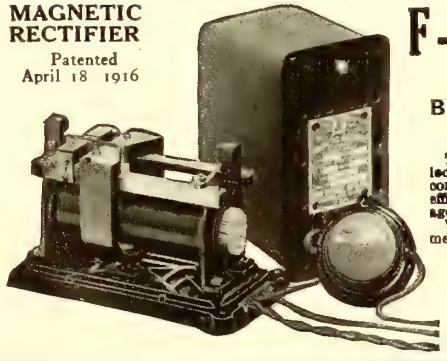
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touch each other, and should be slightly elevated from the bottom of the beaker, the anode being so placed that the spiral reaches slightly below the cone.

The electrodes are then connected to the battery, the platinum *cone* being connected to the negative terminal, and a current of 0.5 to 1 ampere past thru the solution. If the current from a dynamo or from storage batteries is used, it must be reduced to the requisite strength by introducing a system of resistance coils. If too strong a current is employed, the deposited copper is rough and less coherent. When only an occasional analysis is to be made, two or three Daniell cells may be used. In this case the zinc plate of the battery is negative and should be connected to the platinum *cone*. The copper is gradually deposited upon the platinum cone, and the blue color of the solution becomes fainter and fainter, until at last the liquid appears to be quite colorless. This operation necessitates several hours for its completion, and may be conveniently permitted to continue all night. To ascertain whether the precipitation is finished, one or two drops of the solution are withdrawn by means of a pipette, and a little hydrogen sulfid added, which should produce no coloration. The beaker is then lowered away without interruption of the current, the anode at the same time being disconnected and removed with the beaker. The cone is then dismounted and rinsed with water by means of a wash-bottle. It is then dipt once or twice into a beaker of alcohol, and placed in a steam oven for a few minutes to dry, and then weighed.

The gain in weight gives the copper in the amount of copper sulfate employed, from which the percentage of copper is thence calculated.

The electrolytic method is one that is much employed in the commercial analysis of valuation of copper ores and of metallic copper, as well as in the estimation of copper in alloys. The analysis is carried out in the following manner: 1. *In copper ores:* From 1 to 1½ grams of the finely powdered ore is weighed out into a porcelain dish, and treated with from 10 to 20 cc. of strong nitric acid. About an equal volume of dilute sulfuric acid is then added, and the mixture gently evaporated to about half its bulk in a covered dish. Water is then added, and the insoluble residue is filtered and washed. Copper ores frequently contain organic matter, in which case this residue will be dark colored, and is liable to retain a small portion of copper. If the quantity of bituminous matter is appreciable, it should be destroyed before treatment with nitric acid, by roasting the weighed quantity of powdered ore taken for the analysis in a porcelain crucible, with free access of air. The filtrat is diluted up to 200 cc. with water, 10 cc. of nitric acid added, and the solution electrolyzed as described above, with a current from two Daniell cells.

Experiment No. 120.

Estimation of Zinc.

About 2 grams of crystallized zinc sulfate are weighed out into a beaker, and dissolved in about 50 cc. of water. Six or seven grams of ammonium oxalat, dissolved in a small quantity of warm water, are gradually added, with constant stirring.

The solution is then diluted to 150 cc., and electrolyzed. The process is complete when a drop of the solution gives no precipitat when warmed with potassium *ferrocyanid* upon a watch glass. The platinum electrode containing the deposited zinc is then removed, thoroly rinsed with water, and finally with absolute alcohol. It is then placed for a few minutes in a steam-oven to dry, and then weighed.

Experiment No. 121.

Estimation of Nickel.

About 2 grams of ammonium nickel sulfat are weighed out into a beaker and dissolved in water, and the solution rendered strongly alkaline by the addition of ammonia. The volume of the liquid is made up to 150 cc. with water, and the solution then submitted to electrolysis. The process may be permitted to continue all night. It is complete when a drop of the liquid gives no precipitat with ammonium sulfid. The cathod is then washed and dried, and weighed as in the former estimation procedure.

Experiment No. 122.

Analysis of German Silver.

About 1 gram of the alloy is weighed out into a beaker, and dissolved in about 15 cc. of strong nitric acid mixed with the same volume of water. The solution is then diluted up to 150 cc. with water, and submitted to electrolysis. Under these circumstances copper alone is deposited. (It must be remembered that nitric acid is decomposed by the passage of an electric current, nitrogen peroxid and oxygen being evolved at the anod, while hydrogen is liberated at the negative electrode. This *nascent hydrogen* reacts upon the nitric acid, with the formation of ammonia. Hence if the current is allowed to continue passing thru the solution after the copper is all precipitated, the nitric acid is gradually decomposed in this manner, and then the zinc in the solution begins to deposit along with the copper.)

When the precipitation is complete (a drop of the solution, when tested by adding sodium bicarbonat and potassium *ferrocyanid,* should give no brown coloration of copper ferrocyanid) the beaker containing the solution should be lowered away from the electrods before the current is interrupted. The cathod with its deposit of copper is rinsed with water (the washing being added to the solution in the beaker), and finally dipt into alcohol and dried and weighed.

The positive electrod is also rinsed into the beaker, and the solution evaporated to dryness in a dish upon a water-bath, with the addition of a little hydrochloric acid, in order to convert the remaining metals into chlorids.

The residue is dissolved in water and a few drops of hydrochloric acid, and the solution transferred to a beaker. Sodium carbonat solution is added until a slight precipitat persists, after which hydrochloric acid is added, drop by drop, until the precipitat just redissolves. The zinc is then precipitated from this solution as zinc sulfid by means of ammonium sulfid. The washed precipitat is dissolved in the smallest possible quantity of strong hydrochloric acid, and the solution evaporated to expel the excess of acid. The residue is dissolved in water, ammonium oxalat is added as described in Experiment No. 120 (Estimation of Zinc), and the solution diluted with water to 100 cc. and electrolyzed.

The filtrat and washings from the zinc sulfid contain the nickel, which may be precipitated either from the double ammonium sulfat or oxalat. *From the double sulfat:* Three or four grams of ammonium sulfat dissolved in 10 cc. of water are added to the solution, and then about 20 cc. of strong ammonia. The mixture is diluted with water to 100 cc. and electrolyzed. *From the double oxalat:* Four or five grams of ammonium oxalat, dissolved in about 20 cc. of warm water, are added to the solution, which is then diluted with water to 100 cc. and electrolyzed, the liquid being maintained at a temperature of about 40 to 50 degrees thruout the operation.

Alloys consisting of copper and nickel only may be analyzed electrolytically in the following manner: From 0.5 to 7.5 gram of the alloy is dissolved in the minimum quantity of nitric acid (diluted as above), and the solution evaporated to dryness with the addition of a few drops of sulfuric acid. The residue is taken up with water, and again evaporated to dryness with a few drops of sulfuric acid to completely expel the nitric acid. The residue is dissolved in water with a few drops of sulfuric acid, and made up to about 100 cc., and the solution electrolyzed by employing a current of 0.5 ampere for from 4 to 6 hours. The electrod is washed and dried and weighed as previously described. To the solution 15 cc. of strong ammonia are added, and the liquid electrolyzed with a current of about 0.3 ampere (or 3 Daniell cells). The nickel will be entirely deposited in about six hours.

Hydrolysis.

Certain salts mixed with water react to some extent with it. Salts of antimony, bismuth, arsenic, tin, etc., are examples, as $SbCl_3 + H_2O = SbOCl + 2H + 2Cl$. SbOCl is precipitated, the solution being slightly acid on account of the presence of hydrogen ions. The stages in the reaction of $SbCl_3$ and H_2O may be as follows:

$$SbCl_3 + 3\,H_2O = Sb(OH)_3 + 3\overset{+}{H} + 3\overset{-}{Cl}$$

$$Sb(OH)_3 + 3\overset{+}{H} + 3\overset{-}{Cl} = SbOCl + 2HCl + 2H_2O$$

Thus in the first equation a base, together with acid ions, is present in the mixture, and that constitutes a case of hydrolysis. The acid is shown in the second equation.

Hydrolysis is the action of water on certain salts to break them up into acids and bases.

Hydrolysis should be carefully distinguished from ionization.

(*To be continued*)

"ELECTRO-MAGNETIC LOG" THAT MEASURES SHIP'S SPEED.

(*Continued from page* 817)

device may be used a long time before the zinc sulfat has to be renewed. Amalgamated zinc, surrounded by the zinc sulfat, forms a non-polarized electrode even tho the chemicals used may be somewhat impure, the zinc sulfat forming a concentrated solution around the metallic zinc.

The magnet is so located that the movement of the magnet thru the water takes place in a direction parallel to the plane of the two plates. The lines of magnetic flux, as shown in Fig. 4, pass from the middle pole N to the side poles S forming a magnetic field which is moved thru the water in a direction *perpendicular* to the plane of the paper, the magnetic field

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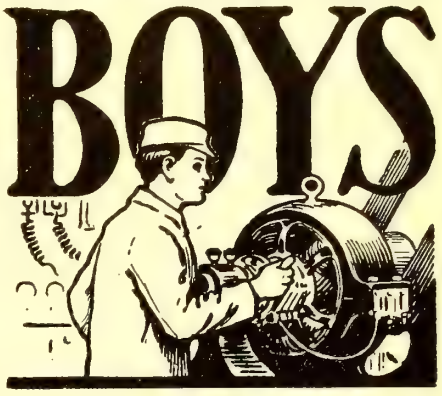


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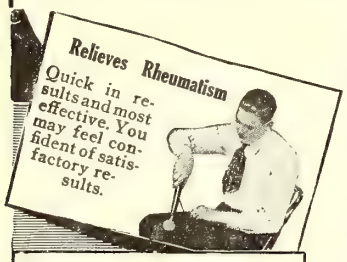
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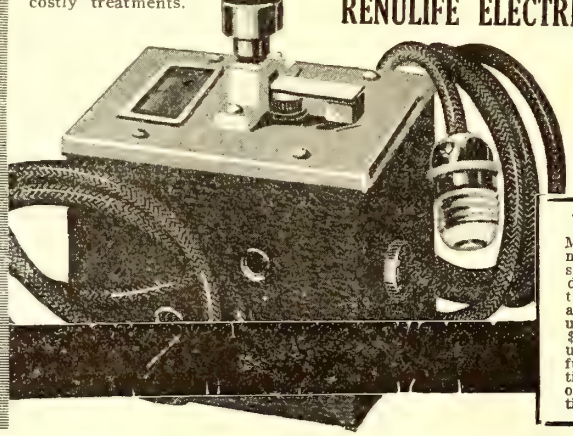
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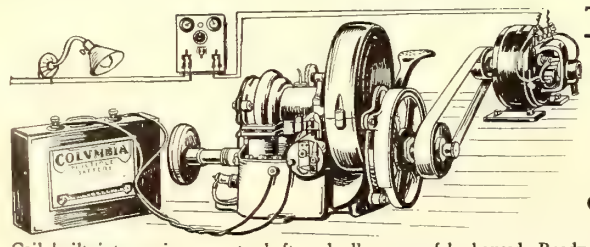
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being *transverse* to the direction of movement of the magnet. The movement of this magnetic field causes a difference of potential between the electrode points in the water at the surfaces of the two earthenware windows, the direction of the electromotive force being indicated by the dotted lines. Since the windows are porous and conducting, and the electrodes are carried along with the magnet, the electrodes should be maintained at substantially the same potential as the points, provided the electrical resistance thru the porous windows between the electrodes is small or the current flowing between the electrodes is small or zero.

In order to measure the difference of electric potential induced between the two points, the two electrodes are connected by a cable to a low resistance coil as shown. A battery maintains a direct current thru the resistance when readings are to be taken, a switch being provided on the indicator panel (on the ship's bridge or in the pilot's cabin) for the purpose of opening and closing this circuit. An ammeter, calibrated to read *knots per hour* directly, and an adjustable resistance are connected in the battery circuit, as the diagram shows. The resistance regulator is moved until the potential drop across the low resistance coil just balances the voltage induced between the two electrodes by the movement of the magnetic field thru the water. A zero instrument (galvanometer) is connected in one of the leads as shown, and the resistance coil is adjusted until the galvanometer shows no current passing between the hydro-electrods.

The value of the resistance being known, then by reading the ammeter the potential drop across it can be computed; this potential drop is equal to the E. M. F. induced between the hydro-electrods, by the movement of the magnetic field thru the water. When the magnetic strength of field is known, the induced E. M. F. for different speeds of ships may be computed or determined experimentally, and the ammeter calibrated to read the speed of the ship in miles or knots per hour, as aforementioned.

By using the zero method, the effect of variations in the resistance of the water and the porous windows between the hydro-electrods is eliminated as a source of error.

The operation of this log device is based upon sound electro-dynamic theory and the inventors have worked out the mathematical analysis for it. These are too technical for consideration here, but in general it may be said that the theoretical action is as follows:

If a magnetic field moves thru a medium, electro-motive forces are induced in that medium, the intensity of which per unit volume is proportional to the product of the velocity of the field by the component of the magnetic force perpendicular to the direction of motion of the field, and the direction of which E. M. F. is perpendicular to the direction of motion of the field and to the lines of force of the field. In other words, we have here to deal with a three-dimensional conducting medium under a steady state of current flow caused by a volume distribution of electro-motive forces.

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POWER WIRING DIAGRAMS, by A. T. Dover. 208 pages; size, 4¼ x 6¾ inches; 254 illustrations; semi-flexible covers, pocket size. The MacMillan Co., New York, American publishers, 1917. Price, $2.25.

A handy pocket-size edition, which should prove of practical service to electricians, especially those who come in contact with the application of motor power to industrial plants.

It contains a very large number of diagrams of standardized apparatus and machinery, and so far as possible actual control apparatus has been kept in mind in laying out the various circuits.

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A large and comprehensive appendix is also included which contains numerous charts, curves, tables and miscellaneous data of practical value.

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HOW TO MAKE HIGH PRESSURE TRANSFORMERS, by Prof F. E. Austin. Second edition, 46 pages; illustrated; size, 4⅝ x 7⅛ inches; stiff covers. Publisht by the author at Hanover, N. H., 1917. Price, 65 cents.

A timely work of unusual interest to amateurs and experimenters especially, that just fits the pocket, as well as the amateur's pocket-book. A wealth of information is included in a very small space pertaining to transformers, from the theory to actual constructional work. The first chapter defines the function of a transformer and gives tables and rules for computing various sizes of transformers with pointers which safeguard the occurrence of errors usually found in home-made apparatus.

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(*Continued from page* 815)

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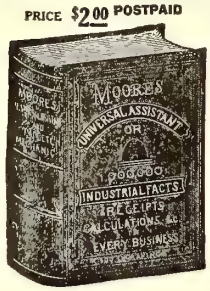
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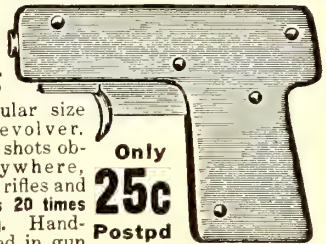
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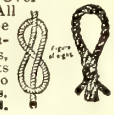
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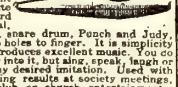
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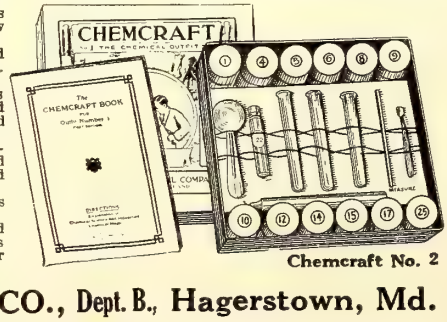
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ranged upon opposite sides of the hull under the mirrors, the searchlights being mounted to project light diagonally upward and toward the respective mirrors on opposite sides of the vessel. The searchlights may be slightly offset from each other, so that the rays of light projected from the two searchlights will not intersect and interfere with each other, and the mirrors serve to throw the rays of light downwardly thru the respective transparent plates fitted in the bottom of the hull.

A submerged submarine would ordinarily be easily located by these downwardly projected rays of light, *and a torpedo discharged vertically downwardly at a time when the vessel is directly over the submarine, would result in a speedy destruction of the submarine.*

A seat for the operator is shown as arranged just back of the transparent plates, and suitable levers are provided for manipulating the mirrors to position them in a proper manner for reflecting the light in the desired direction. (It should be noted that the operator manipulating the underwater search-lights could not himself "spot the submarines. It is a well-known fact that the observers on a battleship are stationed quite a distance away from the search-light. This could be arranged here by flashing alternate beams, observing thru the dark windows.)

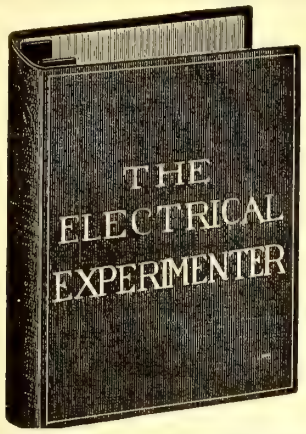
A SYNCHRONOUS MOTOR MADE FROM AN IRON PULLEY.

(*Continued from page* 843)

platinum wire are allowed to protrude thru holes in the bottom of the pan and sealed in with paraffin or beeswax. The sides and bottom of the pan are coated with melted paraffin. The pan and two test tubes are filled with acidulated water (electrolyte) and while under the water the tubes are inverted and placed over the platinum wires. The tubes should be previously graduated by weighing twice as much pure water in one as in the other. The level of the water is then marked on each tube with a little oil paint or scratched with a file.

It is possible to rectify both waves of the alternating current by equipping the shaft with two slip rings besides the commutator as shown in the diagram, Fig. 3, altho it complicates matters considerably. In this case the brush bearing directly on the shaft would be dispensed with, but there would be two brushes bearing on the commutator and a brush for each of the two slip rings.

All of the shaded sections are directly connected to the inner ring in diagram, and the clear segments to the larger ring shown. The commutator must revolve at such a speed that during each half cycle a section passes under each brush; and the brushes must be so set that both of them change connections at about the same time. The adjustment should also be such that the change from one section to the other is made at the time when the current wave is passing thru zero. The connections being properly made, the rectified current will be a pulsating current, all of the pulsations in the rectified side of the circuit being in one direction, as indicated by diagram, Fig. 3. Many other interesting and extremely instructive experiments can be conducted with this little synchronous motor. Books dealing with the subject in a clear manner are the following: "Alternating Currents Simplified," by Elmer E. Burns; "Alternating Current, Theory, Practise and Diagrams," by Horstman and Tousley. More advanced students who may be interested in rotary converter actions, etc., will find these problems ably dealt with in "Alternating Current Electricity," in two parts, by Timbie and Higbie.



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THE CHEMISTRY OF SELENIUM.

(*Continued from page* 845)

tion which now contains Selenic acid (H_2SeO_4), is obtained and when cold, diluted with water, filtered, and then heated with a quarter of its volume of fuming hydrochloric acid, until three-quarters of the liquid has evaporated. By this process, chlorin is evolved, and is reduced to Selenious acid (H_2SeO_3). The cold solution is then poured off from the sediment and saturated with sulfur dioxid, when selenium separates out as a red powder.

(1) $HgSeO+3SO_2+2H_2O = 3H_2SO_4+Se$

Selenium may also be prepared by digesting the lead-chamber deposit on a water-bath with a concentrated solution of potassium cyanid until it assumes a pure gray color:

(2) $KCN+Se = SeKCN$

From this solution the selenium is deposited in red-flakes, on the addition of hydrochloric acid. This deposit contains both lead and copper, and these impurities are removed by distillation or by being fused with a mixture of Niter (Potassium Nitrat) and Sodium Carbonat, and this is again treated with hydrochloric acid and sulfur dioxid. These impurities may be removed by evaporating the selenium to dryness with nitric acid, and reducing the aqueous solution of selenious acid by means of sulfur dioxid.

Properties:

Selenium, like sulfur with which it is isomorphous, exists in three different allotropic forms, three well defined forms being known.

1. Amorphous, Vitreous, and Colloidal selenium, being slightly soluble in carbon disulfid. These three differ in appearance but may all be considered as belonging to the same allotropic modification, and are sometimes known as "liquid" selenium.

(a) Amorphous: This modification is formed as a finely divided brick-red powder, when a solution of selenious acid is precipitated by sulfur dioxid gas, or when the acid is reduced by Zinc, Stannous (Tin) Chlorid, or other reducing agents, and is also formed by the electrolysis of the acid.

This form is slightly soluble in carbon disulfid, which produces a change to dark gray metallic selenium at about 97 degrees. This form has a specific gravity of 4.26.

Amorphous selenium is often obtained in a colloidal form, which is very unstable, and will not keep, and which is soluble in water. This colloidal modification is formed when a solution of sulfuric dioxid is added to a solution of selenious acid, and when a diluted solution of the acid is reduced by

(*Continued on page* 870)

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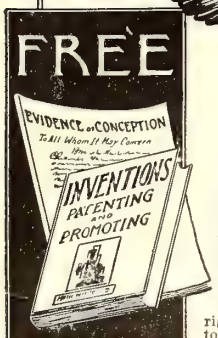
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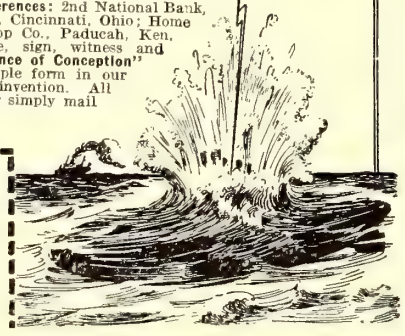
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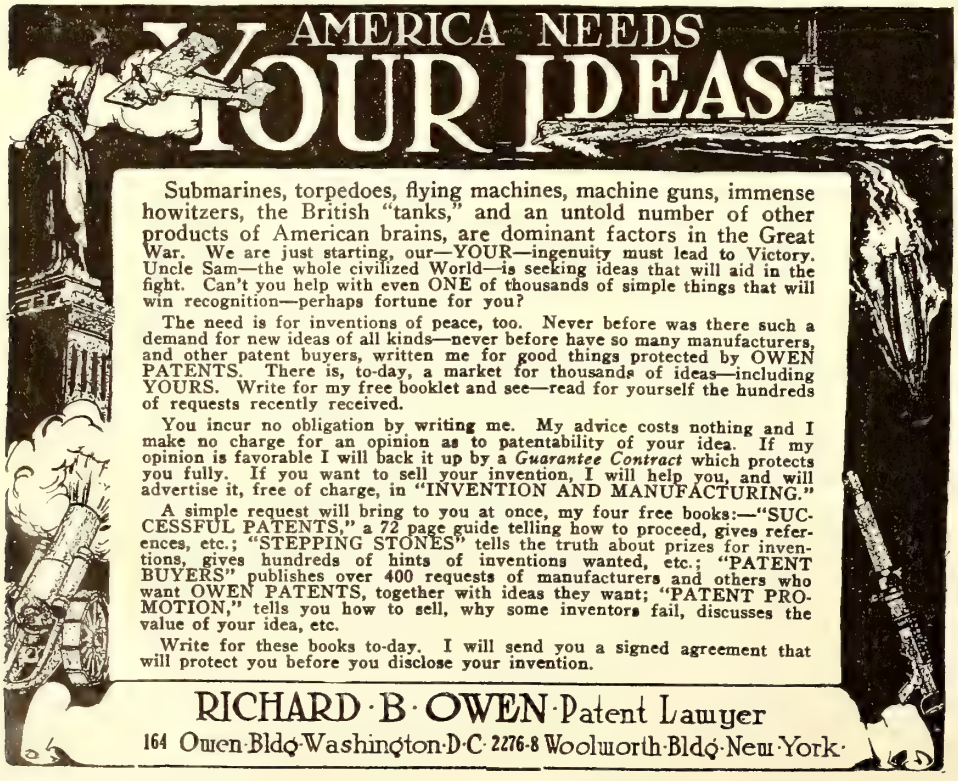
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Should advice be desired by mail a nominal Sketches and descriptions must be clear and ex ten on.

ELECTRIC PARACHUTE.

(209) Loyd Nord, International Falls, Minn., has sent in an idea whereby a parachute is to be installed on an aeroplane in such a manner that when the pilot becomes endangered, all he has to do is to press a button on the steering wheel which will immediately explode a cartridge by means of certain electrical firing apparatus, which in turn will shoot up a parachute which is attached to the seat on which the pilot remains. This is supposed to disengage from the aeroplane and land the operator in safety.

A. This is an idea that looks very well on paper, but is not practical for the reason that the exploding cartridge would certainly tear the parachute to pieces. Parachutes have been tried on aeroplanes before, but have not met with much success. We do not think that an invention of this kind would be practical.

"BELL SOFTENER."

(210) W. B. Hanlon, Pittsburgh, Pa., has submitted a *bell softener* which comprises a number of brass tubes which are to be struck by a certain re-arranged form of clapper on a bell. This is supposed to do away with the harsh sound. Our advice is asked.

A. A device of this kind does not fall within our idea of a *bell softener.* Quite the contrary, we are certain that it will make the sound just as harsh as if an ordinary gong were used. We are afraid this does not solve the problem of *softening* the noises of an ordinary telephone bell.

COLLAPSIBLE TYPEWRITER.

(211) Harry Drake, Seattle, Wash., writes as follows:

"Could you give me information concerning the possibilities of inventing a collapsible typewriter, weighing only a few pounds and suitable for school use?"

A. The possibilities of this device are, of course, very good, and there should be a vast field for such a machine, if it can be built cheap enough, and if the machine is mechanically right. There are several collapsible machines on the market now, as for instance the "Corona" machine, but this is rather expensive.

CARDBOARD MOUSE TRAP.

(212) A. R. Dunham, New York City, has sent in a clever design and description of a cardboard mouse trap which can be made and sold for less than 10c if necessary. The idea being that once a mouse is in the cardboard box, it can be disposed of with its contents. The thoughtful inventor has even provided the box with a string, and the box is arranged in such a manner that it will not come open of its own accord. These features should prove especially attractive to the "weaker sex."

A. This idea is a very good one. It seems to have commercial possibilities, if worked out right. We would advise our

ADVICE

H. GERNSBACK.

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correspondent to try out a few of these traps in actual practise to see if the mice are not afraid of the contraption, as these rodents are, as a rule, very wily and fear traps of this kind. We believe a patent can be obtained on this device.

SPECIAL FLASHLIGHT.

(213) Thomas A. Pilling, Camp Greene, Charlotte, N. C., submits a design of a flashlight having a special spiral filament bulb and conical concentrator for the rays. The flashlight is supposed to be used by physicians and dentists for exploration of small cavities.

A. A device of this kind is not new. Similar instruments of this sort are being marketed right now. We do not think a patent could be obtained on a device of this kind.

COMPREST AIR SHELL.

(214) F. M. Keesling, New Albany, Ind., has submitted an explosive shell for war purposes in which air, comprest to a very high degree, is used instead of an explosive. The shell is afterwards exploded in a certain manner.

A. We fail to see anything practical in a device of this kind for the reason that the entire arrangement is too complicated, too costly, as well as too cumbersome to handle. We also believe it is somewhat dangerous, as our correspondent proposes to charge the shell with a comprest air up to almost the bursting resistance of the shell itself. We think that the present explosive shell containing ordinary explosives is very much more satisfactory in all respects, being vastly cheaper to manufacture, and having quite a number of other advantages over the comprest air type.

AUTO FASTENER.

(215) Chas. Buerger, Cheboygan, Mich., has asked our advice on a certain fastener for automobile work which contains certain threads, and which for this reason will not loosen up, he claims, due to the vibration of the car.

A. We think that the ordinary snap fastener is altogether more desirable, as threads always work loose when used in an automobile due to vibration, which is well known. We do not encourage the idea.

OIL ATTACHMENT.

(216) Fred Van Dyke, Detroit, Mich., wishes to know if a device whereby a certain oiling device is attached to stock and dies is new, and whether it can be patented. The idea is that every stock and die needs a good deal of oil, which at the present time is supplied by hand, by means of an oil can. Our correspondent does away with this feature, using an automatic oiling arrangement incorporated in the tool itself.

A. This is a very clear idea, and quite novel as far as we can see. We have never seen the like of it, and would advise him to get in touch with a patent attorney.


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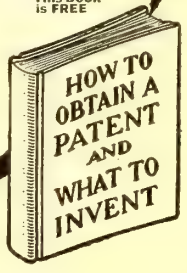
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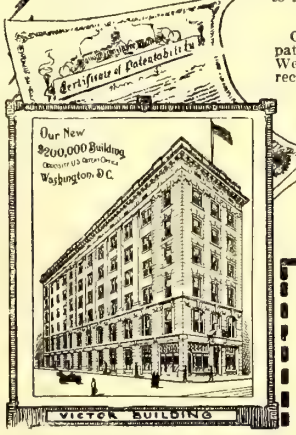
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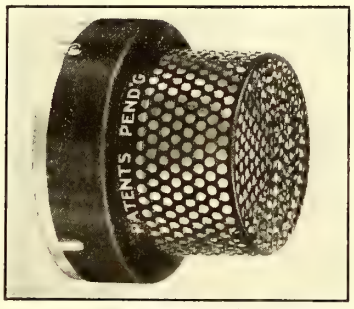
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THE CHEMISTRY OF SELENIUM.

(*Continued from page* 867)

hydrazin hydrat. It can also be prepared by pouring a solution of selenium in carbon disulfid into a large volume of ether, according to Maljisheff. It is a dark red powder which is completely soluble in water, forming a red fluorescent solution, which gradually becomes insoluble on preservation. The solution may be boiled without undergoing any change, but the selenium is deposited on the addition of acids or salts. The solution on spontaneous evaporation deposits the selenium as a red transparent film.

(b) Vitreous: Vitreous selenium is always produced when liquid selenium has been heated to 217 degrees and rapidly cooled. It then solidfies to a dark brownish-black, glassy, amorphous, brittle mass, which is also slightly soluble in carbon disulfid. This form has a specific gravity of 4.28. These varieties have no definite melting point, softening gradually on heating. Like the ordinary amorphous selenium, Vitreous selenium does not conduct electricity.

(c) Insoluble or Metallic Selenium: This modification is obtained by cooling melted selenium quickly to 210 degrees, and then keeping the melted mass at this temperature for some time. The selenium at length solidifies to a granular crystalline mass, the temperature rising suddenly in the act of solidfication to 217 degrees. This change from the amorphous to the metallic condition also takes place, only more slowly at lower temperatures; thus if a mass of amorphous or vitreous selenium be gradually heated it softens and then as soon as the temperature approaches 100 degrees, begins to pass rapidly into the metallic form, the temperature rising to 217 degrees. A similar change occurs at the ordinary temperature when amorphous selenium is placed in contact with quinolin, anilin and certain other liquids in which it is soluble, or by fusing the vitreous form between carbon plates and then allowing to cool slowly. If a concentrated solution of potassium or sodium selenid be exposed to the air, metallic selenium separates out in microscopic crystals, and it is also formed as a crystallin powder when sulfur dioxid is past thru a hot solution of selenious acid, the amorphous form, which is the first product, being rapidly converted to the metallic variety.

Metallic selenium conducts electricity and *exposure to light increases its conducting power.* The peculiar effect to light is best exhibited on selenium which has been exposed for a considerable time to a temperature of 210 degrees, until it has attained a granular crystalline condition. When selenium in this condition is heated, its electrical resistance is increased, whilst on exposing it to the action of diffused daylight, the electrical resistance instantly diminishes; this however, is only a temporary change, for on cutting off the light, the electrical resistance of the selenium slowly increases, and after a short time reaches the amount exhibited before the exposure.

Metallic selenium possesses all the physical characteristics of a metal. In the making of selenium cells the selenium must be in a metallic condition. Vitreous selenium which has *not been annealed,* when used in cell making is useless, due to the vitreous modification being a *perfect non-conductor.* The peculiar sensitiveness of selenium to the electric current, when exposed to light, is attributed to its metallic modification, caused by *annealing.*

Methods of making Selenium Cells:

Various methods of making selenium cells have been described in previous issues of this journal (ELECTRICAL EXPERIMENTER,

July, 1913, p. 39; September, 1916, p. 339; September, 1917, p. 325;) and for experimenters who desire to make cells along these lines, no further comment need be made.

It should be remembered in constructing these cells, that it is imperative that certain conditions be fulfilled in order that the completed cell be satisfactory for the work for which it is designed.

The first condition is, of course, the purity of the selenium used. Marc has observed that impure selenium crystallizes less completely in a given time than pure selenium.

As regards the insulator upon which the wire electrodes are wound, many experimenters advocate the use of porcelain, glass, and mica, the latter being probably the most satisfactory of these, for the work intended, due to the fact that it will withstand high temperatures without being ruptured. Porcelain and glass on the other hand can not be worked into various forms except with difficulty.

Thus we see that a substance is to be used which possesses all these desired properties —namely, that it is a good insulator, will withstand the heat required, and at the same time be sufficiently soft to permit more easily being handled and machined.

Again, most experimenters are using copper wire as electrodes, but the drawback to copper wire lies in the fact that at the temperature required for annealing, a film of copper selenid is formed, which covers the wire. This also materially increases the resistance of the cell, and is therefore undesirable for use as electrodes. Platinum wire is of course the ideal wire for this purpose, but due to the extreme high cost, is beyond the reach of the average experimenter. Therefore a different kind of wire must be utilized for the electrodes, one which will not oxidize at the temperature of annealing.

The present form of application of the selenium to the electrodes and insulator is also unsatisfactory, in that, when the selenium changes to the metallic variety on solidification, unless handled with utmost care (which as a rule is difficult for beginners), an uneven application is obtained instead of a *smooth, thin film,* which naturally does not prove satisfactory. Therefore a method of applying the selenium must be found, one which will deposit it in a thin, smooth film, in place of the lumpy mass which is frequently obtained by the present method.

The writer has been conducting extensive experiments along original lines for the preparation of cells which may prove more reliable than those made at present, and in the near future hopes that he will be in a position whereby he can present a paper describing his results.

Tests for Selenium:

If the substance to be tested is a solid, dissolve it in water (about 10 to 15 cc.), by either crushing or heating the liquid. If a liquid, dilute with distilled water. Shake the mixture thoroly, by placing the thumb over the mouth of the test tube and shaking the contents vigorously. Add 10 cc. of Hydrochloric acid, and then introduce a small piece of tin or tin-foil (1 in. x ½ in.) into the mixture.

A freshly prepared solution of stannous (tin) chlorid may be added to the suspected solution in place of the hydrochloric acid and tin above mentioned.

After a few moments, if selenium is present, a light pink tint to blood-red discoloration will be visible around the surface of the tin, depending upon the amount of selenium present.

This test extracts all of the selenium present, therefore it is also a quantitative as well as qualitative test. It is very sensitive, being capable of detecting such a minute trace as 3/100,000 milligram of selenium if present.

Uses of Selenium:

So much has been said in previous issues of this journal regarding the uses of selenium as well as the application, that the writer will not go over the same ground as covered in these articles.

In 1873 Willoughby Smith noted that the electrical conductivity of selenium varied with light, the metal being about *500 times* as good a conductor under the influence of light as in the dark. This opened a very extensive field for research work among the investigators who were conducting experiments with this substance, and the numerous appliances developed by scientists have been covered in previous papers. The application of the electrical properties of selenium are still in the experimental stage and the future will undoubtedly reveal new apparatus which will depend principally upon these remarkable electrical properties.

Selenium has been used in the glass industry. In 1891 Wetz patented the use of selenium for producing red or orange stain in glass and in 1894 Spitzer employed selenites and selenates, in conjunction with a reducing agent, to color glass. Since then selenium has been used to produce red colored glass, particularly ruby glass, where the red must be clear, without a trace of green, as in railroad signal lights, and photographic dark-room lamps.

Various shades of glass may be obtained by combining selenium with gold and silver, and with opacifying metals, oxides and minerals, such as cryolit, fluorspar, etc. Selenium is also used as a decolorizer in white glass for discharging the green color due to iron.

Wasserman has patented a process for making dyestuff, by using salts of selenium in conjunction with organic salts.

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AT WAR WITH THE INVISIBLE.

(*Continued from page* 819)

cil, in solemn conclave assembled. listened with deep-breathing silence while I partly read, partly related, certain phases of my chance discovery and Firman's part in the great secret. Ingals, whose power as the keenest editorial mind in that great city was so well recognized that he had been selected as chairman of the advisory board, sat at the far end of the long, ebony table, his features twitching with a strong, inner excitement held in abeyance. His head nodded in tigerish acquiescence as I dramatically wound up with Firman's final words of advice to the council. I sat down quickly, my own heart beating discordantly as the vast import of the whole situation came back to me in an overwhelming surge.

There was silence for one brief moment. Then a deep murmur of voices arose. The

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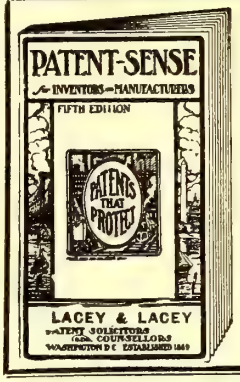
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☐ PLUMBING AND HEATING	☐ Auto Repairing ☐ Spanish
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next instant I saw Ingals rising from his seat without the formality of a request to the Council Chair.

"I move this body accept in its entirety the report of Mr. Elvan," he shot out in sharp, decisive voice, "and that we adopt unqualifiedly Professor Firman's suggestion, abiding decidedly in that scientist's ability to direct our next move!"

The positive ring of his tone imposed itself upon the overwrought nerves of us all. There was no time to reflect and deliberate. The surcharged air of the meeting seemed to have exploded with the lightning decision of Ingal's action. In sheer relief, it seemed to me, a sonorous voice somewhere in that august body rumbled out. "I second the motion!" and the next instant the council had accepted the die and cast it like a challenge in the face of the demon forces.

By Monday morning a startled universe heard aghast, and with mingled feelings of fear and hope, that the Martian insolence was to be defied, and that secret preparations were being perfected with all haste under the direction of a leading scientist.

Thursday noon was the time when the Martian ultimatum was to expire. Since 1 o'clock in the morning of that fateful day the laboratory in the university on Morningside Heights, now converted into a pulsating workshop, had been the scene of tremendous activities. Two by two, a thousand planes had stopt at Firman's windows, around which a screened landing platform had been erected, and received aboard sealed cases of materials and trained operators. As rapidly as they were equipt they departed to their assigned stations. By 10 o'clock the last pair of planes was at the platform. We piled the remaining cases aboard and climbed into one of the machines.

Ava was with me. She had insisted on coming and I had no desire to refuse her. Either we were to be successful, and my joy in the triumph would be heightened by sharing it with her, or we would fail, and then we could perish together in the midst of the cataclysm.

It was an hour pregnant with fatal possibilities, and our faces showed the strain. Even Firman, with his nerves of steel, reflected the general feeling. His eyes were sunk deep in their sockets and his prominent nose was still further accentuated by the hollows in his cheeks.

The scheme he had perfected was gigantic in its simplicity. The planes were stationed in pairs at equal distances above New York. On each plane was a sending and receiving station (tuned to the same wave-length as that of its mate) for a powerful helium ray. The two rays, crossing in the electrical field generated between the planes, reflected the images in their paths on sensitive selenoid plates within the planes. Thus, by covering the entire territory, we would discover the Martians when they landed to plant their contact points, *if Firman's plan did not miscarry.*

Eleven o'clock was the hour when Firman expected the invaders would begin their work in order to fulfill the threat of their ultimatum. Precisely on the second he flashed the order to the sentinel planes to open their batteries.

Our machine was stationed with its mate over Battery Park. As the order was given, and the powerful ray shot out of the crackling batteries, we bent over the selenoid plate with passionate eagerness. Ava's hand was in mine, our fingers intermingled in a clasp that drove every atom of blood from them. Our breaths came and went in short, agitated gasps. I stole a glance at Firman. His eyes were gleaming with deep intensity as he watched every tremor on the sensitive surface.

The area of our electric field included all of Battery Park and the greater part of the bay. The helium rays swept back and forth and ghostly outlines of ships passing thru the harbor and people walking in the park appeared on our plate. For ten minutes we kept our silent vigil, then suddenly our hearts leaped and a rush of blood to my head almost obscured my vision. *Two long, elliptical objects had dropt from the sky and were landing on the grass, a short distance from the water front!*

We would see distinctly every movement of the Martians inside their marvelous planes. The faithful ray penetrated every corner of the craft and pictured the details in spectral outline on the selenoid plate. We even saw the skeletons of the men thru their coverings of flesh, and it seemed as if some hideous creatures from the nether world had come to wreak unholy devastation upon us.

Firman stiffened, a haggard smile of triumph on his sharpened features. An instant longer he watched those phantom figures moving about boldly, confidence in their shield of invisibility making them utterly devoid of caution. Then I saw Firman's eyes crinkle with deliberate grimness, saw him motion to the gunner at his side, and saw the latter adjust his weapon to the range indicated by the finder on the selenoid. His fingers worked deftly, coolly. He nodded to the scientist.

With an audible sigh of satisfaction Firman uttered the word: "Fire!"

A deafening crash shook our plane. From somewhere below came the sound of splintering glass and metal, coupled with shrieks of agony. The crawling image on my plate broke, rose into a thousand fragments and fell in deathly silence. As in a nightmare I heard the next command: "Now the other!"

Again the long, slim gun whipt out its tongue of shooting flame, and from the ground the din of destruction rose in clamoring echo. The invisible fleet lay, a futile ruin, on the soil of the city it had come to destroy.

As those rising from the tortured dreams of a black night, we stared at each other, unable to speak in the first few moments of indescribable relief. Then Ava burst into tears and I took her in my arms.

"The Universe is saved!" I cried in an ecstasy of joy.

"Yes," agreed Firman; then added thoughtfully: "And the Martians take their place in that long blacklist of fools who would conquer the world by force!"

(THE END.)

COSMIC FORCE.

(*Continued from page* 829)

liberated, as with combustion in the form of heat. These crystalized specks of energy may be made up of complex vibrations that have either a positive or negative charge and cling together not only from their own inherent vibratory form but also by the action transmitted from the sun. One form of energy made up in a certain complex form would have its own characteristics, as copper might have ions like Fig. 1, and iron with ions as in Fig. 2, etc. This probably explains why different materials take a definite crystaline form, which is one of the principles on which metallurgy is based.

These specks of energy make up molecules that are in a fixt state and by means of chemistry and metallurgy we are able to disassociate the different classes of molecules by means of their characteristics. These sciences have been developed so that we can now understand a great many of

the characteristics of the energy about us and with which we have to deal, but the greatest understanding and enlightenment will come to us when we delve more deeply into the causes which produce all the conditions about us, that is, what is this universe in which we live and what perpetuates its existence?

ELECTRICITY TO PREVENT FUTURE FUEL CRISIS.

(*Continued from page* 825)

were supplied from one big generator. At first sight it would appear that a 40,000 H.P. machine would be needed to carry the load, but such is not the case. As a matter of fact a generator of *30,000 H. P., or even smaller,* would be ample, for the simple reason that all the industries would never need their full quota of power at the same time. The principle is the same as that which permits a bank to serve its depositors with a cash reserve that is very much less than its total deposits. When producing its own power each plant might occasionally need the full power of its generator, but for the most part the generator would be running below its rated capacity and therefore under conditions of poor economy and high coal consumption per horse-power. By combining all these small loads on to one machine, a much more uniform large load and a much higher operating efficiency are obtained. As a result, the large unit would consume *even less than from ½ to ¼ of the coal* consumed by the individual plants of the 80 industries.

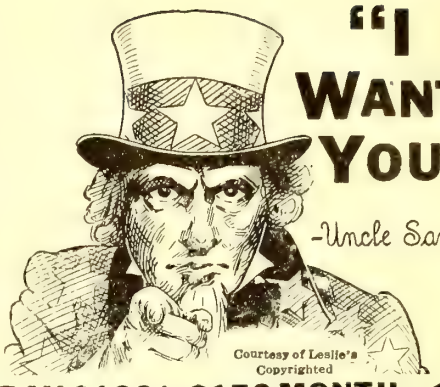
The same principle applies to cities as well as to plants, and if, therefore, several cities were supplied with power from a single system (obtaining its electrical energy from several large steam and water-power generating stations), the saving in fuel as compared with present conditions would be truly remarkable.

Small generators must necessarily be near their loads and the coal they need hauled to them. This, however, is not the case with large machines generating enormous amounts of power and capable of supplying the demands of entire cites. It is thoroly feasible to place the generator at the mine and transmit the electric energy over wires, thus eliminating railroad transportation altogether. The bee-line distance between New York City and the anthracite regions is but 100 miles. Electricity is at this time being transmitted over 200 miles in several American systems, and in one case the distance is over 400 miles. How gratifying it would be at this time if New York's power were independent of railroads and tug-boats!

But where central generating stations had to be located away from the mines, as in many cases it will still be necessary for some time to come, it would obviously be a very much simpler matter to supply with coal a few large plants equipt with every modern time- and labor-saving device than to distribute coal to a large number of small plants situated in all sorts of inconvenient locations and without proper facilities for rapid handling of the fuel. Much of our present trouble is due to the difficulties incident to rehandling the coal-waiting cars, frozen coal, an insufficient number of trucks, teams, and men, etc. Such difficulties would be entirely eliminated were the bulk of the coal to go to a few central points.

Passing now to the fifth point, the electrification of a large portion of our railroad system (no one expects that all of our railroad mileage will be operated electrically during the present century) would be the greatest single step that can be taken in the direction of fuel economy. *American railroads consume nearly 150,000,000 tons of coal annually, nearly one-quarter of our entire output.* Much of this coal consumption could be eliminated by the use of water-power, and almost as much could be saved by generating power in efficient, steam-operated, central station plants, instead of in the naturally wasteful steam locomotives. Some idea of the possibilities can be obtained from the fact that the Chicago, Milwaukee and St. Paul Railroad *saves* annually *a half a million tons of coal and several hundred thousand barrels of fuel oil* by operating 440 miles of its line by means of hydro-electric power.

Equally important, from the stand-point of preventing a recurrence of the present fuel crisis, would be the great increase in traffic capacity that electrification would secure for our railroads. The steam locomotive has about reached the limit of its power and therefore freight trains have also about reached the limits of their length and speed. But with electrical operation of the railroads there is practically no limit to the amount of power that can be applied to a single train. Electric locomotives *several times more powerful* than the largest steam locomotives are already in operation, and still larger ones can be built when occasion demands. With more power available longer trains could be operated at higher speeds, which means that more freight could be hauled in a given time over existing rails.



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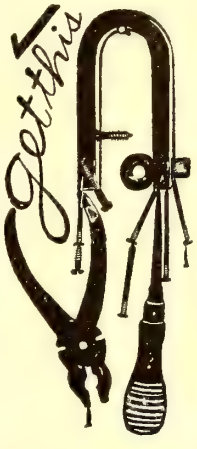
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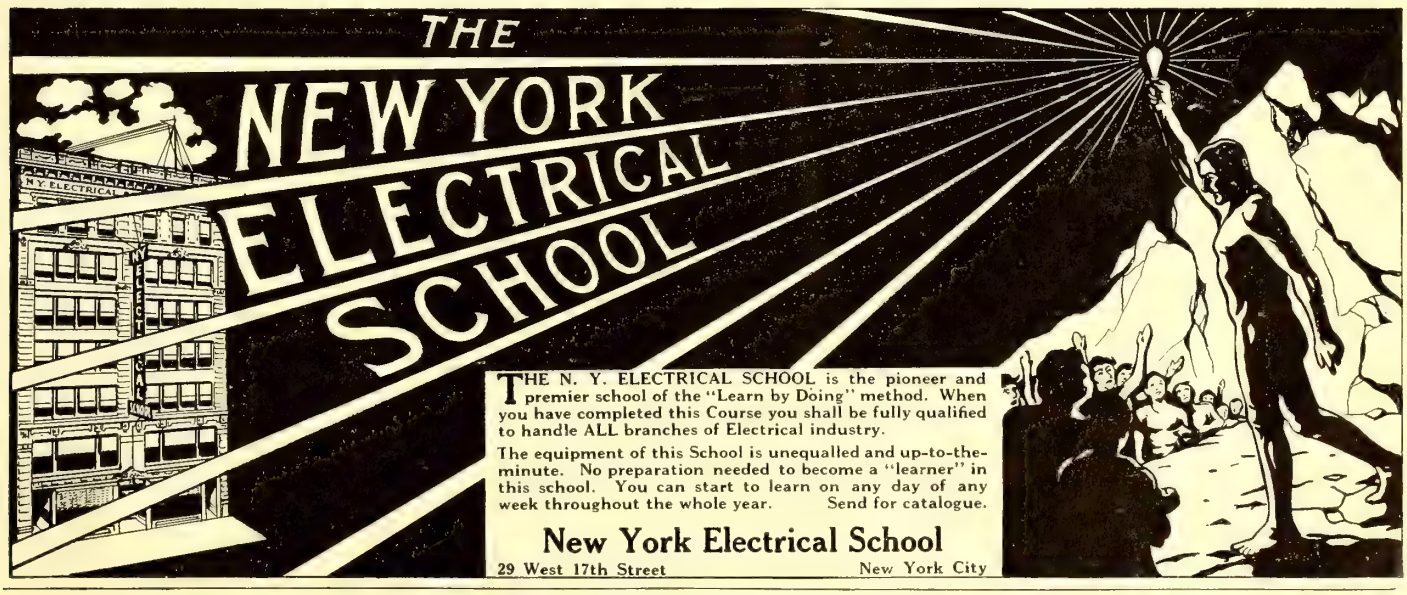
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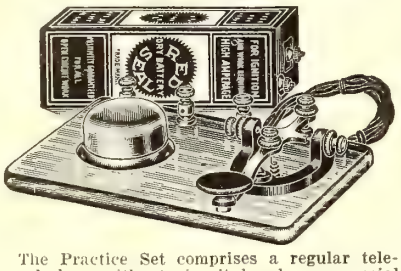
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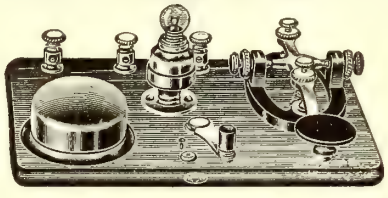
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This fact is well illustrated by the experience of the Norfolk and Western Railroad. Conjestion occurred on a particularly mountainous division of this road because, with three of the largest steam locomotives on each of the long coal trains, speeds of over 7 miles an hour could not be maintained up the steep grades. Electrification of this division was finally decided on, and now electric locomotives haul the trains up the grades at a rate of 14 miles an hour, thus *doubling the capacity* of this division.

Electric operation of the railroads would also speed up the traffic in several other ways. Better time can be made in tunnels, because there is no smoke to hamper the trains. Cold weather has no effect on electric locomotives, because there is nothing about them to freeze up. Electric locomotives are more easily handled than steam locomotives, and switching operations are more quickly performed. Furthermore, they are ready for service without previous attention; they spend less time in the round house for inspection, overhauling and repairs; and, as statistics prove, they maintain their schedules better. All of these things would assist in relieving the present situation.

What effect the reduction in the amount of coal to be hauled would have on railroad service is difficult to determine, but it seems evident that if coal were not today such an important item of freight, the railroads would be easily able to handle the necessary amounts of food, munitions, raw materials and other essential materials.

This discussion has been confined to the factors conspicuously involved in the present fuel crisis—namely, the shortage of coal and the railroad congestion—but the advantages indicated are not the only ones that would be obtained by general electrification by any means. In addition, the cost of power would be greatly reduced; power would be available to millions of people now living outside areas served by electric transmission lines; and an army of power engineers, miners and transporters and handlers of fuel, would be released for other duties. Indeed, the saving in manpower would be one of the most beneficial results.

There is nothing visionary in what has been said. The elements of a general electrification of the nation are all in our hands, and in many places, notably thru the Southern and the Pacific Coast States, the initial steps are well under way. It is the economical thing to do, and now, since the people of the United States have seen what can happen under the old system, it is certain to be done. Many readers of this article will undoubtedly live to see the plan well on the road to realization.

THE TELAUTOGRAPH—WHAT IT IS.

(*Continued from page* 823)

Gray's Telautograph.

The object of the invention by Prof. Elisha Gray, in 1893, was to overcome the difficulty heretofore experienced and provide a writing telegraph or telautograph in which the receiving pen would operate simultaneous with the transmitting pen and produce a facsimile of whatever matter was written by the operator, thereby rendering possible telautographic transmission of any kind of characters and sketches. Subsequent to this numerous patents were granted to Gray and others for minor improvements and for different forms of telautographs, but no appreciable change was made in the fundamental principles employed until about 1899.

The Modern Telautograph Principle.

About that time the Gray National Telautograph Company, from experience previously obtained and at the earnest solicitation of Mr. George Steele Tiffany, the chief experimental engineer of the Company at that time, decided to abandon entirely the old step-by-step method, which until then had been considered the only practical means of obtaining facsimile reproduction. All of the immense amount of work and mental effort of the inventors for the previous fifteen years, representing as it also did an expenditure of hundreds of thousands of dollars in development costs, was thrown into the scrap heap and Mr. Tiffany undertook to devise an entirely new form of telautograph to operate on the theory of recording varying current strengths very much like a recording voltmeter.

In this "Variable Current" instrument the motions of the transmitting pencil causes variations in strength of a continuous current, which, traversing the line wires, affects at the receiving instrument changes in strength of electro-magnets by which the pen is moved in unison with the transmitting pencil.

After several years of work the first telautograph built on this principle was completed, and while crude and cumbersome in its construction, it performed its work with a certain degree of reliabilty and satisfaction. One by one electrical and mechanical difficulties encountered in the perfecting of such an instrument have been overcome by Mr. Tiffany and others asociated with him, and the present telautograph is the practical embodiment of the many improvements devised. In this process of improving three distinct mechanical types of instruments were developed. The first type was put in use in 1901 and was later succeeded by an improved model in 1904, which in turn was superseded by the model of 1907, which in all general features is the same instrument that is in successful operation today.

Construction Problems Solved.

The greatest problem encountered in the improving and refining process of the telautograph has been to design an instrument which would be sensitive enough to respond to the smallest movement of the transmitting stylus and yet not be delicate or fragile but substantially built; an instrument that would not be deranged, but would preserve its adjustment under the most severe conditions of operation. Also, in order to make it a commercial instrument in every sense of the word, it had to be made thoroly fool-proof against careless handling on the part of the operators and against inquisitive meddling of irresponsible people.

That this problem has been solved in the present telautograph may well be indicated by the many strenuous services to which it has been put. For example, it has been mounted on the gun carriage of the heaviest type of Coast Defense gun not more than twenty inches away from the barrel and its adjustments have not been disturbed by the blast and concussion from the firing of the gun. It is also used in rolling mills of steel plants, where it is subjected to heavy and continuous vibration without experiencing any defects in service.

Telautograph Uses

The telautograph in no way replaces, nor is it a competitor of the telephone, because it is not used for communications where ordinary conversation will suffice for the transaction of business. It is only used when the message or order requires accurate or secret transmission or being in written form to prevent misunderstanding thru the deficiencies of the human element. It is more a competitor of the messenger boy with his written momorandums or the pneumatic tubes with their written messages on slips of paper.

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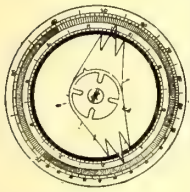


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In hotels, telautograph lines from the telephone switchboard forward guests' orders and complaints to the various hotel departments, which execute and attend to them. It is used between the telephone switchboard and front office to get information as to room numbers of the guests when they are called from outside; between telephone switchboard and bell captain for sending paging messages to locate guests when called on the telephone or called upon and the guests are not in their rooms; between telephone switchboard and service pantry, kitchen and bar for ordering meals and drinks to be served in the rooms; and for various other services far too many to be enumerated.

In department stores the telautograph is a valuable means of communication between the sales floor and reserve stock department in sending orders for replenishing stock in retail departments; for obtaining credit information between the salespeople or tube centers and the credit department when customers desire to charge goods purchased; and between the complaint and delivery departments for tracing out packages lost in delivery or sent to the wrong address.

The railroads make use of telautograph service at passenger terminals for announcing the arrivals and departures of trains, giving the time of arrival or departure and the tracks on which they will arrive or depart. These messages go simultaneously to every department that has to do with the handling of the incoming mail, express, baggage and passengers, and serve also as information to the public. For engine despatching there are telautograph lines between the engine despatcher's office and the roundhouse or engine tower for ordering and assigning engines for outgoing trains and for information as to when and on what track to report. They are further used for instructing yardmasters, station platforms, switchmen, etc., in regard to the makeup of trains.

In steel plants reports of chemical analysis of every "heat" of steel tested in the laboratory are telautographed simultaneously to the rolling mills, shears, mixers, blooming mills, billet mills and shipping department, so that the quality of each "heat" of steel is correctly known at every point where it is handled and the steel may be assigned to an order or orders for which its contents qualify it; also for recording the movements of steel billets from place to place with their distinguishing serial "heat" numbers, likewise for the purpose of identifying each lot.

In commercial, wholesale and retail houses telautographs are used for ordering articles to be brought to sales floors from stock rooms; for issuing shipping orders from order department to stock room or shipping room; for ordering goods short on incomplete orders between packing department or shipping department and stock rooms; for obtaining credit information between sales department or ordering department and credit office; and for many other uses too numerous to detail.

The foregoing are a few typical services that the telautograph renders to its users, but it by no means represents all that this wonderful instrument accomplishes in the saving of time and money or by increasing efficiency in operation of business and industrial enterprises.



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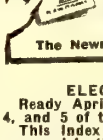
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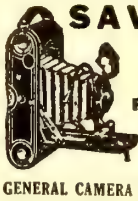
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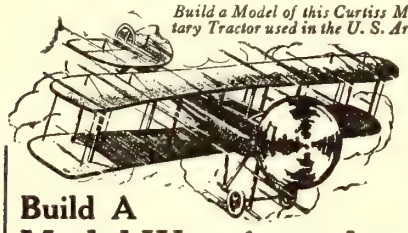
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THE PHENOMENA OF ELECTRICAL CONDUCTION IN GASES.

(*Continued from page* 830)

metal box thru insulators and upon one a metal plate P is placed, while upon the other a very fine strip of gold leaf, hardly larger than a thread, is placed so that it hangs at an angle with the vertical. In practise the terminal A is connected to the body whose charge is to be measured, and the plate P is charged by a constant source to about 200 volts. The attraction between plate P, and the gold leaf L, holds the leaf at a certain angle which decreases, and the leaf starts to fall as soon as the charge leaks away from the body to be measured, and hence lowers the potential of the gold leaf. By using a telescope attachment to observe the leaf, an exceedingly minute loss of charge may be measured and a change in potential of even .0001 (one ten-thousandth) of a volt detected.

By such simple apparatus much has already been done. The most important qualities of the electron, namely its mass and charge, have been measured, and a careful study of different positive ions has been made in an effort to isolate the positive unit ol electricity which corresponds to the negative electron. So far no ion smaller than a molecule of hydrogen has been discovered having a positive charge of electricity, and this is of course a hundred thousand times larger than the electron.

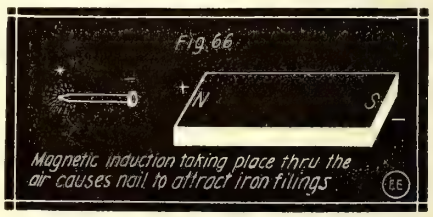
Besides these qualities of ions, four very important facts about their behavior have been studied. The velocities of different kinds of ions has been measured, and their rates of recombination and diffusion. By recombination is meant attraction and reunion of positive and negative ions to form a neutral molecule. By diffusion is meant the thinning out of the ions due to their being attracted to the walls of the containing vessel. Last, but not least, the phenomena of collision of ions has been investigated and it has been found that when ions collide with neutral molecules, fresh ions are formed. These various things represent the main phenomena which have been studied in this great field, the importance of which is just beginning to be recognized. The first question perhaps that anyone would ask is —how are the ions formed in the first place? The answer is that, according to P. J. Thomson's theory, the same thing happens in gases that happens in liquids; in other words, when a molecule falls under the influence of X-ray, heat or some other ionizing agent, the molecule is torn apart in such a way that one or more electrons fasten themselves to one part, making it negatively charged, and leaving the other part positive. These parts then are the ions, and when they travel towards any particular point, constitute a current. A charged body placed in their presence loses its charge thru having it carried away, little by little, by them. Such a slow loss of charge is the leak which an electroscope is so often used to detect.

Besides its practical importance the study of the ionization of gases should go far toward revealing what electricity and matter really are, especially as a gas is the simplest form in which matter exists.

EXPERIMENTAL PHYSICS.

(*Continued from page* 834)

found to no longer hang horizontally (except at the equator), but one end *will dip* (the N pole in northern latitudes and the S pole in southern latitudes), the amount of dip, technically called *inclination,* being equal to the latitude. Thus the dip needle can be used to determine latitude (approximately). The miner uses it to determine the presence of magnetic ores. At most places on the earth the magnetic needle does not point true north, but instead a

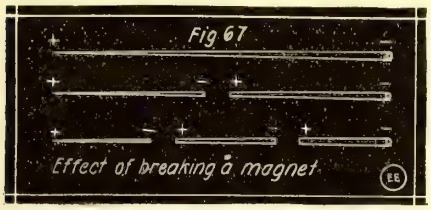


Magnetization by Induction Renders the Nail Magnetic—It Thus Has the Power to Attract Iron Filings or Other Iron, Steel and Nickel Particles. It is Magnetized by the Bar Magnet N—S.

little to the east or west of north. Hence, if we wish to know direction accurately, we must add the correction (called declination) to allow for this, i. e., the *declination* is the *difference in direction between true north and the direction in which the magnetic compass points.* Since the declination varies for different places from year to year, the variations are recorded, so that when surveys are made the true north-south direction can be determined and the land mapt accurately.

EXPERIMENT 70—Place a tack against a magnet and now bring this tack near another tack. The first tack will act as a magnet. Thus we see that when a piece of iron is put in contact with a magnet, it becomes *a magnet itself* and will attract iron. The reason why, then, that a magnet, when dipt into iron filings or nails, lifts a number of them attached to one another is that each becomes a distinct magnet. This influence of a magnet over iron or steel by which it is made a magnet extends

to a considerable distance from the magnet and is called *magnetic induction*. That magnetic induction takes place even tho the iron does not touch the magnet, which is shown as follows: Place a bar magnet upon a table and at one end, in line with and about an inch away, put a large iron nail. Bring some iron filings near the end



Did You Ever Break a Steel Magnet? If You Have, Then Upon Testing Each New Piece Formed, With a Compass Needle, You Have Learned that Each Piece Has a North and South Pole, as This Sketch Shows.

of the large nail furthest away from the magnet and observe that it attracts the filings. If you test this end of the nail with a compass you will find that its polarity is *opposite* to that of the magnet pole nearest it. (See Fig. 66.) It is because of this property of induction that magnets attract iron. When the iron is brought near the magnet, the nearer end becomes *polarized oppositely* to the pole of the magnet, and then, because of the force of attraction between unlike poles, the iron is attracted.

EXPERIMENT 71—Magnetize a needle. Determine its polarity. File a notch at the middle and break it. Examine for polarity again and compare with the polarity of the needle before breaking. Break one of these pieces in the middle and proceed as before. It will be found that each piece in turn becomes a true magnet with poles, as in Fig. 67. Thus every new magnet has a N and a S pole.

EXPERIMENT 72—If a needle is magnetized and then heated to redness by being held in the flame of a Bunsen burner, it will be found, on testing after cooling, that it has lost its magnetism. Try to pick up a red hot piece of steel with a magnet. It will be found that the red hot piece of steel is *non-magnetic*, i. e., induction can not take place and the magnet will not pick it up.

EXPERIMENT 73—The fact that a freely swinging magnet assumes a north-south position shows us that the earth acts as a gigantic natural magnet, with a — pole at the north and a + pole at the south. Naturally one would expect that the earth should have an inductive action, and this can be verified as follows: Select a soft iron rod about a half inch in diameter and about two feet long. Holding it horizontally in an east-west line, present its ends successively to the N and S ends of a compass. Both ends will attract each end of the needle, showing that the bar is not polarized. Next hold the bar in a north-south line and dip it an amount equal to the *inclination*. On bringing the compass near we notice repulsion at one end and attraction at the other end, showing that the bar is now magnetized. Bring the bar again into the first horizontal positon and again it will attract both ends of the needle, showing that it is unpolarized. Place the bar again at the dip angle and in north-south position and give it a few sharp blows with a hammer. Now place it in the first horizontal position, and on testing we find the bar polarized. Now hold the bar horizontal in east-west position and give it a few sharp blows and it will be found to have lost its polarity. This is a conclusive proof of the inductive action of the earth and also furnishes us with phenomena to be considered in formulating a theory of magnetism.

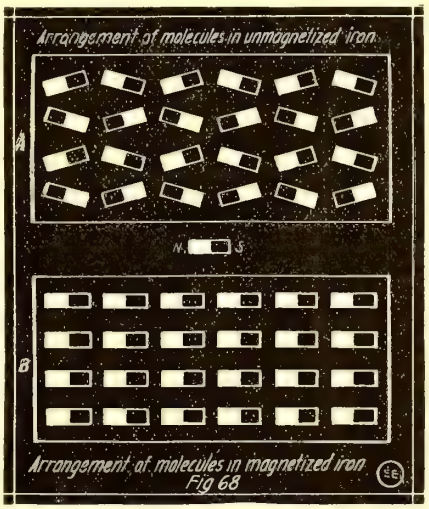
Molecular Theory of Magnetism.

These last few experiments are very important, in so far as they substantiate our theory. In accordance with the molecular theory of matter we assume that a magnet consists of very many minute elementary magnets, arranged as in Fig. 68-B, and an ordinary piece of soft iron also consists of small elementary magnets, but arranged as in Fig. 68-A, i. e., when iron is *unmagnetized* its molecules are arranged helter-skelter, whereas when *magnetized* they are all lined up with their respective + ends in one direction, so that they act as one large north pole, and likewise for the — poles. Obviously, if we break a magnet in half, each piece will be a magnet, and this might be kept up until the original magnet is broken up into its small elementary magnets. This agrees with our theory. If we heat a magnet (since heat causes the molecules to move more rapidly) the magnetism is lost, because the elementary magnets are disarranged from their straight line position of Fig. 68-B to the position of Fig. 68-A.

Induction occurs in accordance with our theory; also when the + end of a magnet is brought near a piece of iron all the — ends of the elemental magnets are attracted to it, acording to the law of attraction, and hence these small magnets line up as in Fig. 68-B. In experiment 73, on striking the iron bar, the tiny molecular magnets were jarred, and hence lined up, due to the earth's induction when placed in a north-south line, while when in the east-west position they were jarred out of the north-south line. As a final conclusive proof of the exactness of the molecular theory, stroke a needle once with a magnet; bring the needle up to a compass and note the deflection; stroke once more and note the increased deflection. After stroking several times it will be found that the point is reached when further stroking no longer increased the deflection, i. e., the needle has reached its point of magnetic saturation. Since the point will be reached when all the little elemental magnets are lined up, no further stroking will cause any change, hence no increase in strength.

The molecular theory of magnetism is a beautiful example of how well the modern physics theories hold, how they explain phenomena, and how they are themselves strengthened by these phenomena. It is because of this that we adhere to them with so much faith and swear by them. Most of them are so well establisht that we vouch for them as we would for facts.

(To be continued)



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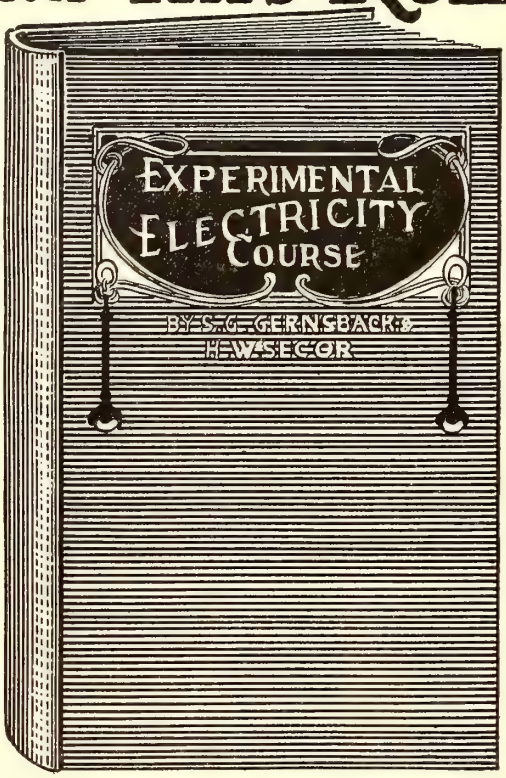
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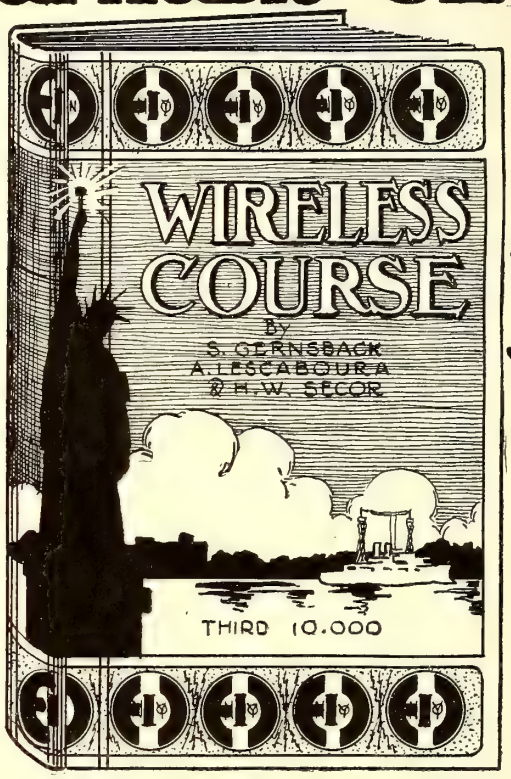
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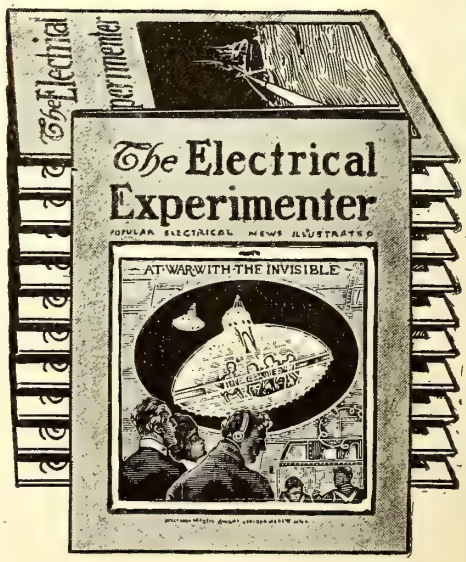
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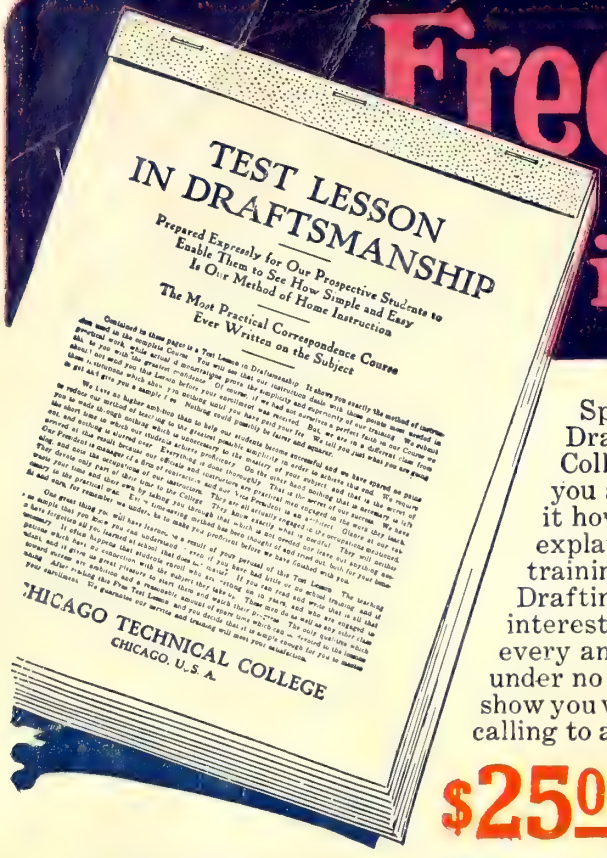
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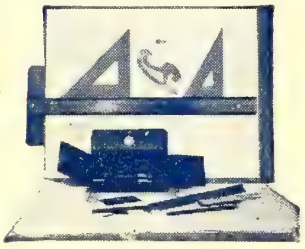
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